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Relationships Between Phonological Awareness and Reading in Spanish: A Meta-Analysis

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Abstract: Previous meta-analyses of the relationship between phonological awareness (PA) and reading have been conducted mostly in children who speak English, a language with an opaque writing system. In this study, we present a meta-analysis that examined mean correlations between three PA tasks testing phonemic, syllabic, and intrasyllabic awareness and three reading tasks testing word reading, nonword reading, and reading comprehension in Spanish, a language with a near-transparent writing system. A random-effects model of 47 articles ($N = 7{,}956$) was used for a multiple

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correlation study that showed a significantly moderate correlation between some of the PA subcategories and the reading tasks in Spanish-speaking children. The largest correlation values were found between syllabic awareness and reading, which highlights the importance of syllable recognition during reading acquisition. In addition, we found that intrasyllabic awareness also plays an important role in reading in Spanish. The findings are discussed from a cross-linguistic perspective.

Keywords meta-analysis; phonological awareness; phonology; reading; reading acquisition; Spanish language

Introduction

Despite the fact that reading and writing appeared much later in human history compared to the appearance of speech, humans currently obtain a lot of the information needed to function in different spheres of life through various types of written texts (Cuetos Vega, González Álvarez, & de Vega Rodríguez, 2015; Vieiro Iglesias & Gómez Veiga, 2004). Although people usually take reading for granted, it is a remarkable, complex, and fragile event due to the many abilities that readers have to master, including decoding, vocabulary knowledge, semantic and syntactic processing, and inference-making (Aslin, 2013).

Several studies of orthographic languages have highlighted the role of phonological awareness (PA), that is, the conscious awareness of the sounds that make up the words of a language and the ability to manipulate them, as one of the main predictors of literacy success (Anthony & Francis, 2005; Caravolas et al., 2012; Caravolas, Lervåg, Defior, Seildlová Málkova, & Hulme, 2013; Ehri et al., 2001; Goodrich & Lonigan, 2016; Holliman, Hurry, & Bodman, 2016; Kirby, Parrila, & Pfeiffer, 2003; Meira, Cadime, & Viana, 2018; Rodríguez, van den Boer, Jiménez, & de Jong, 2015). This ability allows readers to decode words, that is, to map speech sounds onto alphabet letters, to access their meaning and, together with syntactic processing, inference-making and integration of prior knowledge, to comprehend the intended meaning of a written text (Britt & Rouet, 2012; Kintsch & Rawson, 2005; Kintsch & van Dijk, 1978).

However, because alphabetic languages are usually classified as either transparent or opaque depending on their degree of orthographic transparency, the relationship between PA and reading may not be the same in all languages, especially during the first years of reading acquisition. Most meta-analyses that have examined the role of PA in reading have focused on samples of speakers of English, a language with an opaque writing system, but for other transparent languages such as Spanish, there have been no meta-analytic studies that have reviewed the relationship between PA and reading. Therefore, the present

study aimed to present a meta-analysis that examined the relationship between PA and reading in a Spanish-speaking sample (both monolingual and bilingual) from a cross-linguistic perspective.

Background Literature

Phonological Awareness and Reading

It seems that, to decode, readers must have developed, spontaneously or through training, a certain degree of metalinguistic awareness, which is defined as the capacity to consciously reflect and manipulate the structures of the spoken language—such as the syntactic, lexical, pragmatic, morphological, or phonological aspects of a language (Cartwright, Bock, Coppage, Hodgkiss, & Isaac, 2017; Jiménez González & Ortiz González, 1995; Tunmer & Herriman, 1984). In fact, to properly decode a written word, children must be aware that speech is composed of a continuous collection of sounds that become increasingly smaller (words, syllables, rhyme and onset, and phonemes) and must know not only that those sounds can be manipulated but also that they share an arbitrary and conventional correspondence with written units (Anthony & Francis, 2005). Several authors have established that PA in the beginning stages of reading is one of the predictors of future reading abilities, and difficulties in this type of awareness might be the main cause of future reading problems (Caravolas et al., 2012, 2013; Ehri et al., 2001; Melby-Lervåg, Lyster, & Hulme, 2012).

During reading acquisition, children have to learn the way their spoken language is encoded in a writing system and, therefore, how to decode the writing system by using their orthographic, phonetic, and morphological skills (Pugh & Verhoeven, 2018; Verhoeven & Perfetti, 2017). These perceptive processes analyze and categorize the characteristics of a written script. According to Coltheart's double route model (Coltheart, 1985; Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001)—considered to be one of the most consolidated models of reading acquisition that today is still able to provide solid explanations for experimental data from both dyslexic and nondyslexic readers (Cuetos Vega, 2008; Jiménez & O'Shanahan, 2008)—there are two routes: the nonlexical route (also known as the sublexical route) that allows readers to read new words or nonwords through direct decoding, and the lexical route through which readers associate the visual representations of the words that they decode with their existing mental lexicon that contains all their previous knowledge of and experiences with words. Finally, through a syntactic analysis of sentences, together with readers' prior experiences and knowledge and the inferences that they have to make, readers are able

to comprehend the intended meaning of a written text (Britt & Rouet, 2012; Kintsch & Rawson, 2005; Kintsch & van Dijk, 1978). The majority of studies on reading have focused on children learning to read in English, which has one of the hardest orthographies to master (Borleffs, Maassen, Lyytinen, & Zwarts, 2017; Landerl & Wimmer, 2008; Share, 2008). However, due to the differences between alphabetic language systems, it has been suggested that cross-linguistic differences that can affect reading might exist in phonological processing across orthographies (Pugh & Verhoeven, 2018).

One of the most relevant advances in the theory of reading development is that of the predictive power of PA, that is, the ability to reflect and manipulate the units or phonemes of a language (Levelt et al., 1991; Tunmer & Herriman, 1984), for early reading acquisition (Muter & Diethelm, 2001). This skill develops over time as children begin to be aware that speech is made of sounds that are increasingly greater (phonemes, rhymes, syllables, etc.) and as they start detecting that the same sounds appear in different words (Anthony & Francis, 2005). In fact, children start by detecting the larger units that can be written such as syllables, and, with time and practice, they become aware of the existence of the smaller ones that can be written using letters (Ziegler & Goswami, 2005). A wide range of studies (Anthony & Francis, 2005; Caravolas et al., 2012, 2013; Ehri et al., 2001; Goodrich & Lonigan, 2016; Holliman et al., 2016; Kirby et al., 2003; Meira et al., 2018; Rodríguez et al., 2015) has extensively examined this relationship, in various languages, in children learning alphabetic languages even before their formal reading instruction began (Boyer & Ehri, 2011).

The nature of the relationship between PA and reading has been the focus of much controversy among experts in the field. Although some researchers have stated that PA is a unitary cognitive skill that does not need to be divided into different subunits (Anthony & Lonigan, 2004; Anthony et al., 2002; Papadopoulos, Spanoudis, & Kendeou, 2009), several authors have distinguished various types of subcategories (or subabilities) that children acquire gradually (Perfetti, Beck, Bell, & Hughes, 1987; Ziegler & Goswami, 2005): (a) *syllabic awareness*, the capacity to consciously segment, blend, identify, or manipulate the syllables contained in a word (Ziegler & Goswami, 2005); (b) *intrasyllabic awareness*, which allows speakers to compare rhymes and onsets between words (Treiman, 1992); (c) *prosodic awareness*, the ability to perceive the length, pattern, tone, and pauses of statements in order to focus on their most important parts (Wade-Wolley, 2016; Whalley & Hansen, 2006); and (d) *phonemic awareness*, which helps readers discriminate the phonemes that form a word and blend them to form higher units (Boyer & Ehri, 2011;

Ehri et al., 2001; Vieiro Iglesias & Gómez Veiga, 2004). The tasks used for the evaluation of these abilities have varied according to the size of the phonological units analyzed, that is, the type of phonological subcategory, as well as the implicitness/explicitness of the tasks (McBride-Chang, 2004).

The current study addressed the various types of PA subabilities that children acquire. To do so, we divided the tasks analyzed in each study according to the type of phonological subcategory assessed: syllabic, intrasyllabic, prosodic, and phonemic awareness. In addition, we discuss our findings from a cross-linguistic perspective to determine if any of our findings were specific to one language (or one type of language) or if our findings were more general to PA in reading across languages.

Phonological Awareness: A Cross-Linguistic Perspective

The alphabetic principle that is applied to represent a written language in alphabetic scripts—the application of grapheme-phoneme correspondence rules—does not have the same consistency in all alphabetic languages (Defior, 2004). In fact, based on their degree of consistency, alphabetic orthographies are usually classified as either transparent or opaque. More transparent orthographies such as that of Spanish allow fast and direct decoding of letters into sounds because their representations are relatively consistent. However, opaque orthographies such as those of French or English do not have such obvious correspondences (Denes, 2011; Perfetti & Harris, 2013). Therefore, children learning to read in a transparent orthography do so more quickly than do those learning to read in an opaque orthography (Seymour, Aro, & Erskine, 2003).

However, the role of PA in reading in transparent versus opaque orthographies is still not clear. On one hand, some researchers have agreed that PA is crucial in reading acquisition regardless of the type of orthography analyzed (Caravolas et al., 2012; Moll et al., 2014). On the other hand, several researchers have found that, although PA tasks were related to reading, they played a less important role in reading (i.e., had less predictive power when accounting for the development of reading relative to other variables that can influence reading) in more transparent orthographies than in more opaque ones (Mann & Wimmer, 2002; Ziegler et al., 2010).

Due to the differences between alphabetic language systems and to the fact that models of dyslexia tend to focus on phonological processing deficits (without considering the transparency of the language studied), the connection between PA and reading might not be straightforward or universal (Defior, 2004; Pugh & Verhoeven, 2018). When taking into account the role of PA and its subcategories in languages with both transparent and opaque writing

systems, some differences may arise due to their different degrees of orthographic transparency. Defior (2004) established the possibility that the relationship between PA and reading is different depending on the transparency of the language, especially during the first years of reading acquisition, which might explain differences in the development of PA abilities.

As research has shown, segmenting into phonemes (phonemic awareness) seems to be important for children learning to read in a transparent language, and it is a skill that is acquired with relative ease (see, e.g., Caravolas, Volín, & Hulme, 2005, for Czech; Cossu, Shankweiler, Liberman, Katz, & Tola, 1988, and Tobia & Marzocchi, 2012, for Italian; Denton, Hasbrouck, Weaver, & Riccio, 2000, and Jiménez González & García, 1995, for Spanish; Güldnoğlu, 2016, for Turkish; Holopainen, Ahonen, Tolvanen, & Lyytinen, 2000, and Torppa, Lyytinen, Erskine, Eklund, & Lyytinen, 2010, for Finnish; and Patel, Snowling, & de Jong, 2004, for Dutch). In fact, several studies have demonstrated that children who are learning to read in a transparent language reach their ceiling of reading accuracy (i.e., decoding of words and nonwords) at about 6 years of age (for a complete review, see Ziegler & Goswami, 2005).

In addition, the syllabic structure of a language also plays a role in the development of PA. In fact, syllabic awareness seems to be related to reading in transparent languages such as Italian (Cossu et al., 1988) or Turkish (Güldnoğlu, 2016). The syllabic structure of Spanish is considered to be quite simple. According to Guerra (1983), 89% of Spanish syllables are CV, CVC, or CCVV, of which 51% are CV, and this seems to be why syllabic awareness plays a very important role in Spanish in the development of PA and in the acquisition of reading (Casillas & Goikoetxea, 2007; Denton et al., 2000; Gorman & Gillam, 2003; Jiménez González & García, 1995; Jiménez González & Ortiz González, 2000).

Intrasyllabic awareness, that is, the recognition of the onsets and rhymes of words, is an ability that is considered crucial in reading acquisition and development in opaque languages such as English and French (Álvarez, Taft, & Hernández-Cabrera, 2017; Bradley & Bryant, 1985; Bryant, Bradley, MacLean, & Crossland, 1989). However, for its role in reading in more transparent languages, research is still scarce and somewhat mixed: Pfost (2015) established that intrasyllabic awareness was much less significantly related to reading compared to phonemic awareness in German. In sum, further research is needed to determine the contributions of this type of awareness in reading in transparent languages.

Finally, languages also differ in their prosody and, therefore, in their speakers' prosodic awareness. Despite differences due to the stress-timed/

syllable-timed disparities between languages (Casillas & Goikoetxea, 2007; Cuetos, Martínez-García, & Suárez-Coalla, 2017; Jiménez González & Ortiz González, 2000), several studies did not find any significant difference between Spanish (syllable-timed) and English (stress-timed) in the importance of prosodic awareness—especially in rise time discrimination—in reading acquisition and development (Cuetos et al., 2017; Goswami et al., 2011).

In addition, the type of reading tasks used, that is, word reading, nonword reading, and reading comprehension, also might have an impact on the results obtained for PA. Because, as we previously stated, PA is closely associated with decoding and word reading, it has been shown that word and nonword reading tasks are more highly correlated with the different PA subcategories than are reading comprehension tasks when both are measured (Defior, Gutiérrez-Palma, & Cano Martín, 2012; González, 1996). In addition, it was found that nonword reading tasks are more closely correlated with PA than are word reading tasks (Calet, Flores, Jiménez-Fernández, & Defior, 2016). This may be because nonword reading requires a direct conversion of graphemes into their corresponding phonemes, but real words, especially familiar words, can be read using a more direct route, as explained by Coltheart's dual model (1985, 2001).

Thus, in addition to addressing the various types of PA subabilities that children acquire, in the present study, we examined the mean correlations between different PA tasks and the reading tasks of word reading, nonword reading, and reading comprehension from a cross-linguistic perspective.

Research on Bilingual Speakers and Readers

Due to differences in the orthographic transparency of languages, a starting point for looking at the role of PA in reading cross-linguistically was to focus on differences within different languages, especially those with alphabetic orthographies. One way to study PA and reading from a cross-linguistic perspective is to focus on research on bilingual speakers and (emerging) biliterates. Several studies have shown that phonological abilities can be transferred from one language to another by bilingual children (Kuo, Uchikoshi, Kim, & Yang, 2016). Studies by Bialystok, Majumder, and Martin (2003), Branum-Martin et al. (2006), Bursztyn (1999), Durgunoglu (1998), Durgunoglu, Nagy, and Hancin-Bhatt (1993), Khalaf, Santi, Kulesz, Bunta, and Francis (2019), Kovelman, Baker, and Pettito (2008), and Quiroga, Lemos-Britton, Mostafapour, Abbott, and Berninger (2002) showed that bilingual children tend to overlap and transfer the phonological abilities that they have acquired in one language to another language when learning to read.

In fact, these researchers mentioned above established that PA abilities better predict different types of reading (word and nonword reading and reading comprehension) in bilingual children, in both of their languages, than PA abilities predict reading in monolingual children. When monolingual speakers are asked to decode nonwords that look similar to existing words in their language, it is common for them to make mistakes and decode these nonwords as real ones (i.e., they decode the word as a whole unit through the lexical route instead of decoding each grapheme). However, as these researchers have established, bilingual children usually transfer their phonological abilities to the new words that they read in their other language (including languages with a different degree of consistency) and, therefore, are reading the new words through the nonlexical route.

Hence, it seems important to understand if the specific languages spoken by the bilingual participants of PA studies moderate the relationship between PA and reading. This question was addressed in the present study.

Meta-Analyses of Phonological Awareness and Reading

The presence and extent of a relationship between PA and reading in alphabetic languages have been examined in several meta-analyses. For example, Swanson, Trainin, Necoechea, and Hammill (2003) presented a meta-analysis in which they analyzed the correlation that existed between PA, rapid automatized naming (a series of tasks in which participants have to name a series of repeated letters, numbers, objects, or colors as fast as possible), word and nonword reading and reading comprehension, and other abilities in English in a sample of 2,257 children (with English as their L1). They found a mean correlation of .41 between real-word reading and PA and of .43 between nonword reading and PA.

Melby-Lervåg et al. (2012) analyzed a sample of studies composed of English-speaking students. The authors analyzed two types of studies: studies that compared dyslexic students with a control group, and correlational studies among children with no reading problems. Of relevance to the current article is that across the 155 studies that they found of the latter type, they extracted a mean correlation between phonemic awareness and word reading of .57, and between intrasyllabic awareness and word reading of .43.

A longitudinal meta-analysis by Pfost (2015) addressed the fact that the majority of studies had been conducted in English. Pfost's meta-analysis examined the results of 21 independent studies that had taken place in German-speaking countries and that had analyzed the relationship between PA and reading comprehension. The results indicated a mean correlation of .31 within

a fixed-effects model and a mean correlation of .33 within a random-effects model.

Finally, Hjetland, Brinchmann, and Scherer (2020) analyzed the correlation between phoneme awareness and reading comprehension (among other measures) with the goal of discovering which abilities are most related to reading comprehension in preschoolers. They found a correlation of .40 in 64 studies (of which 40 were conducted with English-speaking participants). However, this research did not separate the results by languages and, therefore, cannot inform us when making comparisons between languages.

In conclusion, these meta-analyses generally found that there was a significant moderate correlation between word reading and PA and between nonword reading and PA (Melby-Lervåg et al., 2012; Swanson et al., 2003) as well as between reading comprehension and PA (Hjetland et al., 2020; Pfost, 2015) in English (either as the first or second language) and German (as a first language). However, although it has been demonstrated that PA is one of the main predictors of reading in both opaque (English) and relatively transparent (German) languages, it seems that the role of PA in reading in other languages (i.e., in languages other than English and German) is not yet completely understood. In fact, we were unable to find any meta-analytic study that reviewed the relationship between PA and reading in a very transparent language such as Spanish. Therefore, in this study, we have presented a meta-analysis that examined the relationship between PA and reading in Spanish.

The Present Study

Research has suggested that PA is related to reading in Spanish, but a better view of this relationship is needed, especially from a cross-linguistic perspective. Therefore, we concluded that a meta-analysis of Spanish was needed to understand better the connection between variables such as phonemic awareness, syllabic awareness, and similar abilities so as to establish the strength of the relationships that exist between PA in Spanish and reading in Spanish (among monolingual and bilingual learners) and to determine the correlations that occur between the different subcategories of PA and reading tasks.

This meta-analysis aimed to analyze the relationship between PA and reading in Spanish and was designed to answer the following research questions:

1. What are the relative strengths of association between types of PA (i.e, phonemic, intrasyllabic, syllabic, and prosodic awareness) and reading tasks (i.e., word reading, nonword reading, and reading comprehension) in Spanish?

2. To what extent do the other (first) languages spoken by the participants moderate any associations between PA and reading tasks in Spanish?

Based on the literature analyzed above, we hypothesized that, for question 1, in Spanish there is a moderate to strong positive correlation between PA and nonword reading in which phonemic and syllabic awareness play a significant role, and intrasyllabic and prosodic awareness do not. In addition, for question 2, we expected bilingual participants to obtain higher correlations between reading and PA abilities than would monolingual participants. Finally, due to the importance of PA in decoding, we expected a higher positive correlation between word reading and phonemic awareness and also between word reading and syllabic awareness tasks in all participants, compared to the other types of PA and reading.

Methods

Our meta-analysis was based on the recommendations of Plonsky and Oswald (2015) and was guided by other published meta-analyses, such as those by de Vos, Schriefers, Nivard, and Lemhöfer (2018), Jeon and Yamashita (2014), Ke, Miller, Zhang, and Koda (2021), Plonsky (2011), Uchihara, Webb, and Yanagisawa (2019), and Yanagisawa and Webb (2021).

Literature Search and Inclusion Criteria

We searched for articles, book chapters, meta-analyses, reports, dissertations, conference papers, and publications in peer-reviewed journals in the following databases: ERIH (European Reference Index for Humanities), PubMed, PsycNET, PsycINFO, ProQuest, OCLC World Cat, ÍnDICEs CSIC, Dialnet, and Google Scholar from January 1970 to January 2020. We used the search terms *Spanish*, *Spanish speaking*, and *Castilian* paired with (using the Boolean operator AND) *phonological awareness*, *phon* awareness*, *phonological abilities*, *phonemic awareness*, *prosodic awareness*, *syllabic awareness*, *intrasyllabic awareness*, *reading*, *word reading*, *nonword reading*, and *reading comprehension* to search for articles written in both Spanish and English. We also searched by hand several journals related to reading, such as *Journal of Research in Reading*, *Scientific Studies in Reading*, *Reading and Writing*, and *Reading Research Quarterly*. We also emailed researchers prominent in the field to ask them for unpublished materials. As a result, we obtained 431 abstracts that seemed initially eligible. Figure 1 provides a summary of the study screening criteria, including the number of articles eliminated at each stage (Moher, Liberati, Tetzlaff, & Altman, 2009).

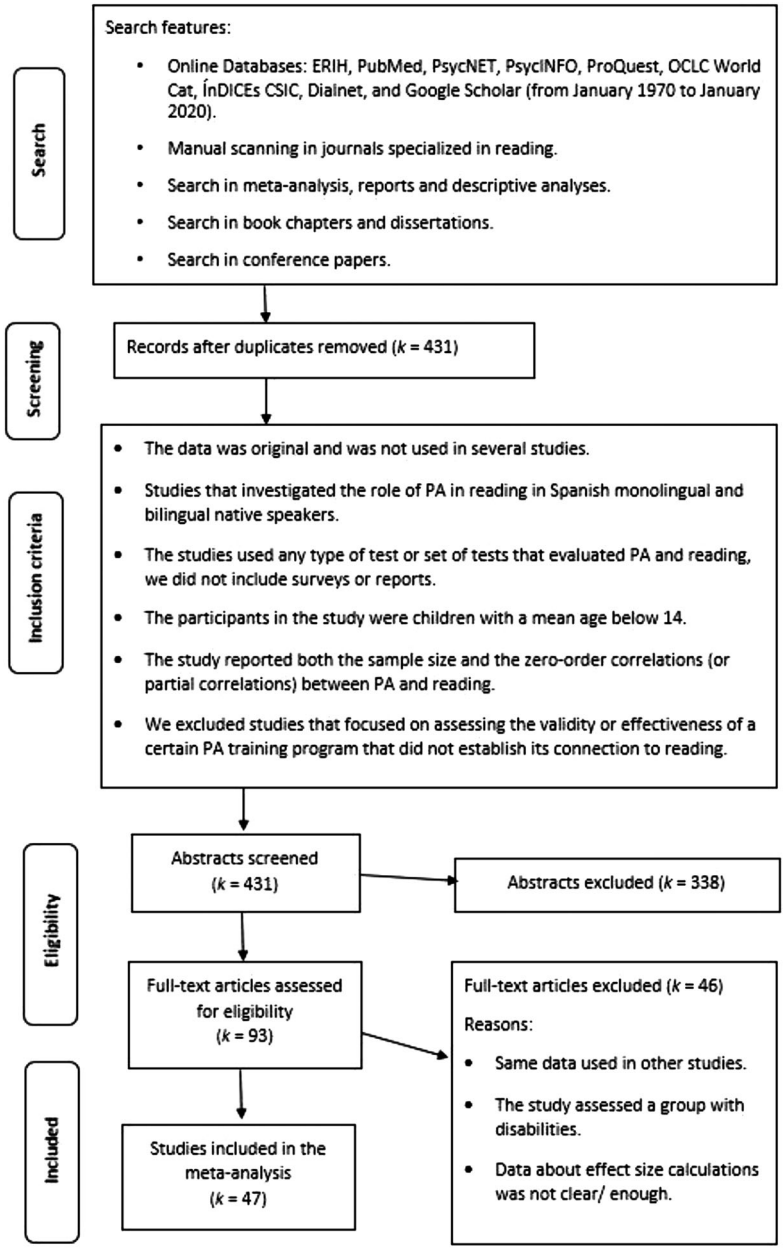

Figure 1 Flow diagram of the study screening criteria.

We did not include studies that had analyzed the role of PA in deaf, blind, or dyslexic children or in children with a specific disorder. However, we did include the control groups from such studies with special populations, as well as studies with students with reading difficulties who were not diagnosed as having any developmental disorder. According to Araújo, Reis, Petersson, and Faísca (2015), longitudinal studies can include correlations based on multiaged samples that could influence our effect sizes. Thus, in our meta-analysis, when a study of these characteristics covered a period greater than 3 years, we considered only the scores obtained when PA and reading abilities were both first assessed in the study (not those that may have been assessed at later stages in the longitudinal design).

To prevent a violation of the independence of observations, we thoroughly examined studies written by the same authors to determine if there were any duplicate samples. In cases where samples overlapped, we included the article that provided the more complete data. For longitudinal studies, we coded the first measurement of reading. For experimental studies (i.e., intervention studies), we included only pretest data. Likewise, when a study had two independent samples (e.g., when one sample was used to analyze PA and reading in average readers and the other sample was used to analyze PA and reading in disabled readers), we analyzed either each sample separately or only the sample that matched our investigation.

Of the initial 431 abstracts, 47 resulted a sample of 7,956 children who met these requirements (the full bibliography of the sample of studies is included in Appendix S1 in the online Supporting Information as well as in the IRIS database at https://www.iris-database.org/iris/app/home/detail?id=york:939492). All three authors coded all of the studies, and the interrater agreement rate across all coded variables was 99%, which indicated a high level of agreement between the coders. Whenever a disagreement between coders occurred, it was solved by reviewing the original article and discussing it. There was no need to consult a fourth coder.

All these precautions and the exhaustive selection of the studies to be included were necessary for the sake of replicability of the meta-analysis as indicated by Boers, Bryfonski, Faez, and McKay (2020).

Recorded Variables and Coding

Due to the heterogeneity of the variables used in the different studies and the different degrees of transparency in the languages spoken by the bilingual samples, we decided to analyze two main types of tasks—PA and reading—that included several subabilities that could be correlated (see Tables S2.1–S2.7

in Appendix S2 in the online Supporting Information for more information). The coding scheme and data (Míguez-Álvarez, Cuevas-Alonso, & Saavedra, 2021) are available on IRIS at https://www.iris-database.org/iris/app/home/detail?id=york:939492

Phonological Awareness

As we stated previously, the PA assessments included several measures that depended on the size of the phonological unit (syllables, rhymes, and phonemes). The types of PA tasks used were categorized as (a) syllabic awareness, (b) intrasyllabic awareness, (c) prosodic awareness, and (d) phonemic awareness. It was common to provide the results of only a series of subtasks of each type of PA task, that is, instead of showing the total score obtained in the phonemic awareness category, some studies reported the results that the participants had obtained in the phoneme deletion task and in the phoneme segmentation task. Therefore, to avoid having an excessive amount of subdata and to be able to correlate them with the scores obtained in the reading tasks, when a study provided only the results of each individual task of a subcategory, the arithmetical mean was calculated.

Reading

Following the classification provided by Araújo et al. (2015), we divided the tasks used to measure reading into three different categories: (a) real word reading, (b) nonword reading (i.e., strings of letters that do not follow the orthographic rules of the language) and pseudowords (i.e., combinations of letters that follow the orthographic rules of the language but do not have meaning), and (c) reading comprehension (i.e., a series of literal or inferential questions related to the texts).

Moderator Variables

We coded studies for participants' age and monolingual/bilingual status, as, according to previous research, these variables may act as moderators between the variables under investigation. We only analyzed the effect of a moderator variable if at least four studies provided the relevant data.

Monolingualism/Bilingualism and Other Languages Spoken

We coded whether the participants were monolingual or bilingual as stated in the publications. If no indication of the bilingual status of the participants was provided, we assumed that the sample participants were monolingual in Spanish. We also coded the other languages that were spoken by the bilingual participants.

Age

We used age as a proxy to differentiate the various stages of reading acquisition and proficiency (though we acknowledge that age is not a precise index for reading ability or proficiency, given individuals' different trajectories). To avoid including the same sample at different ages from longitudinal studies, we coded the age of a sample using a method similar to the one reported by Song, Georgiou, Su, and Hua (2015): When both the age range and the mean age were provided, we coded the mean age. When a study reported only the age range and it was shorter than 1 year, we calculated the median of that study's age range. Last, when a study provided an age range that was greater than 1 year and did not provide any other type of coding about age (such as the mean or median), we decided to exclude it from the analysis that used age as a moderator. In addition, due to the great number of countries included in this study, we decided not to code the school grade of the sample and provided only the ages of the participants. The age range for the studies was between 4.5 and 11.5 years. None of the studies analyzed had children who had reached the limit for exclusion (14 years).

Meta-Analytic Procedures

We used the software R (Version 3.5.2; R Core Team, 2019) and the metafor package (Version 2.0-0; Viechtbauer, 2010) to run the majority of the analyses. Appendix S2 comprises Tables S2.1 through S2.7, in the online Supporting information, alphabetized by author, that show the correlations between the main target constructs, that is, the different PA types: syllabic awareness, intrasyllabic awareness, and phonemic awareness (due to the small number of studies that included this variable, we were unable to include prosodic awareness in our meta-analysis), and the reading task types: word reading, nonword reading, and reading comprehension, as well as the ages of the samples, whether the participants were monolingual or bilingual, and the other languages that they spoke.

We used Pearson's correlation coefficient to measure the effect size between two continuous variables. We deemed that an effect size of $r = .10$ was small, an effect size of .30 was moderate, and an effect size of .50 or greater was large (Borenstein, 2009; Cohen, 1988). Plonsky and Oswald (2014) in their meta-analysis of L2 studies found a different framework of reference for correlation coefficients. However, since our study included a lot of samples with only L1 learners, we decide to follow Borenstein (2009) and Cohen (1988). We calculated the overall correlation through the weighted (by sample size) mean of the correlations that each study provided. As Borenstein, Hedges, Higgins,

and Rothstein (2009) have recommended, because the distributions of samples were not always normal, we used the Fisher's *r*-to-*z* transformation. Then, we transformed the results obtained into correlation units for better interpretation.

When deciding which correlations from our primary studies to include in our meta-analysis, we included both zero-order correlations and partial correlations of PA with reading. Although both zero-order and partial correlation coefficients are measures of the relationship between two variables, they do not measure the relationship in the same way. The difference between them is that the zero-order correlation is a measure of the relationship between two variables without considering other variables, but partial correlation is a measure of the relationship between two variables after other variables are controlled for. Although the possible consequences of including both bivariate and partial correlations in the same analysis should be evaluated more thoroughly, both coefficients are indicators of the degree of association and so the decision to include both was taken in order to maintain a reasonable study sample size.

We analyzed the statistical significance of the mean effect size with a random-effects model. To do so, we calculated 95% confidence intervals, which meant that the effect sizes were statistically significant when a confidence interval did not include 0 (Borenstein et al., 2009). For all the analyses, we established an alpha level of .05 to be our level of statistical significance.

To evaluate if the variation in the correlations between studies was significant, we used the Q test of homogeneity (Hedges & Olkin, 2014). A significant value for the test indicated a reliable variability between all the correlations included in the sample of studies. In other words, the set of individual studies was not homogeneous. However, the Q test only indicates if there is a statistically significant heterogeneity but does not show its extent. Therefore, to assess the percentage of variation that occurred between studies due to heterogeneity (and not by chance), we used the I^2 statistic (Huedo-Medina, Sánchez-Meca, Marín-Martínez, & Botella, 2006).

To help determine whether publication bias existed, we created funnel plots from the analysis of the random-effects models. The funnel plot represents the magnitude of the measured effect (*x*-axis) against a measure of precision (*y*-axis), which is usually the sample size (as in the current study), but which can also be the inverse of the variance or the standard error. Each primary study is represented by a dot. The precision of the results will be higher in studies with larger sample sizes, so the points will be closer together at the top of the *y*-axis and will disperse as they approach the origin of the *y*-axis S3.1–S3.8 in Appendix S3 in the online Supporting Information (for more information

as well as the IRIS database at https://www.iris-database.org/iris/app/home/detail?id=york:939492). We also conducted a metaregression analysis based on the random-effects models to see if the moderator variables affected the effect sizes in the sample of studies. For the categorical moderator variables age and monolingual/bilingual status, we divided the studies into a series of subsets according to their category. Then, we studied the influence of the moderators on the correlation by comparing between the subsets.

Finally, we analyzed the influence of the different kinds of PA tasks and reading tasks on the values of the correlation coefficients by means of a two-way analysis of variance. Analysis of variance was used for comparing *r* values by, for example, Erickson et al. (2016), Mengarelli, Spoglianti, Avenanti, and di Pellegrino (2013), and Singer et al. (2021). This method quantified the possible effect of task type on the correlation and allowed us to determine which of the tasks had a greater or lesser effect on the correlations.

Results

Our meta-analysis involved 47 publications in Spanish containing a total of 116 effect sizes that assessed the relationship between PA and reading in a total sample of 7,956 participants. Only three articles studied the relationship between prosodic awareness and reading, which meant that, due to the small sample size, we were unable to include this type of awareness in our meta-analysis. Table 1 provides a descriptive overview of the characteristics of each correlation pair that was comprised of a PA task and a reading task: the number of studies, the total sample sizes, the age range of participants used in the sample studies, and the correlation ranges. Tables S2.1 through S2.7 in Appendix S2 in the online Supporting Information show the study characteristics of the 47 publications alphabetized by author. In this section, we present the overall descriptive findings and, then, we review the results for each PA subtype separately.

All the studies included a correlational analysis between the results in a reading task and in a PA task, and the majority of them focused on the relationship between reading and phonemic awareness. In fact, 44 of the 47 studies that we reviewed in this meta-analysis assessed the performance of the participants in phonemic tasks. The most common tasks used to measure phonemic awareness were a mixture of phoneme merge, phoneme elision, phoneme identification, and phoneme segmentation. The participants' syllabic awareness was assessed in 19 studies, usually with tasks similar to the ones used to assess phonemic awareness, but, instead of phonemes, the unit of analysis was the syllable. Finally, 18 studies analyzed the relationship between

Table 1 Summary of the descriptive data of the meta-analysis

Phonological awareness task/reading task	*k* studies	*N*	Sample age range (years)	*r* range
Phonemic awareness and word reading	39	5,288	4.50–11.50	–.490–.795
Phonemic awareness and nonword reading	21	3,626	5.10–11.50	–.085–.600
Phonemic awareness and reading comprehension	19	1,593	5.60–10.87	.052–.630
Syllabic awareness and word reading	9	514	5.45–9.89	.183–.800
Syllabic awareness and nonword reading	4	238	5.45–7.62	.117–.416
Syllabic awareness and reading comprehension	6	368	5.60–8.00	.336–.574
Intrasyllabic awareness and word reading	14	1,372	5.50–10.87	–.060–.770
Intrasyllabic awareness and reading comprehension	4	428	5.60–10.87	.012–.446

reading and intrasyllabic awareness through tasks in which the participants had to work with onsets and rhymes.

In the samples that we analyzed, the majority were composed of monolingual Spanish speakers. Only 12 studies included bilingual participants; their first languages were English (10 studies), Basque (one study), and Aymara (one study). Because the participants who were bilingual in English and Spanish came from immigrant Spanish-speaking families and were enrolled in English immersion and bilingual programs in majority English speaking countries, most of the participants were more fluent in Spanish than in English.

Table 2 provides a summary of the correlations obtained in the meta-analysis, whereas Table 3 shows a summary of the impact of the moderator variables obtained for PA tasks with reading tasks in the meta-analysis.

Phonemic Awareness and Its Relationships With Measures of Reading

We found 79 independent correlations, from a sample of 7,956 participants, that provided correlations between phonemic awareness and the tasks of word reading, nonword reading, and reading comprehension. As Figures 2 through 4 and Table 2 show, there were positive and statistically significant mean correlations between phonemic awareness and word reading ($r = .37$), nonword reading ($r = .29$), and reading comprehension ($r = .40$). The Q test results (see Table 2) indicated that the variation between studies was statistically significant between phonemic awareness and each of the three measures of reading. Thus, according to the Q test, there was statistically significant amount of heterogeneity among the studies, and they could not be considered to be in the same direction as the estimated mean outcome.

Regarding the study of publication bias, rank correlation tests and regression tests, as well as funnel plots, were performed. The p values, included in Table 2, of the statistical tests are greater than $\alpha = .05$, except for rank correlation between phonemic awareness and nonword reading. On the other hand, the three funnel plots did not suggest publication bias, thus the hypothesis that there is no publication bias can be accepted.

Afterward, we conducted a metaregression analysis to study the significance of the moderator variables age and monolingualism/bilingualism to see if they had an impact on the pattern of correlations. As Table 3 shows, the moderator variable age did not condition the relationship between phonemic awareness and any of the reading tasks. However, the moderator variable monolingualism/bilingualism showed a statistically significant coefficient for the nonword reading task ($b = –.28$). Because the cases of bilingualism were taken as a reference in the adjusted model, the negative value of the estimated

Table 2 Summary of Q test results, correlations, publication bias probabilities, and impact of moderator variables obtained for phonological awareness (PA) tasks with reading tasks in the meta-analysis

	Q test w/o moderators			Estimated correlation		Publication bias tests	
						Rank correlation	Regression
PA task/reading task	Q(*df*)	*p*	I^2	*r*	95% CI	*p*	*p*
Phonemic awareness and word reading	423.90(38)	<.001	90.1%	.37	[.29, .45]	.51	.34
Phonemic awareness and nonword reading	126.68(20)	<.001	76.2%	.29	[.21, .36]	.03	.92
Phonemic awareness and reading comprehension	44.99(18)	<.001	60.1%	.40	[.33, .47]	.21	.10
Syllabic awareness and word reading	57.19(8)	<.001	80.7%	.42	[.23, .58]	.35	.72
Syllabic awareness and nonword reading	5.23(3)	.16	45.0%	.34	[.15, .50]	1.00	.58
Syllabic awareness and reading comprehension	4.63(5)	.46	19.0%	.46	[.36, .55]	.72	.20
Intrasyllabic awareness and word reading	80.11(13)	<.001	84.9%	.34	[.21, .46]	.58	.81
Intrasyllabic awareness and reading comprehension	18.13(3)	<.001	82.0%	.34	[.12, .52]	1.00	.55

Table 3 Summary of the impact of the moderator variables obtained for phonological awareness (PA) tasks with reading tasks in the meta-analysis

	Age			Monolingual/Bilingual		
PA task/reading task	*b*	95% CI	*p*	*b*	95% CI	*p*
Phonemic awareness and word reading	.00	[.29, .45]	.97	–.04	[.29, .45]	.74
Phonemic awareness and nonword reading	–.02	[.21, .36]	.31	–.28	[.21, .36]	< .001
Phonemic awareness and reading comprehension	–.03	[.33, .47]	.42	.00	[.33, .47]	.96
Syllabic awareness and word reading	.01	[.23, .58]	.91	.27	[.23, .58]	.18
Syllabic awareness and nonword reading	.11	[.15, .50]	.26	–.33	[.15, .50]	.02
Syllabic awareness and reading comprehension	.09	[.36, .55]	.31			
Intrasyllabic awareness and word reading	–.02	[.21, .46]	.71	.03	[.21, .46]	.68
Intrasyllabic awareness and reading comprehension	.04	[.12, .52]	.83			

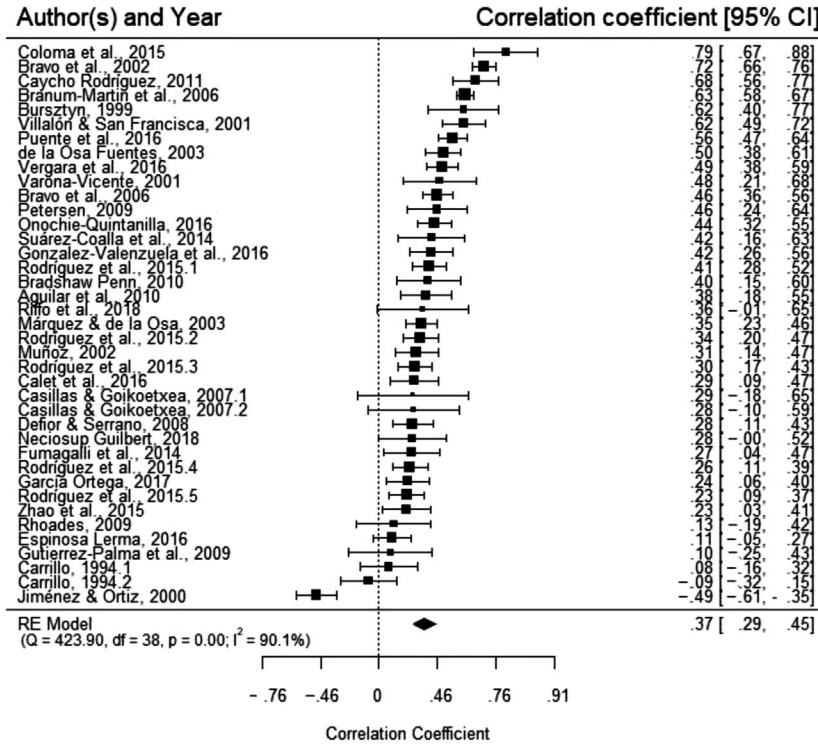

Figure 2 Correlation and confidence interval of each study that correlated phonemic awareness and word reading and overall mean correlation (displayed at the bottom by the symbol ⧫). Coefficients that summarize the random effects model are shown below the authors. RE model = random-effects model.

coefficient should be interpreted as a decrease in the correlation between phonemic awareness and nonword reading among monolingual participants relative to bilingual participants. No evidence was found that this moderator had any influence on the correlation between phonemic awareness and word reading or between phonemic awareness and reading comprehension.

Syllabic Awareness and Its Relationships With Measures of Reading

We found 19 independent correlations, based on a sample of 1,122 participants, that provided correlations between syllabic awareness and the tasks of word reading, nonword reading, and reading comprehension. In this case, as Figures 5 through 7 and Table 2 show, there was a positive and statistically significant mean correlation between syllabic awareness and word

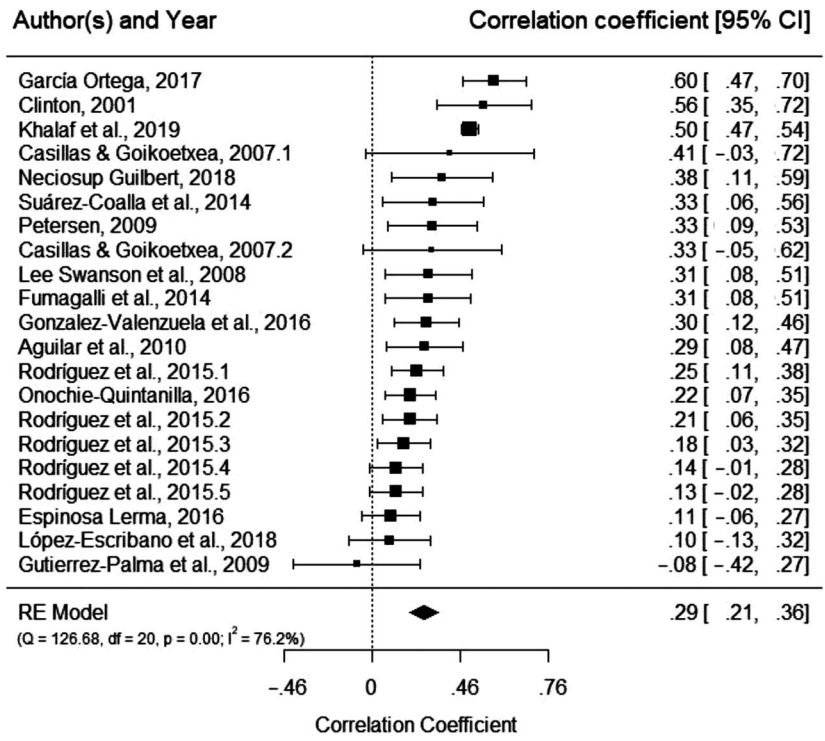

Figure 3 Correlation and confidence interval of each study that correlated phonemic awareness and nonword reading and overall mean correlation (displayed at the bottom by the symbol ⧫). Coefficients that summarize the random effects model are shown below the authors. RE model = random-effects model.

reading ($r = .42$), nonword reading ($r = .34$), and reading comprehension ($r = .46$). The Q test results (see Table 2) indicated that the variation between studies was not statistically significant between syllabic awareness and nonword reading or between syllabic awareness and reading comprehension, indicating that there was no significant heterogeneity among studies and that they could be considered to be in the same direction as the estimated mean outcome. The exception was found in the correlation between syllabic awareness and word reading, for which the variation between studies was significant. Thus, for these variables, according to the Q test, there was a statistically significant amount of heterogeneity among the studies, and they could not be considered to be in the same direction as the estimated mean outcome.

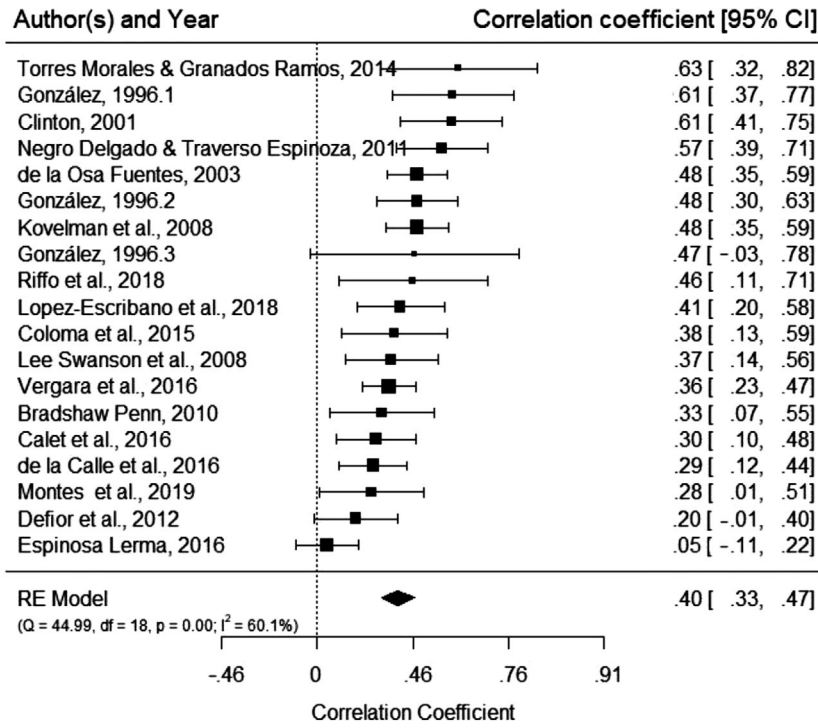

Figure 4 Correlation and confidence interval of each study that correlated phonemic awareness and reading comprehension and overall mean correlation (displayed at the bottom by the symbol ⧫). Coefficients that summarize the random effects model are shown below the authors. RE model = random-effects model.

Finally, for syllabic awareness, all the *p* values of the rank correlation tests and regression tests included in Table 2 are greater than $\alpha = 0.05$, and three funnel plots showed a lack of publication bias. Thus the hypothesis that there is no publication bias can be accepted.

We also conducted a metaregression analysis. As Table 3 shows, the moderator variable age did not condition the relationship between syllabic awareness and any of the reading tasks. The moderator variable monolingualism/bilingualism showed a statistically significant correlation coefficient for the nonword reading task ($b = -.33$). Because the cases of bilingualism were taken as a reference in the adjusted model, the negative value of the estimated coefficient should be interpreted as a decrease in the correlation between syllabic awareness and nonword reading among monolingual participants relative

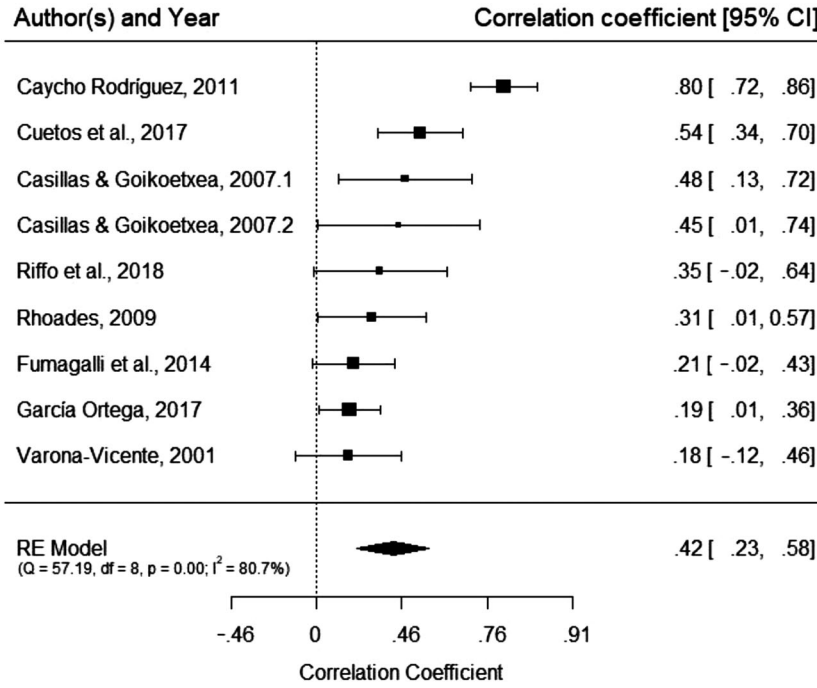

Figure 5 Correlation and confidence interval of each study that correlated syllabic awareness and word reading and overall mean correlation (displayed at the bottom by the symbol ⧫). Coefficients that summarize the random effects model are shown below the authors. RE model = random-effects model.

to bilingual participants. No evidence was found that this moderator had any influence on the correlation between syllabic awareness and word reading. It was not possible to assess the influence of the moderator variable on the correlation between syllabic awareness and reading comprehension because all the studies in this particular sub-analysis included only monolingual participants.

Intrasyllabic Awareness and Its Relationships With Measures of Reading

We found 18 independent correlations, based on a sample of 1,800 participants, that provided correlations between intrasyllabic awareness and word reading and between intrasyllabic awareness and reading comprehension. We did not find any study that assessed the relationship between intrasyllabic awareness and nonword reading. Figures 8 through 9 and Table 2 show that there were positive and statistically significant mean correlations between intrasyllabic

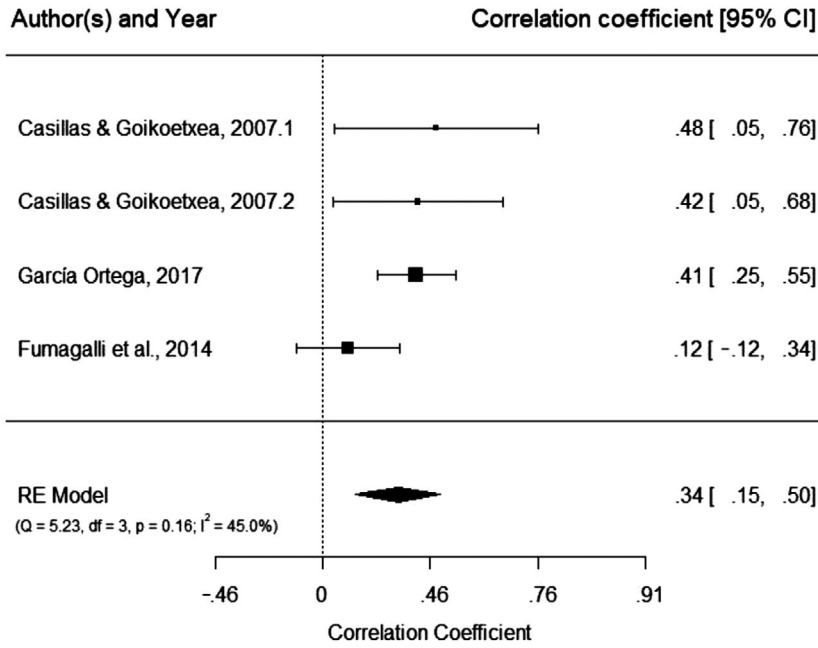

Figure 6 Correlation and confidence interval of each study that correlated syllabic awareness and nonword reading and overall mean correlation (displayed at the bottom by the symbol ⧫). Coefficients that summarize the random effects model are shown below the authors. RE model = random-effects model.

awareness and word reading ($r = .34$) and between intrasyllabic awareness and reading comprehension ($r = .34$). The Q test results showed that the variation between studies was also statistically significant in all cases, which meant that the studies appeared to be heterogeneous. For intrasyllabic awareness, all the p values of the rank correlation tests and regression tests included in Table 2 are greater than $\alpha = 0.05$. The funnel plots again showed a lack of publication bias, indicating the hypothesis that there is no publication bias can be accepted.

As Table 3 shows, no evidence was found that the moderator variables had any influence on the correlations. Besides, it was not possible to assess the influence of the moderator variable monolingualism/bilingualism on the correlation between intrasyllabic awareness and reading comprehension because all the studies that reported correlations of intrasyllabic awareness and reading comprehension included only monolingual participants.

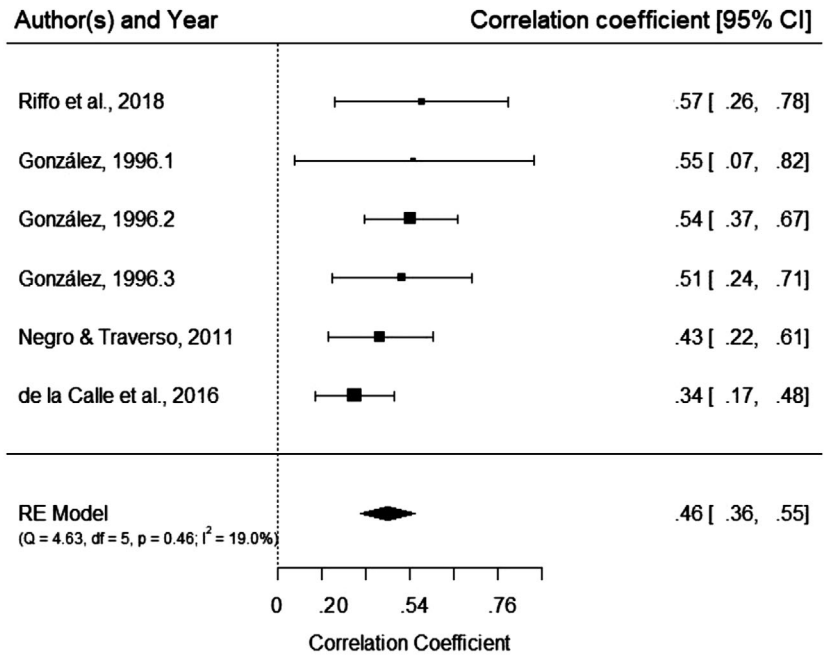

Figure 7 Correlation and confidence interval of each study that correlated syllabic awareness and reading comprehension and overall mean correlation (displayed at the bottom by the symbol ⧫). Coefficients that summarize the random effects model are shown below the authors. RE model = random-effects model.

Analysis of Variance

Finally, a two-way analysis of variance examined the influence of the PA tasks and the reading tasks on the values of the correlation coefficients. As Table 4 shows, there were no statistically significant differences between the types of PA tasks or the types of reading tasks that we analyzed, based on the values of the correlation coefficients.

Discussion

As we mentioned in the Background Literature section, to decode the words of a text, readers must have developed a certain degree of PA, which in the beginning stages of reading is considered one of the predictors of future reading abilities. This relationship between PA and reading has been widely examined in a variety of articles, the majority of them about reading in the English language (which has one of the hardest orthographies to master according to

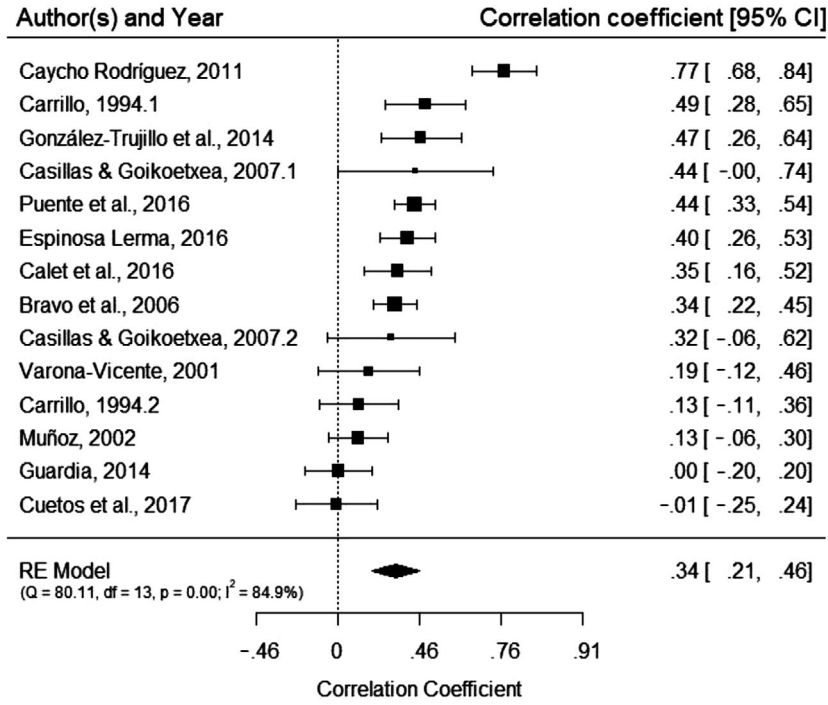

Figure 8 Correlation and confidence interval of each study that correlated intrasyllabic awareness and word reading and overall mean correlation (displayed at the bottom by the symbol ⧫). Coefficients that summarize the random effects model are shown below the authors. RE model = random-effects model.

Borleffs et al., 2017, Landerl & Wimmer, 2008, and Share, 2008). However, the role of PA in reading in languages other than English is not entirely clear. Some researchers have argued that PA is crucial to reading acquisition regardless of the alphabetic script used (Caravolas et al., 2012; Moll et al., 2014); others have found that the role of PA might be less relevant, relative to other factors involved in reading, for languages with transparent orthographies (Mann & Wimmer, 2002; Ziegler et al., 2010). Although the relationship between PA and reading in alphabetic languages has been studied in a few meta-analyses, we were unable to find any meta-analytic studies that reviewed the relationship between PA and reading in Spanish, a highly transparent language. Therefore, in this study we presented a meta-analysis that examined mean correlations between the different subcategories of PA and reading tasks in Spanish. We discuss our findings for each of our two questions.

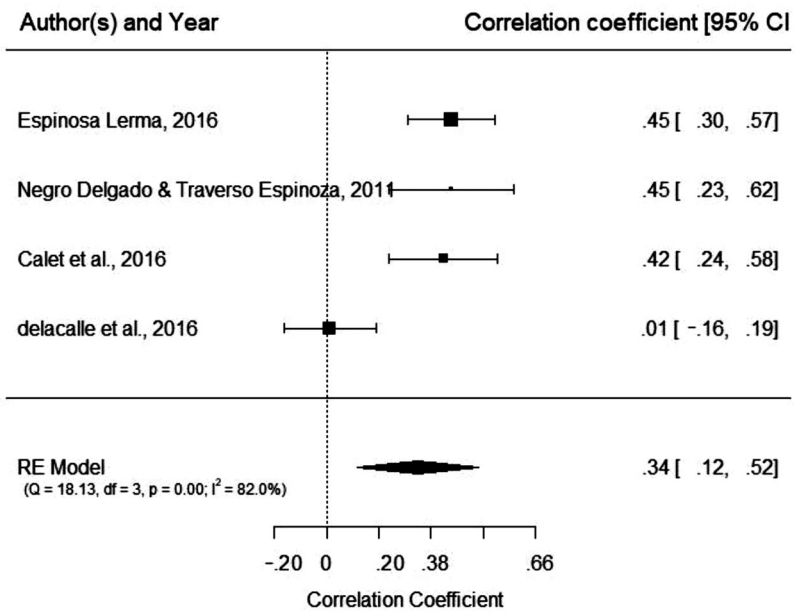

Figure 9 Correlation and confidence interval of each study that correlated intrasyllabic awareness and reading comprehension and overall mean correlation (displayed at the bottom by the symbol ⧫). Coefficients that summarize the random effects model are shown below the authors. RE model = random-effects model.

Table 4 Two-way analysis of variance for phonological awareness (PA) tasks and reading tasks

Measure	*df*	*SS*	*MS*	*F*	*p*	η_p^2
Phonological awareness tasks	2	0.097	0.048	1.291	.279	.022
Reading tasks	2	0.202	0.101	2.695	.072	.046
Residuals	111	4.151	0.037			

Discussion of Research Question 1: Associations Between PA and Reading Comprehension

Our first question sought to examine the relative strengths of association between types of PA (i.e., phonemic, intrasyllabic, syllabic, and prosodic awareness) and reading tasks (i.e., word reading, nonword reading, and reading comprehension) in Spanish. Our meta-analysis showed statistically significant moderate positive correlations between phonemic awareness and word reading ($r = .37$), nonword reading ($r = .29$) and reading comprehension ($r = .40$).

There were also statistically significant positive correlations between syllabic awareness and word reading ($r = .42$), nonword reading ($r = .34$), and reading comprehension ($r = .46$). We also found positive and statistically significant correlations between intrasyllabic awareness and word reading ($r = .34$) and reading comprehension ($r = .34$). We did not find enough studies to enable us to examine associations between prosodic awareness and reading.

When we analyzed the variance of all the tasks, as Table 4 shows, there were no statistically significant differences between the PA subtypes, which implied that no differences were revealed regarding the associations between the PA abilities and the reading tasks as a function of the different subcategories of PA tasks or the different reading tasks used in the sample of studies. It should be noted that a different number of studies contributed to the results of the analyses for the different subtypes of tasks. Nevertheless, if we simply interpret the estimated correlation coefficients in Table 2 descriptively, the subtask type syllabic awareness obtained two of the largest effect size values: with word reading and reading comprehension. This might be because Spanish has a transparent writing system and a simple syllabic structure, though we are unable to establish causal inference between the specific language and the relative strength of the role of syllabic awareness given that these are only correlational (not experimental) studies. Indeed, the correlation effects we found between syllabic awareness and reading were close to the values presented in Swanson et al. (2003) meta-analysis with English-speaking participants (who found $r = .41$ for real word reading and PA and $r = .43$ for nonword reading and PA).

In addition, regarding intrasyllabic awareness, although research has shown its significant role in reading development in opaque languages such as English and French (Álvarez et al., 2017; Bradley & Bryant, 1985; Bryant et al., 1989), research on more transparent languages is still relatively scarce. In our meta-analysis, intrasyllabic awareness presented moderate positive correlations with word reading and with reading comprehension (similar to Pfost's meta-analysis with German speakers). This suggested that the knowledge of rhymes and onsets could also play a part during the first stages of reading development in a very transparent language such as Spanish. More studies are needed in this area, and experimental designs would help to establish a causal rather than correlational relationship.

Regarding the different reading tasks and different PA tasks used across the study sample, we predicted, due to the importance of PA in decoding, high correlations between word reading and phonemic awareness tasks and between word reading and syllabic awareness tasks (Calet et al., 2016; Defior et al.,

2012; González, 1996). Table 4 shows that there were no significant differences in the associations between PA and reading as a function of the different PA and reading subtasks administered. This could partly be explained by the fact that reading—regardless of how it is measured—draws on abilities beyond just decoding, such as vocabulary knowledge (Aslin, 2013; Cuetos Vega et al., 2015).

CIs can also be used to interpret effect sizes, as they show a range of values that are likely around an observed mean score and they "help us situate mean scores in the context of the many other possible values that might represent the true population score (as opposed to that of the sample)" (Plonsky, 2015, p. 40, and see for example, the meta-analyses of Adescope, Lavin, Thompson, & Ungerleider, 2010 and Avery & Marsden, 2019). The CI values found by Pfost (2015) regarding phonemic awareness and word reading (.20 to .33) have some overlap with the lower bound of the interval found in our meta-analysis (.29 to .45) though the current study seemed to find a higher overall mean correlation value with a slightly higher upper bound. On the other hand, regarding phonemic awareness and reading comprehension (CIs of .35 to .48 in Pfost's analysis and .33 to .47 in the present meta-analysis), the intervals overlap almost entirely, suggesting similar findings in the current study to those obtained by Pfost.

Our findings suggested that age was not a moderator variable. Previous research on PA and reading has suggested that as children get older the relationship between PA and reading changes. That is, once children have developed the capacity to read fluently, PA abilities do not contribute to reading relatives to at the start of learning to read (Aro & Wimmer, 2003; de Jong & van der Leij, 1999; Elhassan, Crewther, & Bavin, 2017). One of the possible reasons that we did not find such a pattern of findings could be that out of the sample of 7,956 subjects, 5,679 of them were in the age range of 5.5 to 7.5 years. This could mean that, because of the small age range of the sample, the variable age was not sufficiently well represented in our meta-analysis to be observable as a moderator.

Discussion of Research Question 2: Moderating Effects of Age and Monolingual/Bilingual Status on Associations Between PA and Reading in Spanish

Our second research question addressed the extent to which the (other) languages spoken by the participants moderated any associations between PA and reading tasks. Although the majority of the participants in the studies that we found were monolingual Spanish speakers, we found 12 studies that had

included bilingual participants whose other languages were English (10 studies), Basque (one study), and Aymara (one study). The Basque and Aymara participants had a similar level of proficiency in both of their languages, but the majority of students who were bilingual in English and Spanish were more fluent in Spanish.

Our findings showed that, for the relationship between PA and word reading and PA and reading comprehension, whether participants were monolingual or bilingual was not relevant. We found two notable exceptions to this: The monolingualism/bilingualism moderator variable showed a statistically significant, albeit small, negative coefficient ($b = -.28$) for the correlations between phonemic awareness and nonword reading and between syllabic awareness and nonword reading. As bilingualism was used as the reference in both models, the negative value of the estimated coefficient should be interpreted as a stronger correlation between these variables in bilingual participants compared to the monolingual participants. These results are in line with the research on bilingual English-Spanish children by Bialystok et al. (2003), Branum-Martin et al. (2006), Bursztyn (1999), Durgunoglu (1998), Durgunoglu et al. (1993), Khalaf et al. (2019), Kovelman et al. (2008), and Quiroga et al. (2002). These researchers claimed that their bilingual children likely transferred their phonological abilities to the words that they read in other languages. Because the vast majority of bilingual speakers were more fluent in Spanish, we assume that these children developed their PA skills mainly through Spanish.

Potential Implications for Reading Instruction

Our research showed meaningful positive correlations between PA tasks—phonemic, intrasyllabic, and syllabic awareness tasks—and three different types of reading tasks in Spanish—word reading, nonword reading, and reading comprehension tasks. Classroom reading activities for children often include some kind of PA-related tasks and these may contribute to the development of PA without the need for any specific type of intervention (Suárez, 2013). However, these tasks are not always explicit or systematic, and the results of this meta-analysis could arguably suggest that phonological training may help improve reading in the early stages.

A series of Spanish phonological training programs have been established, such as those developed by Arancibia and Bizama (2011), Bizama, Arancibia, and Sáez (2013), Gutiérrez and Díez (2017), and Porta (2012). These studies used randomized control trials with delayed posttests and provide some evidence that such programs can improve reading skills and reduce future reading difficulties (both in the general classroom and with children at risk of reading

difficulties). Within these training programs, teachers can choose the activities according to the type of text, the learning objectives, and the reading level of the students.

The search for the current meta-analysis revealed that research has tended to focus more on phonemic awareness than on other types of PA. Yet we found that those studies that have focused on syllabic and intrasyllabic awareness did find that these components of PA are also associated with the early stages of reading in Spanish. We therefore tentatively suggest that there may be benefits of instruction that goes beyond phonemic awareness to focus on both syllabic and intrasyllabic levels of PA, though we emphasize that experimental evidence should be gathered first.

Limitations and Future Research

This study has several limitations. First, the number of publications that have examined the relationship between PA and reading in Spanish is small and, thus, we need more such investigations in Spanish and other transparent languages to increase our understanding, especially regarding the relationship between reading and PA tasks other than phonemic awareness tasks. Second, the effects obtained are purely correlational and these do not allow us to draw causal inferences (e.g., it could be that the children who obtained good results on one task simply obtained good results on other tasks), which makes it hard to draw strong conclusions. Third, because PA is an ability that is crucial during the first years of learning to read, we decided to focus on PA awareness in a sample of children younger than 14 years of age. Further research with a broader sample that includes teenagers and adults (both literate and illiterate) are needed to compare the results with those obtained from the children in our meta-analysis. Last, as mentioned by Boers et al. (2020), the outcome of a meta-analysis is determined by how effect sizes are calculated. Therefore, the choice of including zero-order correlations (which reflect only the relationship between two variables) and partial correlations (which also control for other variables) between PA and reading might have influenced the overall mean effect sizes. More research is necessary to investigate this.

Conclusion

Previous research has found that PA in Spanish is a predictor of reading abilities and is highly positively correlated with reading (Fernández López, 2009; Jiménez González & Ortiz González, 1995). However, no study had meta-analyzed the relationship between PA and reading in Spanish, the main goal of this study. We aggregated correlations between PA tasks for phonemic,

syllabic, and intrasyllabic awareness and reading tasks for word reading, nonword reading, and reading comprehension in Spanish.

We found statistically significant positive and moderate correlations between some PA subcategories and some reading tasks in Spanish-speaking children. The largest correlation values occurred, as we expected, between syllabic awareness and all three measures of reading. In addition, we found similar mean correlations between phonemic awareness and reading and intrasyllabic awareness and reading. This could suggest that intrasyllabic awareness may play a bigger role in reading even in a transparent language such as Spanish than had been previously thought.

Although the number of studies was small, our aggregated correlations also suggested that bilingual children's PA had a stronger positive association with reading nonwords when compared with that of monolingual participants in our sample of studies. These results could be explained by the fact that bilingual children are more used to drawing on their phonological abilities when reading new words in other languages and, therefore, find it easier to read nonwords presented during experiments.

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This article has earned Open Data and Open Materials badges for making publicly available the digitally-shareable data and the components of the research methods needed to reproduce the reported procedure and results. All data and materials that the authors have used and have the right to share are available at https://www.iris-database.org/iris/app/home/detail?id=york:939492 and http://www.iris-database.org. All proprietary materials have been precisely identified in the manuscript.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Appendix S1: Bibliography of Articles Analyzed in the Meta-Analysis.
Appendix S2: Study Characteristics.
Appendix S3: Funnel Plots.

Appendix: Accessible Summary (also publicly available at https://oasis-database.org)

How knowledge of the sounds of words relates to reading in Spanish children

What This Research Was About and Why It Is Important

Despite the fact that reading and writing appeared much later in human history compared to speech, we currently obtain a lot of the information needed to function in different spheres of life through various types of written texts. However, learning to read is not an easy task, as readers have to master many abilities, the majority of which have to be learned at school. One of these abilities is to notice how speech is made up of combined sounds that can be split up. In reading, these sounds correspond to letters and, when we read, we transform each letter into its sound. In addition, readers are also able to distinguish syllables and its different parts, called onset, and rhyme. Most previous research

on the relationship between reading and the recognition of sounds has been undertaken with English speaking children, a language in which the sounds and the letters do not match transparently. The current study investigated relationships between knowledge of sounds and reading (including reading real words, invented words, and reading comprehension) in studies that have focused on Spanish, a language in which the sounds and letters do match, that is, it is a transparent language.

What the Researchers Did

- The researchers searched in Spanish and English databases for scientific articles, book chapters, conference papers, and other types of publications that were written between January 1970 and January 2020 and that studied the relationship between sound recognition and reading in Spanish-speaking children.
- After removing the articles that were not relevant to their study (such as those that included participants with disabilities or who were older than 14, or studies that not use appropriate analyses), the researchers ended up with a total of 47 studies that comprised a total sample of 7,956 children.
- The researchers recorded a range of characteristics of the studies, to see if these characteristics affected the results: (1) the type of sound studied (sound, rhyme or syllable); (2) the reading task performed (real word reading, invented word reading, or reading comprehension); (3) whether the participants were monolingual or bilingual.

What the Researchers Found

- Spanish-speaking children's reading abilities are related to their knowledge of Spanish sounds, at least in the early stages of reading. There were too few studies to examine whether this relationship changes as they get older/better at reading.
- One of the strongest associations was between syllable recognition and reading.
- The relationship between onset and rhyme recognition and reading is important for Spanish-speaking children, and (according to findings from previous studies) also in English-speaking children.
- Whether the participant was bilingual or monolingual did not affect the relationship between sound recognition and word reading or reading comprehension. However, the relationship between the awareness of sounds and reading invented words out loud was stronger for bilingual children relative to children who speak one language.

Things to Consider

- Knowledge of sounds was important for reading regardless of the reading task used. This might suggest that teachers could help reading by improving their students' recognition of sounds. However, experimental studies are needed.
- The majority of studies so far have focused on the connection between sound recognition and reading, rather on awareness of rhymes and syllables. Therefore, more research is needed regarding rhyme and syllable recognition, especially in languages with a clear correspondence between sounds and letters.

Materials, data, open access article: Materials and data are available at https://iris-database.org.

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