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English reading performance by Spanish speaking children: A phonologically or semantically mediated pathway?

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Abstract

Reading acquisition involves connections between the spoken language and the writing system. The English-language writing system holds an inconsistent alphabetic system, thus encouraging readers to develop representations between the grapheme and the word. Reading in English as a Foreign language supposes a challenge, especially when the reader's native language is consistent and learners live in a monolingual context, as is the case in Spain. This may cause difficulties in learning the grapheme-phoneme-conversion-rules and using different grain size units. The aim of this study was to address the reading strategies that Spanish children use when reading in English. We considered the influence of word length, lexical frequency, orthographic consistency (in onset, nucleus, coda, and rime), and semantic knowledge on word reading. We analyzed speed and accuracy in a reading aloud task of English words from 94 Spanish-speaking children (fourth, fifth and sixth grade). Participants also completed a translation task into Spanish taken from the previous English ones. Results showed the influence of word length in accuracy, as well as that of children's grade, onset consistency, and semantic knowledge on both accuracy and reading speed. Regarding sublexical units, onset reading accuracy was determined by onset consistency in all grades; nucleus accuracy was determined by rime consistency only in the sixth grade and coda accuracy by rime consistency in the fifth and sixth grades. The present study demonstrates the relevance of Spanish children's semantic knowledge when reading in English. Despite this, and in line with the statistical learning perspective, some regularities are used in correlation with greater reading experience in English.

Keywords Reading acquisition · Reading strategies · Foreign language · Semantic knowledge · Orthographic consistency

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What is already known about this topic

- Different linguistic variables influence reading performance.
- English reading acquisition is a challenge for Spanish-speaking children, due to differences between orthographic systems.

What this paper adds

- Spanish-speaking children benefit from semantic knowledge when reading in English.
- Spanish-speaking children seem to develop sensitivity to English orthographic patterns.

Introduction

Reading acquisition involves making connections between units of the writing system and of the spoken language (Verhoeven & Perfetti, 2022). It implies the assimilation of regularities of the writing system (Harm & Seidenberg, 2004). In this sense, according to the statistical view of reading, children with high ability to assimilate regularities between print and speech will then demonstrate better reading skills as opposed to children with less sensitivity to these regularities (Siegelman et al., 2020). However, reading acquisition, as well as reading strategies, seems to depend on the characteristics of the orthographic system, especially the reliability of print-to-speech correspondences of such (Schmalz et al., 2015). It has been reported that reading in a shallow orthography takes less time than learning to read in a deep one, as the latter includes different pronunciations for the same spelling patterns (Goswami et al., 1997, 1998; Seymour et al., 2003; Thorstad, 1991; Wimmer & Hummer, 1990). Additionally, reading development and strategies may differ when it comes to a second (L2) or foreign language (FL).

Learning to read in L2 or FL is challenging, as children must learn a new code. Most studies on this topic have focused on two main aspects: the cross-linguistic transfer (Commissaire et al., 2011; D'Angiulli et al., 2001; Kahn-Horwitz et al., 2012; Koda, 2007) and the effect of L1–L2 orthographic distance (Bialystok et al., 2005; Faruk & Vulchanova, 2015; Shum et al., 2016). Within this context, learners with an alphabetic L1 (e.g., Spanish, Indonesian, French, or Korean) possess advantages over L1 learners whose written system is non-alphabetic (Koda, 2007; Muljani et al., 1998; Wang & Koda, 2005). However, certain challenges also exist when the orthography of the native language (L1) is consistent (as in Spanish) and that of the FL is inconsistent (as in English).

A substantial body of evidence derives from studies carried out in bilingual or immersion language programs (Goodwin et al., 2015; Lindsey et al., 2003; Manis

et al., 2004; Relyea & Amendum, 2020; van der Velde Kremin et al., 2019). However, relatively little research has focused on English reading in Spanish speaking children who learn English in an academic setting (Hevia-Tuero et al., 2021, 2022; Suárez-Coalla et al., 2020). Taking this into account, the current study provides data on English FL reading, combining accuracy and reaction times, in a population of Spanish children. Considering the importance of English in our present society, the inherent differences between languages, as well as the context of learning English in Spain, this study will be of great interest on both a theoretical and on an educational level.

English writing system and learning to read

The English writing system is considered a deep alphabetic one. The English alphabet consists of 26 letters (5 vowels and 21 consonants), which attempt to represent more than 40 phonemes. The *feedforward consistency* relates to the degree to which the pronunciation of a word is consistent with that of words of similar spelling (Chee et al., 2020). Orthographic consistency exists at the grapheme level (e.g., "ea" is an inconsistent grapheme because it can be pronounced as in "bread"→/brɛd/ or "peak"→/piːk/), or rime level (e.g., "-eak" can be pronounced as in "break"→ /breɪk/or "leak"→/liːk/), (Chee et al., 2020; Glushko, 1979; Schmalz et al., 2015). The orthographic consistency is considered a continuum (values between 0 and 1), the result of dividing the number of friends by the total number of friends and enemies (Chee et al., 2020, for an extensive explication). Friends are words with consistent pronunciation (same spelling and same pronunciation), and enemies are words with inconsistent pronunciation (same spelling and different pronunciation). For example, the words "farm", "arm", and "harm" are friends, since in all three words, the ending "-arm" is pronounced in the same way /-ɑːm/. While the word "warm" is an enemy, as "-arm" has a different pronunciation /-ɔːm/. Consonants are more consistent and predictable in their grapheme-phoneme correspondences (GPCs) than are vowels (Perfetti & Dunlap, 2008). The initial consonant of a syllable is 96% consistent, and the final one is 91% consistent (Treiman et al., 1995). Regarding the vowels, the 5 vowels vary in their GPCs (e.g., the letter 'a' has a different pronunciation in "cat", "call", "car", "table", or "care"), there are 12 vowel digraphs (e.g., "field"→/fiːld/), and their pronunciation is greatly dependent on positioning, graphemic context and morphemic regularities, then leading to conditional consistency (Frith et al., 1998; Kessler & Treiman, 2001; Treiman et al., 1995; Venezky, 1970). However, around 80% of English monosyllables can be read correctly using quite a small set of GPC rules. The remaining 20% of English monosyllables generally contain only one grapheme that eludes their most frequent pronunciation (Coltheart et al., 2001).

Many theories have attempted to describe how word reading develops (Ehri, 2002; Frith, 1985; Seymour & Duncan, 2001; Share, 1995). The different theories diverge in some respects, but they all consider that word reading development constitutes a specialization of several strategies. Initially, English-speaking children acquire and apply GPCs (period where they predominantly use an alphabetic

strategy), but in order to become a skilled reader it is necessary for them to develop direct lexical access (Castles et al., 2018; Ehri, 1999; Frith, 1985; Marsh et al., 1981). According to the *Self-teaching Hypothesis* (Share, 1995), once children learn the GPCs and acquire segmentation and blending processes, they are equipped to apply this knowledge to new words. This is a slow process, but each time the reader successfully decodes a new word, he or she has the opportunity to create an orthographic representation of the word (Share, 2004). In this sense, young children's reading is greatly determined by word length. The effect of word length on reading suggests that word recognition is supported by a sub-lexical strategy, decreasing with reading exposure and ability (Kwok & Ellis, 2014; Martens & De Jong, 2006; Zoccolotti et al., 2005).

As the orthographic representations begin to develop, the effect of lexical frequency starts to become noticeable. The lexical frequency effect has received a lot of attention, and it is considered an indicator of a lexical reading strategy. High-frequency words are processed faster and more accurately than low-frequency ones (Brysbaert et al., 2016, 2017, 2018; Diependaele et al., 2013), with a stronger effect observed in younger readers as opposed to older ones (Davies et al., 2017).

On the other hand, reading performance is strongly influenced by the characteristics of the writing system, orthographic consistency being one of the most distinguishable features of alphabetic writing systems. The *Orthographic Depth Hypothesis (ODH)* refers to the difficulty with which the sublexical strategy can achieve the correct pronunciation of words (Buetler et al., 2014; Katz & Feldman, 1983; Katz & Frost, 1992). Moreover, the ODH emphasizes that the presence of inconsistencies has a negative impact on reading performance (Content & Peereman, 1992; Cortese & Simpson, 2000; Jared, 2002; Jared et al., 1990; Laxon et al., 1991). For instance, more inconsistent words (e.g., pint) take longer to read aloud than those with higher consistency (e.g., duck). Rime consistency has been proven to significantly facilitate latencies and accuracy in word naming and lexical decision tasks (Balota et al., 2004; Chateau & Jared, 2003; Treiman et al., 1995; Yap & Balota, 2009; Ziegler et al., 1997, 2008). Although most studies have paid attention to rime consistency, this does not exclude the possibility that the consistency of other sub-syllabic segments (onset, nucleus, coda) may influence lexical processing as well. As a matter of fact, some studies have shown the value of onset consistency as a predictor of lexical recognition (Balota et al., 2004; Treiman et al., 1995; Yap & Balota, 2009).

Furthermore, the *Psycholinguistics Grain Size Theory* (PGST), (Ziegler & Goswami, 2005) highlights that English-speaking readers must develop intermediate representations between the grapheme and the word (i.e., syllables, rimes, morphemes) to deal with the inconsistencies of the corresponding writing system. In this sense, Goswami, and colleagues (1998) found that a letter-by-letter strategy was more effective in Spanish than in English (or French). Likewise, German-speaking children, in contrast to English-speaking children, achieve analogous results in reading pseudowords that are orthographically similar to real words as in reading control pseudowords (Goswami et al., 2003). This suggests that it is difficult to achieve English reading accuracy using a serial reading strategy, and the use of orthographic rime analogies appears to be a useful strategy (Goswami, 1999, 2000; Goswami et al., 1998; Treiman et al., 1995).

By the same token, a large vocabulary appears to be useful for reading, especially in the case of irregular words (Nation & Snowling, 2004; Ouellette & Beers, 2010; Ricketts et al., 2007, 2016; Taylor et al., 2015; Wegener et al., 2018). Semantics would help to discriminate between two or more possible pronunciations of a word (Share, 1995). The role of vocabulary also fits the *Lexical Quality Hypothesis -LQH-* (Perfetti & Hart, 2002), which highlights the importance of connections between orthography, phonology, and semantics in reading. Words with high lexical quality representations are more easily recognized and at a quicker speed (Bowey & Rutherford, 2007; Duff & Hulme, 2012; Nation, 2009; Ouellette & Beers, 2010; Perfetti, 2017). Several models of reading have recognized this role that semantics plays (the *Dual-route cascade model* of Coltheart et al., 2001; and the *Triangle model* of Plaut et al., 1996). Following the Triangle Model, the three types of mental representations (orthographic, phonological, and semantic representations) are connected, due to learning. These activate each other when a word is presented to us. Hence, semantics would play an important role in orthographic recognition and phonological retrieval of words. In this line, Mckay and colleagues (2008) demonstrated that adults were more successful in creating orthographic representations when they received semantic training prior to reading exposure to the items. In addition, a correlation between semantic knowledge and reading, especially when it comes irregular words, has been proven (Nation & Cocksey, 2009). This supports the claims of potential advantages of a top-down process during the visual word recognition (Mitchell & Brady, 2013).

To conclude, research provides evidence that small grain size units (simple GPCs) do not afford accurate phonological coding in several cases. The English writing system encourages readers to develop intermediate units, and to process words by accessing the lexicon and meaning via the orthographic structure. The orthographic consistency, lexical frequency and vocabulary level all play a particularly important role in English reading, whereas the contribution of word length is less decisive (Katz & Frost, 1992).

Reading in English as a foreign language

The acquisition of reading in two languages implies the development of universal and language-specific mechanisms. It entails interaction and transfer between languages (Cummins, 1979, 2017; de León Rodríguez et al., 2016; Marks et al., 2022). As suggested by the *Linguistic Interdependence Hypothesis,* reading skills acquired in L1 can be transferred to L2 or FL reading (August et al., 2001; Cummins, 2000; Koda, 2007). That being said, the similarities and differences between languages become critical for learning to read, as stated by the S*cript-Dependent Hypothesis* (Geva & Siegel, 2000; Geva et al., 1993; Proctor et al., 2010).

Results about cross-linguistic transfer between alphabetic and logographic writing systems are not conclusive (Gottardo et al., 2001; Keung & Ho, 2009; Wang et al., 2005). Having noted this, several studies support the idea that an alphabetic L1 facilitates word identification in an alphabetic L2 in contrast to a logographic L1 (Gholamain & Geva, 1999; Gottardo, 2002; Koda, 2000; Lindsey et al., 2003;

Muljani, et al., 1998; Páez & Rinaldi, 2006; Wang et al., 2003). A clear and universal phenomenon of crosslinguistic transfer in different bilingual populations has been demonstrated (French–English: Comeau et al., 1999; Italian–English: D'Angiulli et al., 2001; Korean–English: Wang et al., 2006; Spanish–English: Durgunoglu et al.,1998; Gottardo, 2002; Lindsey et al., 2003; Sun-Alperin & Wang, 2011). Nevertheless, some interferences between alphabetic orthographies could also be observed. For instance, English learners whose L1 is transparent could have difficulties in learning English GPCs and in using different grain size units. Early reading experience in a shallow orthography could lead to greater reliance on phonological or sublexical recoding in L2 or FL (Bhide, 2015; Hevia-Tuero et al., 2021). Nevertheless, reliance on L1 knowledge depends on proficiency, and ceases with language development (Koda, 2007). With regards to Spanish-speaking children, to the best of our knowledge, there are no studies to date that address reading aloud strategies in English as FL. Only one study includes a task in which lexical frequency is manipulated, controlling the phonology of the words. This study highlights the role of lexical frequency in reading speed and accuracy (Suárez-Coalla et al., 2020). Spanish children (8–12 years old) showed a better performance in high than in low frequency words, suggesting that they do indeed develop orthographic representations. We do not have studies that address other variables such as orthographic consistency or the role of semantic knowledge.

Finally, other factors (e.g.: amount and quality of new language exposure or teaching methodologies) could have an impact on reading performance as well (Birch & Fulop, 2020; Farukh & Vulchanova, 2015; Woore, 2022). The presence of new phonemes, which do not occur in L1, presents a challenge for new learners, a phenomenon explained by the *Linguistic Affiliation Constraint Hypothesis* (Darcy et al., 2013; Pallier et al., 2003; Russak & Saiegh-Haddad, 2011; Saiegh-Haddad et al., 2010). Due to this, English phonology may be complex for some L2 or EFL learners with a smaller phonemic inventory in their language. However, we can find very different situations. For, instance, in the United States, many children speak a language other than English at home, yet at school and in the community, they are exposed to their L2, which in turn offers as substantial linguistic advantage (Durgunoğlu, 1998; National Reading Panel, 2000; Relyea & Amendum, 2020; Rolla San Francisco et al., 2006).

In addition, the teaching method in use constitutes another important factor. It has been pointed out that the *systematic teaching of phonics*, as opposed to the *whole-word or look-and-say* teaching methodology (Carnine, 1977), has been reported to have a great benefit on reading in both native and non-native speakers (Birch & Fulop, 2020; Ehri, 2020; Grabe, 2008; Murphy Odo, 2021; Pérez-Cañado, 2006; Woore, 2022). That being said, the use of context and support for meaning would also prove to be useful when it comes to reading accuracy (Harm & Seidenberg, 2004; Plaut et al., 1996; Share, 1995).

EFL teaching methodologies vary significantly depending on the policy of each country (Kirkpatrick, 2020). In Spain, English literacy begins at the age of six, coinciding with the first year of Primary Education (European Education and Culture Executive Agency, 2023). This order events causes Spanish children to already have some knowledge of alphabetic writing systems by the time this new language is

introduced. On the contrary, students don't receive explicit instruction on the characteristics of the English writing system. In Spanish schools, phonology, orthography, and word meaning are generally taught at the same time, following an English textbook which includes different topics throughout the school year. This teaching method could then pose a major challenge, given the limited exposure to English phonology and meanings outside of school that children receive.

The current study

The objective of this study was to address the reading strategies that Spanish-speaking children employ when reading in English. To achieve this objective, we explored the influence of psycholinguistic variables (length, lexical frequency, and orthographic consistency), in addition to semantic knowledge, on word reading accuracy, reading speed, and sublexical reading errors, with possible differences across grades.

Considering the differences between L1 (Spanish) and FL (English), along the English teaching methodology in Spain, this study will be of great interest at both a theoretical and an educational level. Specifically, we explore English reading performance with the aim of answering the following research questions:

- To what extent do Spanish-speaking children rely on lexical or sublexical strategies when reading in English?
- Are they sensitive to the orthographic consistency of English?
- Does the pattern of reading strategies change across grades?
- Is lexical-semantic knowledge a determining factor in English reading in this population?

Based on previous literature, we hypothesize that:

- There will be a significant effect of word length on reading accuracy, especially in younger children, pointing to the use of a sublexical strategy.
- The significant effect of spelling consistency on reading speed and accuracy (greater accuracy and speed in more consistent words) will be limited, due to still short exposure to English reading and scarce instruction in English orthographic rules. This effect could be more evident in higher grades.
- The significant effect of lexical frequency will be more evident in older children, indicating the use of a lexical strategy resulting from reading experience.
- The semantic knowledge will play a role, both in accuracy and in reading speed, in line with the *Triangle Model* (Plaut et al., 1996) and the *Lexical Quality Hypothesis* (Perfetti & Hart, 2002).
- Regarding sublexical units (onset, nucleus, coda) there will be more errors in the nucleus and coda than in the onset of the syllable, due to the greater inconsistency of these parts; moreover, the influence of orthographic consistency will be smaller in the lower rather than the higher grades, as they would not have had time to acquire sensitivity to orthographic consistency.

Method

Participants

A total of 94 Spanish children (fourth, fifth and sixth grades) participated in the study. Thirty-four children (19 girls and 15 boys, in the 4th grade) were approximately 9 years old (M_{age} = 9.14 years; SD = 4 months), thirty-two (18 girls and 14 boys, in the 5th grade) were approximately 10 years old (M_{age} = 10.09 years; SD = 3 months) and twenty-eight (10 girls and 18 boys, in the 6th grade) were approximately 11 years old (M_{age} = 11.07 years; SD = 3 months). All of them were native Spanish speakers who attended the same primary education school in the north of Spain. All children received English classes for four hours a week in addition to one and a half hours of a natural science subject in English. In this school, children are introduced to English from kindergarten onwards by learning basic vocabulary (1 h in first, 1.5 h in second, and 2 h in third grade). In primary education, the English language is taught through a textbook that includes several units, each dedicated to different topics (the animals, the house, the body parts, …). Children receive 3 weekly hours of English in first and second grade, and 4 h from third to sixth grade. By following the textbook, and alternating the topics, children learn vocabulary (written and oral form) and grammar. The textbook in use provides many writing activities (written naming, filling in the gaps, answering questions…), listening assignments, and reading comprehension tasks. As for reading, children do not explicitly receive decoding instructions in English, and phonics is not a major unit in the curriculum. Only a small number of dedicate a limited amount of time to this aspect in sixth grade. In this sense, we consider that, in terms of reading instruction, these children are mainly receiving a kind of look-and-say method.

We collected information on children's Spanish reading level using the word and pseudoword sub-tests of the PROLEC-R standardized literacy test (Cuetos et al., 2014). Data from these subtests confirm that children show a typical reading development in their L1, see Table 1. Children with cognitive, motor, learning, or behavioural impairments were excluded from the study. In addition, children speaking a second language at home were also excluded. The socio-economic situation of children in school was average.

The procedure of the experiment was approved by the Ethics Committee of Research of the Principality of Asturias, Spain, and it has been carried out in

Table 1 Summary of participant Spanish reading from PROLEC-R test

	4th grade *M* (*SD*)	5th grade *M* (*SD*)	6th grade *M* (*SD*)
Words accuracy (out of 40)	38.41 (1.42)	37.78 (2.28)	38.62 (1.20)
Word reading time (40 words)	31.66 (5.89)	27.31 (6.38)	23.31 (4.66)
Pseudowords accuracy (out of 40)	33.79 (3.50)	31.90 (4.90)	34.00 (3.63)
Pseudowords reading time (40 pseudowords)	60.05 (13.22)	53.75 (10.97)	46.37 (11.68)

accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

Materials

A reading aloud task, including 76 English monosyllabic and morphologically simple nouns was designed. The words were selected from a database created in our laboratory (in preparation). This database compiles the words included in the two most frequently English textbooks used by Spanish primary education schools. The lexical frequency from those two publisher companies, one of which is used in the school that participated in the study, has been included in the database. The stimuli were selected considering several criteria. All words were one-syllable nouns (content words) and had the three parts that a syllable can have: onset, nucleus, and coda. The onset and coda could be consonants or consonant clusters (e.g., dog, crab, bush). Words with this structure have been included to consider the orthographic consistency of each of the parts as factors. We avoided polysemous words, as well as cognates. Furthermore, all words appear in the English textbooks before the end of grade 4, with the exception of just 10 words (21 words appeared for the first time in the 1st grade textbook; 19 words in the 2nd grade textbook; 17 words in the 3rd grade textbook; 5 words in the 5th grade textbook; and 5 words in the 6th grade textbook). On the other hand, different variables (length, lexical frequency, and feedforward consistency) were considered, with the goal of including a wide variety of values, to then know the effect of these continuous variables. The words were 3 to 6 letters long (M_{length}=4.34; SD=0.87); the English lexical frequency according to the English textbook in the school ranged from 1 to 176 occurrences (M=23.77, SD=28.96); and the feedforward consistency scores of the onset from 0.034 to 1 (M=0.95, SD=0.12), the nucleus from 0.022 to 0.935 (M=0.39, SD=0.25), the coda from 0.236 to 1 (M=0.94, SD=0.12), and the rime (nucleus+coda) from 0.080 to 1 (M=0.82, SD=0.24) according to Chee and colleagues' consistency norms for 37,677 English words (2020). The English lexical frequency from the textbooks correlates positively with Log of Frequency of a word as reported by the HAL Study (M=9.78, SD=1.41; r=0.392, p<0.001) (Balota et al., 2007), and negatively with grade of word introduction at school (M=2.64, SD=1.50; r=−0.455, p<0.001). In addition, Spanish lexical frequency (Martínez & García, 2004) of the translation words (M=466.527, SD=497.040) was not considered, but this correlates positively with the English lexical frequency according to the English textbook (r=0.253, p=0.027), and the Log of Frequency of a word as reported by the HAL Study (r=0.623, p<0.001).

A list with all the words and their individual characteristics can be found in the Appendix.

Procedure

Stimuli were presented, and responses were then recorded using DMDX (Forster & Forster, 2003) on a Windows XP laptop. Each trial had the following sequence of events: first a white screen was displayed for 500 ms, then a black asterisk was presented in the center of the screen for 500 ms, the asterisk was replaced by the stimulus (in 14-point Arial type) which remained on the screen for 1500 ms. A pilot study was conducted to determine the adequate time of stimulus presentation. We found that this time was sufficient taking into account the word length and the age of participants. Stimuli were presented in two blocks of 38 words each and appeared randomly in each block. The two blocks were separated by a pause and preceded by two practice trials to familiarize the child with the task. Children were seated at approximately 30 cm from the screen, and at the beginning of the test, it was explained to them that they had to read the words as accurately and quickly as possible. They were also encouraged to read the words even if they did not recognize them. Children were told the following: "You must read some English words. The words will appear on the computer screen. You will have to read them aloud as quickly as possible without making any mistakes".

Participants completed the reading aloud task during an individual session, in a quiet room in their school. The recordings were subsequently analyzed using *CheckVocal* (Protopapas, 2007) by a bilingual speech therapist, and we obtained reading accuracy (subtle mispronunciations, which involve a small distortion, were not considered reading errors) and reaction times (RTs) from the resulting spectrograms.

After the reading task, children had to perform a translation task. Participants were given a piece of paper with the same 76 words on it, and they were instructed to write the Spanish translation for all the English words they knew. This last task's aim was to assess whether children knew the meaning of the words of the experimental task. It was considered semantic knowledge. We discouraged using a specific vocabulary task in parallel, because the aim was to find out whether the reading of these words (which could be a representative set) was determined to some extent by semantic knowledge. Each word has been coded as (1) if the child writes the correct Spanish translation (meaning) of the word and as (0) if he or she gives an incorrect translation or no translation at all. Possible spelling errors in Spanish were not considered. The total duration of the two tasks combined was around 30 min.

Data analysis

We recorded a total of 7144 responses (4th = 2584; 5th = 2432; 6th = 2128). We considered reading accuracy, along with RTs. The statistical analysis was carried out using the R software version 4.1.3 (R Development Core Team, 2022), and *lme4* (Bates et al., 2015), *lmerTest* (Kuznetsova et al., 2017), *broom.mixed* (Bolker & Robinson, 2022) packages.

Results

Word reading accuracy

For the accuracy analysis, we included all responses (4373 correct responses = 61.21%; 2678 incorrect responses = 37.49%, and 93 no responses = 1.30%). A Generalized Mixed Effects Modelling (GLMM), using the binomial family and the Laplace approximation for the likelihood, was performed. The aim was to estimate the odds ratios that a response would be accurate given a set of predictors. Random effects of both participants and stimuli were considered. Grade, length, semantic knowledge, English lexical frequency, onset consistency, nucleus consistency, coda consistency, and rime consistency were considered fixed effects. The absence of collinearity between the factors was tested, and an ICC of 0.374 was obtained. The significance level used was 0.05.

Starting from a maximal model that included all interactions with the grade, and given the existence of non-significant coefficients, we opted to apply a backward algorithm to simplify the model. The mixed effects logistic regression analysis showed grade effect, $\chi^2_{(2)} = 12.7861$, $p = 0.001$, as children in the 6th grade have a higher probability of reading accuracy than those in 4th grade, $p < 0.001$, *OR* 2.39, *SE* = 0.582, *CI* 1.48–3.85, see Table 2; length effect, $\chi^2_{(1)} = 16.8754$, $p < 0.001$, as short words, with fewer letters, are more likely to be read correctly than long ones, $p < 0.001$, *OR* 0.508, *SE* = 0.083, *CI* 0.368–0.702; semantic knowledge effect, $\chi^2_{(1)} = 51.1965$, $p < 0.001$, where properly translated words are more likely to be read correctly than words that children don't know the meaning, $p < 0.001$, *OR* 2.48, *SE* = 0.314; *CI* 1.93–3.18; and onset consistency effect, $\chi^2_{(1)} = 7.1816$, $p < 0.01$, as words with more consistent onset are more likely to be read correctly than less consistent ones, $p < 0.001$, *OR* 22.5, *SE* = 26.2; *CI* 2.31–220.00. In addition, we found an interaction between grade and semantic knowledge, $\chi^2_{(2)} = 10.3872$, $p < 0.01$, revealing that the effect of translation is grade-dependent, with a higher probability of correctly reading well-translated words in 6th grade than in the 4th and 5th grades, $p < 0.001$, *OR* 0.573, *SE* = 0.099, *CI* 0.409–0.804.

Onset, nucleus, and coda errors

To find out which part of the syllable is the most challenging for Spanish children and whether it depends on their grade and consistency, each of the parts of the syllable (onset, nucleus, and coda) has been coded as error (1), or non-error (0). First, we calculate the percentage of error by grade in each of the sub-syllabic units. Then, a Generalized Mixed Effects Modelling (GLMM), using the binomial family and the Laplace approximation for the likelihood, was performed for each part. Random effects of both participant and stimulus were included, while grade and consistency were considered fixed effects.

Children in the 4th grade committed 1490 errors: 210 (14.09%) in the onset, 811 (54,43%) in the nucleus, and 469 (31.47%) in the coda; those in the 5th grade

Table 2 Summary of percentage of reading and translation accuracy by grade

	4th grade		5th grade		6th grade	
	Incorrect reading	Correct reading	Incorrect reading	Correct reading	Incorrect reading	Correct reading
Incorrect translation	34.32	26.31	24.75	24.21	19.36	23.40
Correct translation	9.59	29.76	13.11	37.91	14.23	43.00

made 1201 errors: 128 (10.65%) in the onset, 665 (55.37%) in the nucleus, and 408 (33.97%) in the coda; and in those the 6th grade committed a total of 881 errors: 94 (10.67%) in the onset, 480 (54.48%) in the nucleus, and 307 (34.84%) in the coda.

Onset errors

In the onset analysis, we considered grade and onset consistency as fixed factors. The final model was *onset-error ~ onset consistency + grade + (1|participant) + (1|stimulus)*. We found grade effect, $\chi^2_{(2)} = 5{,}893{,}159$, $p < 0.001$, as the probability of error was smaller in the 5th grade, $p < 0.001$, *OR* 0.528, *SE* = 0.00, *CI* 0.527–0.528, and the 6th grade, $p < 0.001$, *OR* 0.338, *SE* = 0.00, *CI* 0.337–0.338, than in the 4th grade. As for the effect of the onset consistency, $\chi^2_{(1)} = 80{,}289{,}459$, $p < 0.001$, the higher the value in the onset consistency, the greater the probability of error decreases significantly, *OR* 0.0096, *SE* = 0.00, *CI* 0.00955–0.00957. The Tukey's HSD Test for multiple comparisons found significant differences between 4 and 5th grades ($p = 0.015$), and 4th and 6th grades ($p = 0.002$).

Nucleus errors

For the nucleus analysis, we considered grade, nucleus, and rime consistency as fixed factors. The final model was *nucleus-error ~ rime consistency * grade + (1|participant) + (1|stimulus)*. Only the rime consistency by grade interaction was significant, $\chi^2_{(2)} = 17.8037$, $p < 0.001$, as the higher the value of rime consistency, the lower the probability of error in 6th grade, $p < 0.001$, *OR* 0.241, *SE* = 0.081, *CI* 0.124–0.467. The Tukey's HSD Test showed significant differences between 4 and 6th grades ($p = 0.011$).

Coda errors

For the coda error analysis, grade, coda, and rime consistency were considered as fixed factors. The final model was *coda error ~ rime consistency * grade + (1|participant) + (1|stimulus)*. Once again, similarly to the nucleus analysis, only the rime consistency by grade interaction was significant, $\chi^2_{(2)} = 7.5399$, $p = 0.023$, as the higher the value of rime consistency, the lower the probability of error in 5th grade, $p = 0.014$, *OR* 0.426, *SE* = 0.148, *CI* 0.215–0.843, and 6th grade, $p = 0.024$, *OR* 0.435, *SE* = 0.161, *CI* 0.211–0.900. However, the Tukey's HSD Test did not show significant differences between grades in the percentage of coda-error.

Reaction times in words

Reaction times were measured from the time of the presentation of the stimulus to the consequent onset response. For the analysis of RTs, we only considered the RTs of the correct words with a minimum of 50% accuracy, a total of 52 words, that involved 4888 responses (4th = 1768; 5th = 1664; 6th = 1456), with 3654 of correct responses (74.75%). The characteristics of this set of words were: length (3 to

6 letters, $M_{length} = 4.17$; $SD = 0.85$); English lexical frequency according to the English textbook in the school ($M = 27.48$, $SD = 33.16$); and the feedforward consistency scores of the onset ($M = 0.97$, $SD = 0.56$), the nucleus ($M = 0.41$, $SD = 0.24$), the coda ($M = 0.93$, $SD = 0.15$), and the rime (nucleus + coda) ($M = 0.81$, $SD = 0.23$). The English lexical frequency correlates positively with Log of Frequency of a word as reported by the HAL Study ($M = 9.91$, $SD = 1.43$; $r = 0.395$, $p = 0.04$), (Balota et al., 2007), and negatively with grade of word introduction at school ($M = 2.38$, $SD = 1.42$; $r = -0.434$, $p = 0.001$).

A linear mixed model has been constructed to predict RTs as a function of the set of predictor variables (grade, length, semantic knowledge translation accuracy, English lexical frequency, onset consistency, nucleus consistency, coda consistency, and rime consistency). Participants and stimulus were entered as random effects. Starting from a maximal model that includes the interactions of the different variables with the grade, and given the existence of non-significant coefficients, we opted to apply a step-by-step selection algorithm to simplify the model. The final model was *RTs ~ semantic knowledge + onset consistency + grade + (1|participant) + (1|stimulus).* The intraclass correlation coefficient for this model is 0.363, and no collinearity is detected between the predictor variables, as verified through the variance inflation factors.

According to this, we found grade effect, $F(2, 90.8) = 8.9935$, $p < 0.001$, as 6th and 5th graders initiated the response significantly faster than 4th graders (6th *estimate* $= -74.63$, $SE = 18.129$, $t(91.127) = -4.117$, $p < 0.001$; 5th *estimate* $= -49.658$, $SE = 17.496$, $t(91.116) = -2.838$, $p = 0.006$); semantic knowledge effect, $F(1, 333.2) = 9.1681$, $p < 0.01$, as RTs were lower when translation accuracy is equal to 1 (*estimate* $= -15.973$, $SE = 5.275$, $t(3332.080) = -3.028$, $p = 0.002$); and onset consistency effect, $F(1, 50.1) = 6.8127$, $p < 0.05$, as the higher the consistency of the onset the lower the RTs, (*estimate* $= -335.344$, $SE = 128.479$, $t(50.128) = -2.610$, $p = 0.011$).

Discussion

The aim of this study was to explore reading performance and strategies used by Spanish-speaking children when reading in English FL. Spanish-speaking children in Spain had to read English monosyllabic words out loud. We studied the influence of psycholinguistic variables (length, lexical frequency, and orthographic consistency), in addition to semantic knowledge, on word accuracy and reading speed. Besides, we explored the effect of orthographic consistency on the onset, nucleus, and coda of the syllable.

Results indicated that reading accuracy depends on children's grade, the word length, onset consistency, and semantic knowledge. Moreover, the effect of semantic knowledge appears to be determined by grade, with a high probability of correctly reading words that they know the meaning of in 6th grade.

Concerning reading errors in the sublexical units of the syllable (onset, nucleus, and coda), children committed the highest number of errors in the nucleus, followed by the coda and the onset. This pattern was expected, considering the huge

inconsistencies of vowels in front of consonants (Treiman et al., 1995). Moreover, there were notable grade related differences. While onset consistency determined the onset reading accuracy in all grades, this was not the case for the nucleus and the coda. Specifically, nucleus reading accuracy was determined by the rime consistency only in 6th grade, and rime consistency determined reading accuracy of coda in 5th and 6th grades.

With regards to reading speed, 5th and 6th graders initiated the response significantly faster than 4th graders, and reaction times were shorter when children knew the meaning of the word, as well as when onset consistency was high.

Our results indicate that reading accuracy and reading speed increased with grade level, as reported by several studies in different orthographic systems (Cuetos & Suárez-Coalla, 2009). However, the number of errors remained high in 6th grade (33.60%), backing the idea that English has a very challenging orthography when compared to other more transparent orthographic systems, such as Spanish. Numerous studies maintain that differences in reading acquisition are determined by orthographic depth, with high levels of reading accuracy at early ages in transparent orthographies (Cuetos & Suárez-Coalla, 2009; Hoxhallari et al., 2004; Landerl, 2000; Orsolini et al., 2006; Seymour et al., 2003). Furthermore, the effects of different variables provide information on the reading strategies used by Spanish speaking children when reading in English. The length effect in reading accuracy could denote that Spanish-speaking children are using a reading sublexical strategy. The length effect on both reading accuracy and reading speed have been repeatedly described in the past, especially in the case of the transparent orthographies during the early ages of reading acquisition, as a marker of sublexical reading (Cuetos & Suárez-Coalla, 2009; Spinelli et al., 2005; Zoccolotti et al., 1999, 2005). By contrast, word length does not seem to be a determinant variable for opaque orthographies (Ziegler et al., 2001). In our context, it should be noted that Spanish children may experience some language interference during reading. The English language includes more phonemes than the Spanish one. The English writing system is opaque, includes digraphs, clusters, and some GPCs rules are incongruent with some Spanish ones (Hevia-Tuero et al., 2021). In addition, Spanish children start school without the phonological repertoire of English, so it is a considerable challenge for them to acquire some English phonemes in addition to the GPC rules.

On the other hand, the superiority of semantically known words over unknown ones seems to suggest the reported benefits of semantic information for reading, which is especially evident in reading accuracy of 6th graders. This result should be consistent with the existence of orthographic and semantic representations. However, children may also be learning that English words are read differently from Spanish words. Note that this result changes with grade in reading accuracy, suggesting that students in the 6th grade have more orthographic, semantic, and phonological representations of English words than do younger students. More years of schooling, and therefore more hours of language teaching/learning, are likely to have a noteworthy impact. The semantic knowledge effect suits the semantic weight for reading, proposed by the *Triangle Model of Reading* (Harm & Seidenberg, 2004), which is very appropriate when dealing with irregular words. When a written word is offered to a child, the three connected mental representations (orthographic,

phonological, and semantic representations) will be mutually activated. Thus, semantics would help in the orthographic recognition and phonological retrieval of words. In the same vein, the *Lexical Quality Hypothesis* (Perfetti & Hart, 2002) emphasizes the role of semantic knowledge in word recognition. Our data fits with the assumption that vocabulary and semantic information helps readers to recognise written words, according to a *top-down* process (Kirby et al., 2008). On top of that, semantics would help to recover the pronunciation of the word in cases of orthographic inconsistency (Share, 1995). Nevertheless, this semantic advantage was only evident for 6th graders, as they have a larger vocabulary than 4th and 5th graders. At this point, we could consider that a sublexical reading strategy, which is very reliable in Spanish, does not support English reading, and Spanish speaking children use language-specific mechanisms for reading in English. It is probable that differing contextual characteristics, such as English methodology or English exposure, are highly decisive factors, as the *Interactive Transfer Framework* argues (Chung et al., 2019; Das et al., 2011; Nakada et al., 2001; Tan et al., 2003).

Contrary to expectations, lexical frequency was not found to have an impact on reading, neither in accuracy nor reading speed. In several studies, word frequency resulted to be a major predictor of lexical access speed in both the L1 and the L2 (Brysbaert et al., 2016, 2017, 2018; Diependaele et al., 2013; Suárez-Coalla, et al., 2020), but here it was not the case. The effect of this variable is possibly masked by semantic knowledge. As mentioned above, in Spain, the acquisition of new English vocabulary is largely done through written language, hence there may be an overlap between semantic knowledge and lexical frequency. Besides, it would be interesting to consider the onset consistency effect. Even when Spanish children seem to perform a lexical reading, the onset consistency emerges as a predictor of both reading accuracy and reading speed, reported in previous studies (Balota et al., 2004; Treiman et al., 1995; Yap & Balota, 2009). This implies that they pay attention to the first grapheme of the word, which could mean that sub-lexical reading is also and simultaneously activated.

With regards to rime consistency, it has been reported to significantly facilitate latencies and accuracy in word naming and lexical decision tasks (Balota et al., 2004; Chateau & Jared, 2003; Treiman et al., 1995; Yap & Balota, 2009; Ziegler et al., 1997, 2008). On the contrary, we did not find an effect of rime consistency on reading latencies, but can still appreciate some sensitivity to the consistency, reflected in the reading accuracy of the sub-lexical units. In addition, the effect of rime consistency, rather than of the nucleus or the coda consistency, supports the need to rely on units larger than the grapheme for reading in English (Ziegler & Goswami, 2005). Moreover, the impact of rime consistency in the upper grades seems to indicate an exposure effect, which is evident. As stated by the statistical learning approaches, reading acquisition is an exercise of assimilation of statistical regularities (Sawi & Rueckl, 2019; Siegelman et al., 2020; Steacy et al., 2019), but it takes time. Therefore, even when the semantic role was evident, an adaptation to English regularities could be suspected in older Spanish-speaking children.

In summary, our study allows us to demonstrate the role that semantic knowledge plays when Spanish-speaking children are faced with English-language reading. However, some regularities seem to be used with greater reading experience

in English. These results suggest that Spanish-speaking children do indeed develop some sensitivity to certain regularities of the English writing system, even when they do not receive explicit instruction in the process of English decoding, nor systematic instruction in phonics.

Limitations and future directions

Despite the contributions of this study, it is necessary to consider some limitations that it holds. Firstly, it would be desirable to perform a longitudinal study, rather than a cross-sectional one, including more participants. It would also be very informative, in order to study cross-linguistic transfer, to take into account L1 reading performance (accuracy and speed of reading words and pseudo-words) in the analyses. Additionally, it could be of great interest to have a language control group, either with a similar (Italian) or a close language with a deep orthography (Portuguese), as it would provide a great deal of information on the mechanisms of EFL reading. In any case, this type of study is always complex, considering the possible influence of a myriad of other variables (e.g.: methodology, age at the start of language learning, etc.). At the same time, collecting data on older children (Secondary Education) to find out how Spanish-speaking children develop orthographic strategies and sensitivity to English GPCs over time could be very interesting and insightful. Last but not least, other linguistic aspects, such as syllable length and complexity, would also be deemed of great importance for future studies.

Appendix

Word	Eng_freq	Length	Onset	Nucleus	Coda	Rime
Beach	63	5	0.985816	0.536261	0.7083333	1
Beak	3	4	0.985816	0.536261	1	0.516129
Beard	6	5	0.985816	0.100102	1	0.666667
Bed	25	3	0.985816	0.430565	0.9980276	0.921569
Bird	11	4	0.985816	0.073435	1	1
Bone	7	4	0.985816	0.236635	1	0.789474
Bread	19	5	1	0.263534	0.9980276	0.917808
Bridge	24	6	1	0.708092	1	1
Bush	1	4	0.985816	0.047029	0.9814815	0.285714
Cat	30	3	0.893359	0.481889	0.9918367	0.844828
Cheese	46	6	0.800995	0.885892	0.4148148	0.75
Clock	65	5	1	0.32956	0.995935	0.981818
Coat	17	4	0.893359	0.756881	0.9918367	1
Crab	11	4	0.99705	0.481889	0.9741379	0.658228
Dad	29	3	0.980992	0.481889	0.9980276	0.591241
Desk	8	4	0.980992	0.430565	1	1

Word	Eng_freq	Length	Onset	Nucleus	Coda	Rime
Dog	47	3	0.980992	0.145912	0.9919679	0.380952
Doll	18	4	0.980992	0.32956	1	0.230769
Door	8	4	0.980992	0.035917	0.9984902	0.761905
Food	152	4	0.962316	0.589792	0.9980276	0.092593
Foot	3	4	0.962316	0.319471	0.9918367	0.615385
Friend	176	6	1	0.060811	0.9615385	0.888889
Frog	2	4	1	0.32956	0.9919679	0.595238
Gate	4	4	0.764444	0.145241	1	1
Girl	39	4	0.764444	0.073435	1	1
Glove	19	5	1	0.239151	1	0.482759
Grape	19	5	1	0.145241	1	1
Hat	39	3	0.957055	0.481889	0.9918367	0.844828
Health	6	6	0.957055	0.263534	1	1
Heart	5	5	0.957055	0.022472	0.9375	0.923077
Hen	1	3	0.957055	0.430565	0.9310995	0.746528
Horse	22	5	0.957055	0.145912	1	0.933333
Job	22	3	0.990712	0.32956	0.9741379	0.510204
Juice	12	5	0.990712	0.281481	1	1
King	54	4	0.993711	0.708092	0.9435028	1
Leaf	1	4	1	0.536261	0.9897959	0.833333
Leg	33	3	1	0.430565	0.9919679	0.941176
Life	20	4	1	0.198168	1	1
Luck	40	4	1	0.780531	0.995935	1
Man	37	3	0.971113	0.481889	0.9310995	0.742671
Meal	9	4	0.971113	0.536261	0.9728183	0.529412
Month	26	5	0.971113	0.239151	1	1
Moon	26	4	0.971113	0.589792	0.9310995	1
Mouse	14	5	0.971113	0.610054	0.5851852	0.939394
Mouth	37	5	0.971113	0.610054	0.8785047	0.785714
Night	42	5	0.869863	0.198168	0.989011	1
Noise	8	5	0.869863	0.935484	0.4148148	1
Nose	25	4	0.869863	0.236635	0.4148148	0.666667
Noun	6	4	0.869863	0.610054	0.9310995	0.918919
Path	4	4	0.978924	0.481889	0.8785047	1
Pear	15	4	0.978924	0.263534	0.9984902	0.08046
Pen	6	3	0.978924	0.430565	0.9310995	0.746528
Queen	15	5	0.974843	0.7	0.9310995	1
Rice	7	4	1	0.198168	1	1
Road	5	4	1	0.756881	0.9980276	0.482759
Room	61	4	1	0.589792	1	0.846154
Shark	10	5	1	0.112216	1	1
Shirt	34	5	1	0.073435	0.9375	1
Skin	8	4	0.979592	0.708092	0.9310995	0.897183

Word	Eng_freq	Length	Onset	Nucleus	Coda	Rime
Sleeve	7	6	1	0.885892	1	1
Son	4	3	0.992038	0.239151	0.9310995	0.534442
Song	58	4	0.992038	0.145912	0.9435028	0.864865
Spoon	1	5	0.986486	0.589792	0.9310995	1
Square	17	6	1	0.068376	1	1
Stair	1	5	0.955882	0.228381	0.9984902	1
Street	16	6	1	0.885892	0.9918367	0.952381
Sun	50	3	0.992038	0.780531	0.9310995	0.965691
Sword	16	5	0.034722	0.145912	1	0.785714
Thief	12	5	0.798165	0.486486	0.9897959	1
Wall	8	4	1	0.045928	1	0.972973
Week	46	4	1	0.885892	1	1
Weight	4	6	1	0.585859	0.989011	0.714286
Wife	2	4	1	0.198168	1	1
Wood	12	4	1	0.319471	0.9980276	0.537037
World	47	5	1	0.239151	1	1
Worm	4	4	1	0.239151	1	0.333333

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