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The effects of morphological and syntactic knowledge on reading comprehension in Spanish speaking children

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Abstract

Reading comprehension is a complex task requiring many underlying skills. Syntactic awareness and morphological awareness are two such skills that have been shown to be related to reading comprehension. However, the majority of studies have been carried out in English, and very few have explored these skills in mono- lingual Spanish speaking children. Here we explored to what extent syntactic aware- ness and morphological awareness contributed to text comprehension in Spanish. 501 typically developing Spanish speaking 4th graders were assessed on non-verbal intelligence, word and nonword reading, oral vocabulary, morphological and syntactic knowledge, along with reading comprehension ability. After excluding children with poor decoding or low non-verbal intelligence, 234 children were retained for analysis. Multiple linear regression modelling was used to assess the unique contribution of each variable to reading comprehension. As per findings reported in English, syntactic knowledge was a significant predictor of comprehension after controlling for age, gender, non-verbal IQ, word reading and oral vocabulary, as well as morphological knowledge. In contrast, and contrary to results normally reported for English speaking children, morphological knowledge did not explain any variance in reading comprehension beyond that explained by the control variables. These results highlight the important contribution of syntactic knowledge to text comprehension in Spanish speaking children, as well as the importance of undertaking research in languages other than English.

Keywords Morphological knowledge · Reading comprehension · Spanish · Syntactic knowledge

Introduction

Poor reading comprehension has lifelong detrimental effects, including the areas of education, employment, health and relationships (Hinshaw, 1992; National

Research Council, 2012; NICHD, 2000). For this reason, it is important to understand the processes underlying reading comprehension, and much effort has been invested in this enterprise (Levesque, Kieffer, & Deacon, 2017). One of the most widely known models which attempts to explain reading comprehension is known as *the simple view of reading* (Gough & Tunmer, 1986; Hoover & Gough, 1990). This model defines competence in reading comprehension as the product of two necessary characteristics: decoding and oral language comprehension. Thus, according to this model, reading comprehension requires the accurate identification of individual written words (decoding) along with higher level linguistic abilities, such as syntactic and semantic processing (among others). The combination of these two factors ultimately makes it possible to extract meaning from written text (Cutting & Scarborough, 2006).

Despite decoding being one of the two main factors proposed to underpin reading comprehension, there is strong evidence that decoding and reading comprehension operate relatively independently and that the factors that predict their development are different (Altani, Protopapas, Katopodi, & Georgiou, in press; Kim, 2015). Thus, phonological processes have greater predictive power in reading decoding whereas vocabulary and grammatical aspects have a more prominent role in language comprehension (Perfetti & Stafura, 2014; Ricketts, 2011). A logical consequence of this theoretical approach is that the relationship between word reading fluency and reading comprehension becomes weaker with age (Yovanoff, Duesbery, Alonzo, & Tindal, 2005). Consequently, the strongest relationship between reading comprehension and decoding is found in first grade, when children learn to read (Gentaz, Sprenger-Charolles, & Theurel, 2015). After this point, other factors, such as oral language, exert a stronger influence on reading comprehension.

Consistent with this idea, oral language has repeatedly been shown to be linked with reading comprehension (e.g., Cutting, Materek, Cole, Levine, & Mahone, 2009; Catts, Fey, Zhang & Tomblin, 1999; McCardle, Scarborough, & Catts, 2001; Nation & Snowling, 1998). In particular, specific comprehension deficits have been shown to be associated with oral language weaknesses (Cain, Oakhill, Barnes, & Bryant, 2001; Catts, Adlof, & Weismer, 2006; Nation, Adams, Bowyer-Crane, & Snowling, 1999; Nation, Cocksey, Taylor, & Bishop, 2010; Nation & Snowling, 2000). Consequently, in order to better understand how read- ing comprehension develops researchers have focused on its relationships with a number of high level linguistic capabilities.

In one of the first works in this area, Bowey (1986) carried out a correlational study in a sample of fourth and fifth grade children which looked at the relationship between reading comprehension and syntactic awareness. Syntactic awareness is considered to be knowledge of the rule system in a particular language that governs how words are combined into larger meaningful units, such as utterances, phrases or sentences (Brimo, Lund, & Sapp, 2018). Bowey found a significant relationship between reading comprehension and syntactic awareness even after controlling for vocabulary and decoding skills. In another classic study, Demont and Gombert (1996) followed 23 typically developing French speaking preschool

children for 3 years, performing a total of six evaluations (one in kindergarten, two in first and second grade and one in third grade). In each evaluation data were collected on metalinguistic skills related to phonology and syntax, as well as measures decoding and reading comprehension ability, along with intelligence and vocabulary knowledge. After controlling for intelligence and vocabulary knowledge, these authors reported that syntactic awareness was the best longitudinal predictor of reading comprehension.

Subsequent works have compared the association of syntactic factors to levels of competence in reading comprehension by comparing children with good comprehension to *poor comprehenders*—a term used to describe children who have a weakness in reading comprehension which is unexpected based on what one would predict from their word reading skills and general ability. It has been estimated that poor comprehenders make up approximately 10% of the school-aged population between 7 and 11 years (Yuill & Oakhill, 1991). Nation and Snowling (2000) examined the influence of syntactic awareness on reading comprehension in a sample of 30 nine-year-old children, equally divided into normal readers and poor comprehenders. All children were matched on age, decoding skills and nonverbal IQ. These authors reported that, compared to normal readers, the poor comprehenders exhibited inferior performance in the syntactic-related tasks. Waltzman and Cairns (2000) reported similar results in a sample of 63 English speaking third grade students. More generally, there are a number of other studies which have shown that spoken syntax levels contribute differently to reading comprehension in children with average reading comprehension compared to children with below-average reading comprehension (e.g., Brimo et al., 2018; Cutting & Scarborough, 2006; Stothard & Hulme 1992). And while some studies have failed to find a link between syntactic awareness and reading comprehension (e.g., Cain 2007, Cain & Oakhill 2006), a recent meta-analysis examining a total of 14 articles found that "there was a significant difference between children with average and below–average reading comprehension on spoken–syntax assessments" (Brimo et al., 2018, p. 431). Thus, the balance of evidence suggests that higher levels of syntactic awareness may facilitate better reading comprehension.

Morphology is another linguistic ability which has been linked to reading comprehension. Morphological awareness can be defined as "the awareness of and ability to manipulate the smallest units of meaning in language" (Levesque et al., 2017). Many studies have reported a link between morphological awareness and reading comprehension in typically developing children. For example, Deacon and Kirby (2004) carried out a 4 year longitudinal study with 143 English speaking Canadian children which commenced in Grade 2 and finished in Grade 5. Morphological awareness was assessed using a verb tense manipulation task. These authors found that morphological awareness contributed significantly to reading comprehension, after controlling for prior measures of reading ability, verbal and nonverbal intelligence, as well as phonological awareness. More recently, Kirby et al. (2012) analyzed the relationship between morphological awareness and the development of reading comprehension in a sample of 103 children who were followed from kinder- garten to third grade. Morphological awareness measured at both grade 2

and grade
3 was found to predict grade 3 reading comprehension after controlling for nonverbal IQ, oral vocabulary and phonological awareness. Furthermore, grade 3 morphological awareness continued to explain unique variance in reading comprehension after controlling for both word reading fluency and accuracy.

Morphological awareness has also been linked with reading comprehension in children classified as poor comprehenders. Tong, Deacon, Kirby, Cain, and Parrila (2011) separated a group of 132 English speaking Canadian 5th graders into three groups—unexpected poor comprehenders, expected average comprehenders and unexpected good comprehenders—based on their performance in a number of reading and cognitive tasks. Morphological awareness was assessed by evaluating inflectional and derivational morphology. These authors concluded that that children with unexpectedly poor reading comprehension have specific difficulties with morphological awareness in the presence of good phonological awareness skills. Interestingly, these authors noted that the weakness was present in derivational, but not inflectional morphology.

Despite arguing to this point for the existence of relationship between reading comprehension and both syntactic and morphological awareness, it should be noted that compared to other factors (such as decoding skills, and vocabulary knowledge) syntactic and morphological awareness have received relatively limited attention from studies exploring reading comprehension. In evidence of this, a recent selective meta-analysis which examined 48 studies related to reading comprehension did not include syntactic processing measures (Kudo, Lussier, & Swanson, 2015). Similarly, Spencer, Wagner, and Petscher (2019) acquired data from a sample of over 80,000 children to examine the reading comprehension and vocabulary skills of children who were identified as having poor reading comprehension despite adequate decoding. Neither vocabulary nor morphology were included in this study. Moreover, Levesque et al. (2017) recently stated that "the relation between morphological awareness … and reading comprehension remains in need of specification" (p. 1), while Rastle (2018) stated that morphology "has been largely neglected in theories of reading acquisition" (p. 1).

The reduced amount of data regarding the effects of syntactic and morphological awareness on reading comprehension (compared to other factors, such as decoding) is exacerbated by the fact that the majority of studies to-date which have examined these relationships have been carried out in English. It has been consistently pointed out that English orthography is very different from many other languages in terms of transparency. Share (2008) has argued that because of this common models of reading developed using evidence gathered from English-speaking participants are "ill equipped to serve the interests of a universal science of reading" (p. 584).
But differences between English and other languages do not only affect transparency and the decoding component of reading. Different languages also differ from English in relevant ways in syntax and morphology. This is the case of Spanish. For example, the inflectional morphology between English and Spanish varies greatly (Gutiérrez-Clellen, Restrepo, Bedore, Peñña, & Anderson, 2000; Vivas, 1979). Spanish verbs are inflected for tense, person, number, mood, and aspect and these

inflections vary according to the verb stems, of which there are three types. In contrast, English verb inflections are far less rich and do not change for mood, or aspect, and only change for third person singular (e.g., I *jump* versus he *jumps*). Furthermore, Spanish verbs are inflected for past, present and future tenses whereas English verbs are only inflected for the past (e.g., the suffix -ed). Spanish also marks articles for gender and number, something which is not necessary in English (see Gutiérrez-Clellen et al., 2000, for a detailed discussion of the differences in morphology between the two languages). Consequently, the Spanish morphological system can be considered to be far richer than that of English. Thus, it is plausible that morphological awareness may be more strongly linked to reading comprehension in Spanish, relative to English, given that morphological processing in Spanish will provide a richer framework on which to construct the overall meaning of a text being read.

In terms of syntax, again there are important differences between the two languages. For example, English is a strict subject-verb-object (SVO) language in which the subject must precede the verb, which in turn must precede the object (one exception are imperative sentences, such as "eat your vegetables"). Spanish is also considered to be an SVO language. However, as per most romance languages, this order is variable, and topicalization and focus can take precedence over syntax. Thus, for example, to emphasize who did a particular act, in English one might say "*he* did it", placing emphasis on "he". In contrast, in Spanish it would be common to alter the normal SVO order, placing "he" at the end of the sentence as in "lo hizo él" [literally, did it he], even though "él lo hizo" [literally, he did it] is also syntactically correct. There are many other differences between the two languages in terms of syntax, especially in the use of pronouns—for example subject, pronouns are optional in Spanish. Consequently, syntactic awareness may be less important for reading comprehension in Spanish, compared to English, given the less rigid structure that exists in Spanish.

Although it is not difficult to find studies which have explored the factors related to reading comprehension in monolingual Spanish speaking children (e.g., López-Escribano, de Juan, Gómez-Veiga, & García-Madruga, 2013), given the important differences between English and Spanish just described in terms of syntax and morphology, surprisingly few studies have included these two factors. We should also add that there are a various studies using bilingual children which have looked at the effects of syntactic and morphological awareness on reading comprehension (e.g., Silverman et al., 2015), but the results of these studies almost certainly reflect an interaction between the two languages, or focus on the learning of the non-native language, and as such, are generally uninformative from the point of view of monolingual children.

Nevertheless, there are two studies which have looked at syntactic awareness and reading comprehension in monolingual Spanish speaking children (Bizama, Arancibia, Sáez & Loubiès, 2017; Salvador Mata, Gallego & Mieres, 2007). In the first of these, Bizama and colleagues evaluated a group of 161 children from grades 2 to 4 who came from a socially disadvantaged background and attending schools classified as vulnerable. These authors reported that a medium-to-large correlation existed between syntactic awareness and reading comprehension, although they

did not control for any other variables apart from age and intelligence. Furthermore, it is worth noting that the children in this study scored below what would normally be expected for their age in both areas, no doubt reflecting their disadvantaged back- ground, and thus these results are not generalizable to typically developing children. In the second study, Salvador Mata and colleagues evaluated a sample of 166 children from southern Spain taken from 5th and 8th grades (mean ages 10;9 and 13;8, respectively). In regression analyses controlling for lexical knowledge and phono- logical awareness, these authors found that syntactic awareness, but not morphological awareness was a significant predictor of reading comprehension. Nevertheless, despite the large age difference within the sample (3 years), these authors did not report controlling for age. Thus, one must interpret these results with caution.

Turning now to morphological awareness, although some recent studies have examined its relationship to decoding in Spanish speaking children (D'Alessio, Jaichenco, & Wilson, 2018; Suárez-Coalla, Martínez-García, & Cuetos, 2017), apart from the previously described study by Salvador Mata et al. (2007), we are unaware of other studies that have examined the relationship between reading comprehension and morphological awareness in monolingual Spanish speaking children.

In summary, evidence exists which suggested that syntactic and morphological awareness are related to reading comprehension (e.g., Brimo et al., 2018; Kirby, et al., 2012), although the relationship between these two factors and reading comprehension has been less studied than other factors, such as decoding and vocabulary knowledge (Kudo et al., 2015; Levesque et al., 2017; Rastle, 2018; Spencer et al., 2019). Furthermore, even fewer studies exist which have examined these relationships in monolingual Spanish speaking children. Nevertheless, given the large number of differences between English and Spanish in both syntax and morphology, it cannot simply be assumed that results reported for English would transfer directly to Spanish. Thus, the aim of the present study was to explore the relationship between reading comprehension and both syntactic and morphological awareness in monolingual Spanish speaking children.

In terms of the developmental trajectory of language skills in Spanish, although children have generally acquired the major structures of the language by 6 years of age, they have nevertheless not fully developed their expressive oral language skills (López-Ornat, 2011). It is from this age, known as the "late stage", that children's skills in discourse, along with reading and writing increase (Bavin, 2009). Thus, we opted for an older sample to ensure that oral language skills were well developed. This also ensured that the children would have passed from the stage of *learning to read* to the stage of *reading for meaning*. Consequently, in the present study, we were interested to determine the degree to which both syntactic and morphological awareness contributed to the level of competence in reading comprehension in typically developing fourth grade monolingual Spanish speaking children. Based on results reported from studies largely carried out with English speaking children, we expected that both syntactic and morphological awareness would be related to reading comprehension (e.g., Brimo et al., 2018; Kirby, et al., 2012). In particular, given that the Spanish morphological system is richer than that of English, we expected

that morphological awareness would play an important role in reading comprehension, even after controlling for syntactic awareness. Additionally, given the robust and repeated finding that syntactic awareness is related to reading comprehension in English, we also expected that this ability would be related to reading comprehension in Spanish.

Methodology

Participants

The initial sample comprised 501 Grade 4 students (234 girls, 267 boys) with a mean age of 9 years, 4 months (*SD* = 6 months, range: 7 years, 11 months—10 years, 11 months) at the commencement of the study. All children were recruited from schools located in and around the southern Spanish city of Seville, Spain's fourth largest city. A total of 20 schools took part in the study with the majority of these being public (14), but there were also 5 semi-public (known in Spain as "colegios concertados") and one private school. The schools were selected to be approximately evenly distributed geographically throughout the greater Seville region. Although three schools were located in disadvantaged areas, the remainder could be considered to be located in areas of average socio-economic status. The mean number of fourth grade classes per school was 2.2 (range 1–5, mode, 1). The initial sample was drawn from a total of 44 different classes with total class sizes ranging from 15 to 43 students. Students with known learning difficulties, or who did not return signed consent forms, or who were absent either on the day the consent forms were distributed, or on the day of the first testing session, were excluded from the study. Consequently, the average number of children per class who participated in the study was 11.4. All participants had parental and school consent to take part in the study and the study was approved by the Andalusian Biomedical Research Com- mittee (regional health administration).

Tests and materials

Reading efficiency

The Test Colectivo de Eficacia Lectora (Collective Test of Reading Efficiency - TECLE; Carrillo & Martín, 1999) was used. This test evaluates reading efficiency, conceived as a combination of two basic elements of reading: comprehension and fluency. The test consists of 64 written sentences of different syntactic, orthographic and semantic complexity. In each sentence one word has been omitted and students are required to indicate which of four alternatives correctly completes the sentence. The four possibilities consist of the correct response, a word that is orthographically similar but semantically or syntactically inadequate, a pseudoword that is orthographically similar to the correct choice, and a pseudoword that is phonologically similar to the correct option. For example, "Tu pelota es de color … [Your ball is the

color …]" followed by the options "rojo [/roxo/; red – correct word]", "robo [/robo/; robbery - semantically inadequate]", "roco [/roko/; pseudoword - orthographic distractor]", and "rogo [/roxo/; pseudoword - phonological distractor]". The test is preceded by several examples which are explained to the participants as many times as required. There is a time limit of 5 min to complete the test and participants are made aware of this prior to commencing. One point is awarded for each correct response while each erroneous response incurs a penalty of .5 points and each omission a penalty of .2 points. The maximum possible score is 64 points and scores below zero are possible in cases where the participant has many incorrect responses or omissions. Cuadro, Costa, Trías, and Ponce de León (2009) have reported high test–retest and internal reliability values (r = .88; Cronbach's α = .96).

Intelligence

Non-verbal intelligence was assessed using the Spanish version of the Raven Progressive Matrices (Raven, Court, & Raven, 1995). The standard set of matrices was used in this study. The test consists of 60 abstract diagrams which have a small section missing. Underneath the diagram are 6 possible alternatives to complete the diagram. On each trial the participant is required to indicate the correct response. There is no time limit and 1 point is awarded for each correct response. The manual does not provide test–retest or reliability scores for the Spanish population.

Word and pseudoword reading

The word reading and pseudoword reading subtests of the Batería de Evaluación de los Procesos Lectoras, Revisada (Evaluation of Reading Processes, Revised; PRO- LEC-R; Cuetos, Rodríguez, Ruano, & Arribas, 2007) were used. The word reading subtest consists of 20 high-frequency and 20 low-frequency words between 5 and 8 letters long, containing either 2 or 3 syllables. One point is awarded for each word read aloud correctly with no penalty for erroneous responses. Additionally, the time in seconds to read the whole list is recorded. To calculate the final score, considered to be a measure of reading fluency, the number of correctly read items is divided by the total reading time (in seconds), and this result is then multiplied by 100. Thus, despite having a fixed number of items, the scoring for this task is open ended given that total reading time is also taken into account. The value for Cronbach's alpha provided in the manual is α = .74.

The 40 items for the pseudoword reading task were created by changing one or two letters from each of the items in the word reading task. Application and scoring of the pseudoword reading task are identical to the word reading task. The value for Cronbach's alpha provided in the manual is α = .68.

Receptive vocabulary

The Spanish version of the standardized Peabody Picture Vocabulary Test (PPVT- III; Dunn & Arribas, 2006) was used. In this test, the child selects one of four pic- tures to match a spoken word in meaning. Items are grouped in blocks of 12 items and the

test is discontinued when a participant commits 8 errors in any block. There are 192 items in total and one point is awarded for each correct response. The Span- ish version has a value for Cronbach's alpha of $\alpha = .91$.

Morphological knowledge

The Morphology subtest of the Batería de Lenguaje Objetiva y Criterial – Screening (Screening battery for objective and criterial language—Revised; BLOC-SR; Puy- uelo, Renom, Solanas, & Wiig, 2007) was used. The test evaluates the participants' knowledge of inflectional morphology for regular and irregular verbs, pronouns (personal, possessive and reflexive), comparatives, superlatives and derived nouns. On each trial the participant sees a picture and the administrator describes the picture. The administrator then changes the phrase slightly and asks the participant for help in finishing the phrase. For example, the participant sees a picture of a child eating and ice cream and hears "A este niño le gusta mucho comer helados [This boy really likes eating ice cream]". This is followed by "¿Me ayudas terminar esta frase? Mañana él … [Can you help me finish this sentence? Tomorrow he…]", with the correct response being "will eat an ice cream". Forty-seven items are administered in total although 15 are demonstration items and are not awarded points. Accordingly, the maximum possible raw score is 32. The manual states that the reliability is high—Cronbach's alpha is $\alpha = .86$. Although explicit test/retest values are not given, the manual states that there is a very high correlation ($r = .989$) between this subtest, and an older, more extensive version of this instrument (BLOC-C; Puyuelo, Wiig, Renom, & Solanas, 1998) containing 190 items. One can infer from this that test/ retest reliability acceptable.

Syntactic knowledge

The Test de Comprensión de Estructuras Gramaticales (Grammar Structure Comprehension Test - CEG; Mendoza, Carballo, Muñoz, & Fresneda, 2005) was used. This test was inspired by the Test for the Reception of Grammar (TROG; Bishop, 1989) and is similar in format to the PPVT-III. On each trial the participant hears spo- ken phrase is required to indicate which of four pictures best represents the spoken phrase. There are 80 items and one point is awarded for each correct response. The manual states that Cronbach's alpha is $\alpha = .91$.

Text comprehension

The text comprehension subtest of the Test LEE (Defior et al., 2006) was used. The participants had to read three texts and six questions about each text. The passages to be read consisted of one narrative and two expositive texts. For each text there were three literal questions about explicit information in the text and three inferential questions. Rereading the text after reading the questions is permitted. Participants must also suggest a title for each text and choose the most appropriate abstract from a number of alternatives. Possible scores range from 0 to 48 (0 to 16 for each text). The manual states that Cronbach's alpha for fourth grade is $\alpha = .72$.

Procedure

A total of 10 people assessed the children with all receiving training in the use of the instruments prior to the commencement of the study. Evaluations took place within schools during the children's normal class time. There were three sessions in total. In the first session, reading efficiency (TECLE) and non-verbal intelligence (Raven) were evaluated in a group setting which lasted approximately 1 hour, and the entire sample evaluated over a period of approximately 3 weeks. In the second session, children were evaluated individually on word and pseudoword reading (PROLEC- R), followed by text comprehension (Test LEE). This session lasted between 20 and 30 min per child, and the entire sample was evaluated in approximately 4 weeks. Finally, children were evaluated individually on their receptive vocabulary (PPVT), syntactic knowledge (CEG) and morphological knowledge (BLOC) in the third session, and this lasted anywhere between 60 and 90 min per child. These sessions were completed in approximately 4 weeks. Testing order was the same for all children, and is as described above, except for session 3, in which the testing order was randomized.

Results

In the non-verbal intelligence task (Raven Progressive Matrices), 81 children scored in the 10th percentile, or below. A further 90 children failed to reach the threshold for the 25th percentile, which is the next percentile level provided in the manual. Consequently, to ensure that low intelligence was not a factor for other tasks, all of these children (171) were excluded from further participation.

For the PROLEC-R reading tasks, the test manual provides ranges for "normal reading", "mild difficulty" and "severe difficulty" for each school grade. For word reading, 22.0% of children who were assessed were classified as with mild or severe difficulties while 19.7% of children assessed in the nonword reading tasks was classified has having a mild difficulty. Consequently, a further 96 children were excluded for scoring below the normal range on one or both of the decoding measures.

One possible explanation for these apparent high exclusion rates is that the children were evaluated very early in the school year, and both the non-verbal intelligence tasks and the reading task use standardized scales that are based on entire school years. So, unlike the Peabody Picture Vocabulary Test, which uses a different standardized scale for every 3 month increment in age, both the Raven Progressive Matrices and the PROLEC-R instruments use standardized scales that span an entire grade. Thus, had the children been assessed later in the school year, these exclusion rates would probably have been lower. The descriptive statistics for all variables for the 234 children retained for analysis are presented in Table 1. Examination of the *z*-scores for both skewness and kurtosis indicates a departure from normality for some of the variables (values in excess of ± 1.96). To account for this slight non-normality, boot-strapping using 1000 samples was performed for the subsequent correlation and regression analyses (Pek, Wong, & Wong, 2018).

To gain a first impression of the relationship between text comprehension and the other variables, we performed a series of correlations, the results of which are shown in Table 2. Both morphological awareness (r = .17) and syntactic awareness (r = .36) were significantly positively correlated with text comprehension, although the relationship with syntactic awareness was twice as strong. The correlation between morphological awareness and syntactic awareness was also significant and positive (r = .30). Of the control variables, reading efficiency, non-verbal IQ, word reading, and receptive vocabulary were all significantly and positively correlated with text comprehension. Interestingly, despite the high correlation between word and pseudoword reading, and despite the significant correlation between word reading and text comprehension, the relationship between pseudoword reading and text compre- hension was weak and non-significant. It should be noted that there was a small but significant negative correlation between age and syntactic knowledge. However, this was entirely driven by two children—a young child with very high syntactic knowl- edge and an old child with very low syntactic knowledge. When these two children were excluded from the correlation, the relationship was no longer significant.

To assess the contribution of syntactic and morphological knowledge to text comprehension we conducted a series of hierarchical regression analyses. In the first step the control variables reading efficiency, non-verbal IQ, word reading, pseudoword reading, receptive vocabulary and gender were added to the model. In subsequent steps, syntactic and morphological knowledge were added to the model, with the order varied to assess the unique variance explained by each with the other variable already in the model. The results of these regressions are shown in Table 3.

The control variables on their own (step 1) explained 19.6% of the variance in reading comprehension. When syntactic awareness was entered into the model immediately after the control variables (step 2a), it explained 3.1% (p = .003) of additional variance in the text comprehension task. Although significant, the size of this effect is considered small (β = .21, p = .001). Adding morphological knowledge after syntactic knowledge (step 3a) did not improve the model (p = .787), meaning that morphological awareness did not explain any additional variance in reading compression beyond that explained by the control variables and syntactic awareness. Furthermore, when morphological knowledge was added to the model prior to syntactic awareness (step 2b), it did not explain any additional variance beyond that explained by the control variables (ΔR^2 = .2%, p = .438). Nevertheless, adding syntactic knowledge after morphological knowledge (step 3b) significantly improved the model (ΔR^2 = 2.9%, p = .004). Confirming that morphological awareness explained virtually no variance beyond that explained by the control variables, the effect size for syntactic awareness when added after morphological awareness was virtually identical to that when added prior (β = .21, p = .002).

In summary, syntactic awareness explained a small but significant amount of variance in reading comprehension beyond that explained by the control variables, even after controlling for morphological awareness. In contrast, despite being signif-

icantly correlated with reading comprehension, after taking into account the control variables, there was a lack of evidence to support the hypothesis that morphological awareness was related to reading comprehension.

Discussion

In the present study we set out to explore the relationship that syntactic and morpho- logical awareness have with reading comprehension in a sample of typically devel- oping 4th grade monolingual Spanish speaking children. The motivation for this was that, despite there being a number of studies that have explored these relationships (among others, Bowey, 1986; Brimo et al., 2018; Deacon & Kirby, 2004; Demont & Gombert, 1996; Kirby, Deacon, Bowers, Izenberg, Wade-Woolley, & Parrila, 2012; Nation & Snowling, 2000; Waltzman & Cairns, 2000), the relationship between syn- tax, morphology and reading comprehension remains understudied (e.g., Levesque et al., 2017; Rastle, 2018;, Spencer et al., 2019). Furthermore, it cannot simply be assumed that results thus far reported in English will be the same in Spanish given the differences that exist between English and Spanish in terms of morphology and syntax (e.g. Gutiérrez-Clellen et al., 2000). Somewhat surprisingly, perhaps, there are extremely few studies which have examined these relationships in monolingual Spanish speaking children. Thus, the aim of the study was to address this shortfall.

The first finding was that syntactic awareness explained unique variance in text comprehension ability after controlling for reading efficiency, decoding ability, receptive vocabulary, non-verbal IQ, as well as for morphological knowledge. This result is in line with findings reported in English (Bowey, 1986; Nation & Snowling, 2000; Waltzman & Cairns, 2000) and French (Demont & Gombert, 1996), and so is unsurprising. Nevertheless, we suggested in the introduction that the increased flexibility in Spanish syntax, compared to that of English, may have reduced the strength of this relationship—for example, the flexibility permitted with word order in Spanish may mean that children pay less attention to this aspect of syntax with a consequent reduction in comprehension. Nonetheless, this flexibility is not entirely content free, as examples such as “él lo hizo” versus “lo hizo él” (“he did it” versus “*he* did it”) have subtly different meanings. Thus, based on the regression results, syntax awareness in Spanish is a factor which appears to aid reading comprehension.

In contrast, morphological awareness did not explain any unique variance in text comprehension beyond that explained by the control variables despite the fact that a significant, albeit weak correlation existed between the two ($r = .17$). The lack of a relationship between morphological knowledge and reading comprehension is sur- prising for two reasons. Firstly, a relationship between morphological awareness and reading comprehension has frequently been reported in English speaking samples (e.g., Levesque et al., 2017; Tong et al., 2011). Secondly, morphology in Spanish is richer than that found in English (Gutiérrez-Clellen et al., 2000; Vivas, 1979). Thus, we had expected this rich content to aid children in extracting meaning from text.

What factors could explain this surprising result?

In the first instance, perhaps the richness of Spanish morphology presents a challenge to young children. Thus, even though our sample showed a normal range of scores for their age (as indicated by inspecting the standardized percentile scores) potentially, the 9-year-old children in our study had not yet fully mastered some of the more complex morphological rules in Spanish. Consequently, this may have led to morphological awareness not explaining any variance in reading comprehension. To test this idea, follow-up studies would need examine the morphology-comprehension relationship using an older sample of Spanish speaking children.

Secondly, morphological knowledge is itself made up of a complex set of dif- ferent but related skills. Thus, its relationship with reading comprehension may not be straightforward. For example, Tong et al. (2011) reported that unexpected poor comprehenders scored lower on a derivational, but not inflectional morphol- ogy task, compared to normal comprehenders. Furthermore, Levesque et al. (2017) have suggested that in addition to a direct contribution from morphological aware- ness to reading comprehension, there may be two indirect relationships—the first mediated by morphological decoding and then word reading efficiency, and in the second pathway, morphological awareness helps children identify unknown words, which in turn improves reading comprehension. The salient point to take from these two studies is that the specific type of morphology assessed is potentially very relevant, a point also made by Tong, Deacon, and Cain (2014). The instrument we used to evaluate morphological awareness (BLOC-SR; Puyuelo et al., 2007) assesses 11 different types of morphology. However, in order to allow for the assessment to be completed within a reasonable amount of time, it does not contain a large number of items in any one of the categories. Thus, if only certain aspects of morphological knowledge influence reading comprehension, it is possible that our test lacked sufficient items of the relevant types of morphology, and thus lacked sensitivity.

Another possibility to account for the fact that that syntactic, but not morpho- logical knowledge, was related to reading comprehension could be due to types of question employed by the two instruments.[1] The evaluation for syntactic awareness uses a four alternative forced choice format, whereas the morphological awareness assessment relies on open ended questions. Thus, when children were unsure of the correct response in the morphological evaluation, they were unlikely to have generated the correct response by chance whereas random correct responses were possible in the syntactic awareness evaluation. The suggestion here is that this difference could lead to the morphological evaluation having less sensitivity than the syntactic evaluation. Nonetheless, we do not believe that this is the case—the scores for the morphological task had a wide range, were normally distributed, and showed no evidence of floor or ceiling effects—all signs of adequate sensitivity. Irrespective, questions regarding a possible lack of sensitivity, or specificity in the types of morphological knowledge that may influence reading comprehension in Spanish, can only be resolved by follow-up studies in which a very broad and extensive assessment of morphological knowledge is carried out. Finally, despite a possible lack of sensitivity in the instrument we used to assess morphological awareness, we note that our result agrees with one of the few previous studies carried out with monolingual

Spanish speaking children—that of Salvador Mata et al. (2007), who also failed to find a relationship between morphological knowledge and reading comprehension in Spanish speaking children of similar age to our sample.

Implications, limitations and future research

The results of the present study have clear empirical implications. In the first instance, the positive relationship between syntactic awareness and reading comprehension provides some evidence that that interventions designed to improve reading comprehension which are based on improving syntactic knowledge are likely to be effective, at least in children with a similar age to those used in the present study. Secondly, the lack of a relationship between morphological awareness and reading comprehension suggests that morphology based interventions designed to improve reading comprehension in Spanish speaking children might not be effective. Why is this important? In the introduction we noted that there were very few studies which had examined the relationship between syntactic and morphological awareness, with reading comprehension in Spanish speaking children. A similar situation exists in terms of interventions designed to improve literacy in Spanish speaking children. For example, in a recent intervention designed to improve oral vocabulary, Gomes- Koban, Simpson, Valle, and Defior (2017) noted that there had only been three pre- viously published studies that had examined vocabulary training in Spanish-speak- ing children, although each of these had design issues. A similar situation exists in the area of reading comprehension—in a meta-analysis looking at studies designed to improve reading comprehension in Spanish speaking children, Ripoll and Aguado (2013) reported that just two included follow-up evaluations to assess the long term benefits of the interventions. While some more recent interventions have been car- ried out (e.g., Crespo, Jiménez, Rodríguez, Baker, & Park, 2018; López-Escribano,
2016), none have looked at either syntax or morphology as possible factors. Thus, by providing data regarding the relationship between syntactic and morphological awareness with reading comprehension, these results inform the development of more future interventions designed to improve reading comprehension in Spanish speaking children.

Having suggested that the present research could inform future interventions, we nevertheless note the following limitations. In the first instance, all of the children included in the present study were typically developing children. Thus, the results cannot be extrapolated to children with poor reading fluency or decoding skills, or who scored poorly on non-verbal intelligence. Secondly, the children who participated in our study came from just a single grade—4th year in primary education. Thus, the data presented here may not form a useful base for reading comprehension aimed children of different ages. Finally, given that did not find a relationship between morphological awareness and reading comprehension, something that has been reported in English, it is possible that our morphological assessment lacked sensitivity,

In conclusion, syntactic, but not morphological knowledge was found to be related to concurrent reading comprehension in a group of Spanish speaking 4th graders after controlling for oral vocabulary, reading fluency, reading efficiency, non-verbal IQ and age. This result adds to our knowledge of reading comprehen- sion in monolingual Spanish speaking children as the majority of similar studies carried out with Spanish speaking children have used bilingual participants. Despite certain limitations, such as the sample including only typically developing children, the present study suggests a promising research avenue in looking at the efficacy syntactic based intervention to improve reading comprehension. Nevertheless, the results should be interpreted cautiously and further research in this area should be undertaken.

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TABLES

Table 2 Correlations between all variables included in the study

	2 (RE)	3 (NVI)	4 (WR)	5 (PWR)	6 (RV)	7 (MK)	8 (SK)	9 (Age)
1. Text comprehension (TC)	.16*	.29***	.19**	.11	.38***	.17**	.36***	− .03
2. Reading efficiency (RE)	–	.18**	.54***	.52***	.21**	.13#	.25***	− .04
3. Non-verbal intelligence (NVI)		–	.07	.02	.38***	.31***	.37***	− .04
4. Word reading (WR)			–	.66***	.07	.08	.19**	− .06
5. Pseudoword reading (PWR)				–	.13*	.04	.18**	− .09
6. Receptive vocabulary (RV)					–	.20**	.39***	− .04
7. Morphological knowledge (MK)						–	.30***	− .08
8. Syntactic knowledge (SK)							–	− .18**

Table 1 Means, standard deviations (*SD*) and ranges for all measures for the 234 children (113 girls 121 boys) retained for analysis

Measure	Mean	(*SD*)	Range	Skewness		Kurtosis		Maximum
				Value	*Z*-score	Value	*z*-score	Possible score
Reading efficiency (TECLE)	28.5	(9.32)	− 11–58	.37	1.15	1.46	2.30	64
Non-verbal intelligence (Raven)	37.8	(5.87)	27–52	.02	.06	− .55	− .87	60
Word reading fluency (PROLEC-R)	114.1	(27.92)	76–222	1.19	3.75	1.75	2.76	n/a[a]
Pseudoword reading fluency (PROLEC-R)	63.0	(14.72)	43–136	1.38	4.33	2.73	4.30	n/a[a]
Receptive vocabulary (PPVT)	117.5	(14.18)	77–169	.01	.02	.16	.25	192
Morphological knowledge (BLOC)	23.2	(4.09)	11–32	− .27	− .85	− .20	− .32	32
Syntactic knowledge (CEG)	70.5	(4.69)	57–79	− .45	− 1.40	− .45	− .70	80
Text comprehension (LEE)	39.6	(5.30)	21–48	− .58	− 1.84	.06	.10	48
Age (months)	112.2	(3.98)	95–131	.00	.00	1.99	3.13	n/a

The minimum possible score for all tasks is zero, except for the TECLE task, which penalizes omissions and incorrect and responses. For this reason, one child obtained a negative score as a result of their relatively high error rate compared to the number of their correct responses. Refer to the Methods section for more details on how this task is scored. Skewness and Kurtosis *z*-scores were calculated by dividing the statistic by 2 standard errors. "n/a" means not applicable

[a]The final score for both PROLEC-R tasks is created by dividing the number of correct responses by the time taken to read the list. Thus, there is no upper limit to the scores

Table 3 A Three-Step hierarchical multiple regression analyses (bootstrapped) predicting text comprehension from syntactic and morphological awareness, controlling for reading efficiency, non-verbal IQ, word and pseudoword reading ability, receptive vocabulary, age and gender

Step	Variable	Simple correlation		Regression analysis					Model change	
		r	r^2 (%)	*b*	95% CI	*SE*	β	*p*	ΔR^2 (%)	*p*
1	Reading efficiency (TECLE)	.16	2.7	.00	[− .08, .08]	.042	− .00	.965		
1	Non verbal IQ (Raven)	.29	8.2	.14	[− .03, .25]	.059	− .15	.012		
1	Word reading	.19	3.7	.04	[− .01, .07]	.015	− .21	.013		
1	Pseudoword reading	.11	1.3	− .03	[− .09, .03]	.030	− .08	.373		
1	Receptive vocabulary (PPVT)	.38	14.1	.12	[− .07, .17]	.024	− .31	.001		
1	Age (months)	− .03	0.1	− .05	[− .19, .12]	.080	− .03	.575		
1	Gender	− .07	0.5	− .39	[− 1.59, .91]	.634	− .04	.556		
2a	Syntactic knowledge (CEG)	.36	12.7	.24	[− .09, .37]	.074	.21	.001	3.1	.003
3a	Morphological knowledge (BLOC)	.17	2.9	.01	[− .04, .06]	.025	.02	.780	0.0	.787
2b	Morphological knowledge (BLOC)	.17	2.9	.02	[− .03, .08]	.025	.05	.424	0.2	.438
3b	Syntactic knowledge (CEG)	.36	12.7	.23	[− .08, .38]	.075	.21	.002	2.9	.004

Two versions of the model were run. In “model a” syntactic knowledge was entered in step 2 followed by morphological knowledge in step 3. In “model b” this order was reversed. For both models, step 1 contained control variables. R^2 = 19.6% for step 1. Total R^2 for the full model containing 3 steps is 22.7%. 95% CI = Bootstrapped 95% confidence intervals. ΔR^2 = the additional variance explained in each step