Beyond phonological awareness: stress awareness and learning word spelling

Running head: stress awareness and learning word spelling

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ABSTRACT

This study investigates whether prosody is related to spelling acquisition. The awareness of a particular prosodic feature, lexical stress, may play some role in the acquisition of word spelling. A sample of 89 Spanish 3rd graders participated in this study. Control measures included non-verbal intelligence, vocabulary, and phonemic awareness. Results highlighted the potential role of prosodic knowledge in learning word spelling. Lexical stress awareness accounted for unique variance in word and sentence writing from dictation. In particular, stress awareness was related to stress errors (in word and sentence writing) while phonemic awareness was related to phoneme errors (in word writing). These data support the view that, in addition to phonological awareness, prosodic (lexical stress) awareness has the potential to be relevant for learning word spelling.

INTRODUCTION

It is widely accepted that phonological awareness plays a role in literacy acquisition, particularly relevant in the first stages of reading instruction (Defior, Martos, & Cary, 2002). The research about this topic has focused on the awareness of phonemes, rimes or syllables. However, other aspects of phonology that are necessary for reading, such as prosody (e.g., intonation or stress), have been less investigated. The present study goes beyond phonemes and sublexical units to focus on prosody and its relationship to writing (spelling) acquisition. As with phonological awareness (henceforth PA), the awareness of prosody may facilitate spelling acquisition.

Defining prosody

Prosody refers to a type of abstract organization of speech, but also to the suprasegmental features linked to this organization (Cutler, Dahan, & Donsenlaar, 1997). Therefore, prosody can be studied as a phonological subsystem of hierarchically arranged units, such as the syllable, the foot (group of syllables), the phonological word, or the utterance (Nespor & Voguel, 2007). Moreover, prosody relates to the study of prosodic features, such as intonation, stress, and timing. Prosody may also be understood as suprasegmental phonology, since prosodic units and features involves more than one single phoneme or segment. This research focuses on one of these features, the stress, which refers to syllable prominence. This feature may be studied as the pattern of strong/weak syllables within the phrase, or metrical stress (Goodman, Libenson, & Wade-Woolley, 2010). However, in this research we focus on lexical stress, or the syllable prominence within the word. This prominence in Spanish is based on the combination of fundamental frequency, intensity, and duration (Llisterri, Machuca, Mota, Riera, & Ríos, 2003), but it is not related to vowel reduction (Dauer, 1983).

The awareness of lexical stress (henceforth, stress awareness or SA), has been related to stress assignment in reading aloud in Spanish (Gutiérrez-Palma, Defior, Jiménez-Fernández, Serrano, & González-Trujillo, 2016). Up to we know, the relationship between stress assignment and SA has not been studied in other languages. Moreover, instead of SA, other terms have been used in the literature, which has mainly addressed the relationship between linguistic rhythm and literacy (e.g., Thomson & Jarmulowicz, 2016). These terms include “speech rhythm sensitivity” (e.g., Wood, Wade-Woolley & Holliman, 2009), or the more specific term of “metrical stress sensitivity” (e.g., Goodman et al., 2010), where the stress is related to rhythm perception. There is a lack of consensus in the literature about the meaning of “sensitivity”, although by analogy to “phonological sensitivity” (Loningan, Burgess, Anthony & Barker, 1998), “stress sensitivity” could be related to a general skill for dealing with stress. As a convention for this study, we will use the term SA because it well describes an explicit metalinguistic skill closely related to stress.

This paper focuses on the role of SA in spelling acquisition. As stress is orthographically marked in some Spanish words (see the next section), SA may play some role in learning when to use the stress mark. Furthermore, as stress is related to syllable prominence, it may facilitate the perception of syllables, which are very important units for reading and writing in Spanish (e.g., Carreiras, Álvarez, & de Vega, 1993; Álvarez, Cottrell, & Afonso, 2009).

Orthographic stress

Lexical stress is necessary not only for speaking and reading aloud, but also for writing, at least in some languages such as Greek or Spanish where a word’s spelling includes a stress mark (´). This orthographic mark is placed over the stressed vowel (e.g., *bal**ó**n* [ball]). The placement of this mark in Spanish is rule-based[1]: the mark should appear on all words with antepenultimate stress (e.g., *tú-ni-ca* [tunic]); on words with penultimate stress when they end in a consonant other than *n* or *s* (e.g., *lá-piz* [pencil]); and on words with final stress when they end in a vowel or in the consonants *n* or *s* (e.g., *tu-pé* [toupee]; *ba-lón* [ball]) (Real Academia Española, 1999).

The stress mark is present in few words with penultimate stress (4.6%[2]); in a higher percentage of words with final stress (27.8%); and in all words with antepenultimate stress[3]. These percentages are negatively correlated with the distribution of the different types of phonological stress: 78% penultimate, 18% final, and 3% antepenultimate (Quilis, 1993). This pattern suggests that the stress mark indicates exceptions to certain statistical regularities. Therefore, learning the appropriate use of the stress mark is important not only for writing without orthographic mistakes, but it may also facilitate word reading (Gutiérrez-Palma et al., 2016). This study investigates whether lexical stress awareness is related to the correct writing of the Spanish stress mark.

Prosody and literacy acquisition

Lexical stress is closely related to the concept of rhythm (at least in stress-based languages). Some authors have proposed that rhythm plays a role in literacy acquisition, and thus it could be argued that lexical stress is linked to literacy acquisition through rhythm. On the contrary, in syllable-timed languages (e.g., Spanish) the recurring unit is the syllable, not stress (Pike, 1945), and it may be argued that SA has a rather limited role in literacy

[1] These are general rules with exceptions and particularities (Real Academia Española, 1999).

[2] These percentages were calculated over 31491 words included in the *Buscapalabras* application (Davis & Perea, 2005).

[3] There are words with stress in a position previous to the antepenultimate, but they include pronouns or particular endings (e.g., *come* + *te* + *lo* = *cómetelo* [eat it]). The present work focuses on monomorphemic words.

acquisition. However, this distinction (stress- vs. syllable-timed) is problematic as rhythm perception depends on more features than just timing (for a review, see Arvaniti, 2009), and it has been proposed that there is a continuum between more and less stress-based languages (Dauer, 1983). Spanish would fall in the middle of that continuum, and as a consequence the stress appears to have the potential to affect rhythm perception, and therefore to influence literacy acquisition, as suggested by Gutiérrez-Palma et al. (2016).

One of the first models of rhythm and literacy acquisition was formulated by Wood, et al. (2009). They proposed that speech rhythm sensitivity is a relevant factor in literacy acquisition, similarly as it is in oral language acquisition. Speech rhythm can help infants to segment the speech stream into word-like units (Nazzi, Bertoncini & Mehler, 1998). It could be argued that those infants with better speech rhythm skills will have some advantage for vocabulary and language acquisition. As vocabulary grows, PA skills develop which facilitate literacy acquisition. Furthermore, in this model speech rhythm sensitivity is directly linked to PA, regardless of vocabulary. This direct relationship has multiple implications. First, stress (necessary for rhythm perception) may facilitate the identification of phonemes (Kitzen, as cited by Holliman et al., 2014), and therefore phoneme awareness. Second, as rhythm perception requires vowel perception, speech rhythm sensitivity might facilitate the isolation of the rime and thus rime awareness.

Wood et al. (2009) further proposed that speech rhythm sensitivity is linked to morphology. For example, rhythm may be used to distinguish compound words from single words (e.g., *pintauñas* [nail polish]; *pinta* [paint], *uñas* [nails]). Furthermore, the stress component of rhythm may also be useful for learning morphological stress rules—for example, adding a morpheme may change the word's stress position (e.g., ***ma****lo* [bad] vs. *mal****dad*** [badness]). In Spanish, lexical stress can also be used to differentiate minimal pairs of words from different grammatical classes (e.g., ***ju****go* [juice], *ju****gó*** [he/she played]).

Holliman et al. (2014) tested Wood et al.'s (2009) model with English children aged 5 to 7. The model fits fairly well if additional links are included: between vocabulary and morphological awareness, between rhyme and phoneme awareness or morphological awareness (non-significant in the final model), and between phoneme and morphological awareness. Additionally, direct links between prosody and phoneme and morphological awareness might not be necessary, as these links were not significant in the final model. Therefore, Holliman et al.'s (2014) results suggest that prosody is directly linked to vocabulary and rhyme awareness, and through vocabulary and rhyme awareness to the rest of variables. Further to these links between SA and literacy acquisition, Wood et al. (2009) also suggested that metrical stress sensitivity can explain additional variance "…linked to the need of lexical stress to be assigned during the reading of polysyllabic words" (p. 19). This suggestion may have interesting implications for orthographic learning. According to the self-teaching theory (Share, 1995), orthographic learning requires phonological recoding of novel letter strings. If stress is necessary for phonological recoding, then children who are better at assigning stress should have an advantage for learning a word's spelling. Therefore, factors related to stress assignment, such as SA (Defior, Gutiérrez-Palma, & Cano-Marín, 2012; Gutiérrez-Palma et al., 2016), might be indirectly linked to orthographic learning.

Supporting this hypothesis, Wood (2006) found that stress sensitivity was related to literacy acquisition in English. In their study, children aged 5 to 7 had to recognize mispronounced words in several conditions, including reversed stress (e.g., *sof**á*** instead of ***só**fa*, with a full vowel in the stressed syllable). Results showed that stress sensitivity accounted for spelling regardless of age, PA, or vocabulary. Other studies in English have found a similar relationship in word reading, regardless of age, vocabulary, or PA (Holliman, Wood, and Sheehy, 2008); or regardless of age, vocabulary, PA, short-term memory, or non-linguistic rhythm skills (Holliman, Wood & Sheehy, 2010). However, in the case of children with reading difficulties, once vocabulary and PA are both controlled for, there are no differences with a chronological control group (11-10 years) in stress sensitivity (Holliman, Wood, & Sheehy, 2012).

Results may be different for orthographies that include a stress mark, such as Spanish or Greek. As prosody forms part of a word’s spelling in these languages, they provide a good opportunity to study the role of stress sensitivity in reading and writing acquisition. For example, studies in Spanish have identified links between stress sensitivity and reading ability. Gutiérrez-Palma and Palma-Reyes (2007) used the task of Dupoux, Peperkamp, and Sebastián-Gallés (2001) that consisted of discriminating between minimal pairs of pseudowords that included phonemic (*kú**pi** vs. kú**ti***) vs. prosodic contrasts (*m**í**pa vs. mip**á***). 1^{st} and 2^{nd} graders who were better at discriminating between prosodic contrasts also read pseudowords more accurately and with fewer stress errors. Gutiérrez-Palma, Raya, and Palma (2009) found a similar relationship between fluency (speed of text reading) and stress assignment (pseudowords), even when phonological awareness was controlled for.

Dupoux et al.’s (2001) task is more implicit than explicit and is therefore more a measure of stress sensitivity than of SA. Gutiérrez-Palma, Defior, Jiménez-Fernández, Serrano, and González-Trujillo (2010) developed a more explicit task that consisted of listening to three-syllable pseudowords (e.g., ***pá**fica*, *ni**po**ra*, *ziro**tal***) and indicating the stressed syllable. This task involves thinking explicitly about word stress and therefore could be considered a way to measure SA rather than stress sensitivity. Defior et al. (2012) used this task with 5^{th} grade children to examine the relationship between prosodic skills and word reading and writing (spelling). They found that SA was related to reading and word writing accuracy, regardless of phonological awareness. Similarly, Jiménez-Fernández, Gutiérrez-Palma, and Defior (2015) found that 3^{rd} grade children with dyslexia performed worse on this task when compared to a chronological control group. However, when the task used words, and phonological awareness was controlled, these differences disappeared. Moreover, differences between using words or pseudowords (reaction times) were not significant for the dyslexia group, suggesting that they had difficulties accessing stress representations. This evidence is mainly correlational. However, there is research in Spanish suggesting a causal link between SA and reading acquisition. In a follow up study, Calet, Gutiérrez-Palma, Simpson, González-Trujillo and Defior (2015) found that even when nonverbal intelligence, vocabulary, PA, and reading level (autoregressive effects) were controlled, SA[4] at the start of grade 1 predicted reading at the end of that year. Given that children learn to decode words during 1st grade, this result suggests that SA might be related to stress assignment, as it is a necessary component of word decoding.

If SA and PA are linked to different components of word decoding, then they should be related to different measures of word reading. To test this hypothesis, Gutiérrez-Palma et al. (2016) examined word reading in a sample of 3rd to 6th graders and found that SA is mainly related to stress errors (e.g., *ap**ó**stol* [apostle] read as *apost**ó**l*) rather than to grapheme-to-phoneme errors (e.g., ***ap**óstol* read as ***ab**óstol*). Defior et al. (2012) found that SA was related to both types of errors, but it was more highly correlated with stress errors. They also examined spelling errors and found that SA accounted for similar variance in stress and phoneme errors. A tentative explanation for these findings is that assigning stress requires thinking simultaneously about both stress and final sounds. As a result, children with higher SA skills may develop better phonological awareness of final sounds. This may be particularly true for children in later grades (5th grade in Defior et al.'s study), as they have received several years of formal instruction on stress rules.

The reviewed studies suggest a relationship between SA in both reading and writing, although research has been mainly conducted on reading. Significant results have been found

[4] They used the term sensitivity instead of awareness, but the task was very similar to that used by Gutiérrez-Palma et al. (2010) and required participants to think explicitly about stress.

in both English and Spanish, but there are still no clear results showing that SA and PA affect different components of word decoding.

Study approach

If SA and PA are linked to different components of word decoding, they should relate to different measures of word reading and writing. In the case of writing, stress errors may involve mistakes when writing the stress mark. This study tests whether SA, and not PA, is related to stress mark errors, and whether PA, not SA, is related to phoneme errors.

In the Andalusian educational system (southern Spain), stress rules are taught in the 2nd cycle (3rd and 4th grades) of Primary Education (http://www.juntadeandalucia.es/educacion/descargasrecursos/curriculo-primaria/lengua.html). Although children are introduced to these rules in 3rd grade, they do not receive intensive instruction until 4th grade. In this grade, children still commit a high percentage of stress errors (50.38%) (Defior, Jiménez-Fernández, & Serrano, 2009). It is not until the 3rd cycle (5th and 6th grades) that children are expected to avoid stress errors in their writing. Therefore, while 3rd graders may have a basic knowledge about when to use the stress mark, they actually learn the rules in 4th grade, and probably do not make a strong effort to follow the rules until 5th grade. As a result, SA might be more closely related to phonological awareness of the last sounds in 5th than in 3rd grade. In this study we have chosen 3rd grade students in order to maximize the dissociation between SA and PA.

Importantly, previous research has also not examined the role of SA when writing words in a sentence context. It could be argued that word meaning is more activated when writing sentences, and that it could affect the recovery of a word's phonology and orthography. This is possible because, according to the general models of word spelling (e.g., Caramazza, 1988; Romani, Olson, and Di Betta, 2005), a word's meaning is connected to its phonology and orthography. Therefore, the activation of meaning could in turn activate these two types of information, which would then facilitate writing the word. If this is the case, accuracy differences (related to SA or PA) might be less evident when writing words in a sentence context. This study explores this hypothesis by including a task of sentence writing.

METHOD

Participants

Participants were 89 children (47 boys) from 3rd grade of Primary Education. They had been taught to read using the phonics method. Six participants were excluded from the final sample: three did not complete all the experimental tasks, one did not have Spanish as his first language, and another two had been diagnosed with learning difficulties. The final sample was composed of 83 participants (44 boys), with a mean age of 104.7 months (*SD* = 4.1), and medium socio-economic status (as determined by the school's neighborhood). This sample was obtained from two public schools. Parental informed consent and verbal assent from each child were obtained before the testing session. This study was approved by the university Ethical committee and it was in accordance with the general human subjects' guidelines for this kind of research.

Instruments and measures

Standardized test and other tasks designed *ad hoc* were used for the purposes of this research.

Non-verbal intelligence. The *Raven's Progressive Matrices* (Raven, 1996), *SPM* subtest, was used. The number of correct responses, with a maximum possible score of 60, was registered.

As described in the manual, studies that use this subtest obtain a split-half reliability generally above .9, and a test-retest coefficient between .83 and .9.

Vocabulary. The Spanish adaptation of the K-BIT: Kaufman's Brief Intelligence Test (Cordero & Calonge, 2000), expressive vocabulary subtest, was used. The number of correct responses (starting with item 16), with a maximum possible score of 28 (the first two items were used for practice), was registered. As described in the manual, the split-half reliability for vocabulary (considering the two vocabulary subtests) ranges between .76 and .86 (for children aged 8 and 9, respectively).

Phoneme awareness (oddity). An oddity task was used. This task consisted of listening to three words (e.g., *saco* [coat], *silla* [chair], *zorro* [fox]) and choosing the one that begins with a different sound (*zorro*). A trained collaborator pronounced the words, approximately at a rate of one per second. Participants were given a booklet with triplets of drawings corresponding to the words they would hear. They were asked to mark with an "X" the drawing whose name began with a different sound. There were 6 triplets of words for practice and 28 triplets for testing. In almost all cases, words were disyllables. A similar task with the same stimuli was used by Defior, Herrera, and Serrano (2006).

The number of correct responses, with a maximum possible score of 28, was registered. Cronbach's alpha was .9.

Phoneme awareness (segmenting). The *LEE*'s phoneme segmenting subtest (*Test de Lectura y Escritura en Español - Test of reading and writing in Spanish,* Defior et al., 2006) was used. This sub-test is composed of 14 words of increasing difficulty (length and syllabic structure), plus three practice items. Participants were asked to segment the words they heard into single phonemes (e.g., *frase* [sentence] segmented as /f/, /r/, /a/, /s/, /e/). The number of words correctly segmented was registered, with a maximum possible score of 14. In the test's instructions, it is explained that a response is correct if participants pronounced either the sounds or the letters' name. For this research, and for maximizing the measuring of PA, we only scored the sounds. Cronbach's alpha in our sample was .81, very close to the Cronbach's alpha for 3rd graders (.85) that is described in the manual.

Stress awareness. The Defior et al. (2012) stress task was used here. This task consisted of listening to pseudowords to detect the stressed syllable. Pseudowords (all trisyllables) were used to eliminate the influence of lexical knowledge in detecting stress. The Defior et al.'s stimuli were used, and included 2 practice items plus 18 test items. A given item's structure was either CV-CV-CV or CV-CV-CVC; 6 had antepenultimate stress (e.g., *bápujo*), 6 had penultimate stress (e.g., *nipora*) and 6 had final stress (e.g., *zirotal*). Stimuli were controlled to avoid evident resemblance to real words. Sound recordings of the pseudowords were made (female voice) and played back during the task.

Children were asked to respond on an answer sheet containing a 3-column table. They had to indicate the syllable that sounded the strongest by writing a mark (X) in the first column (stress on the first syllable), in the second column (stress on the second syllable), or in the third column (stress on the last syllable).

The number of correct responses (a maximum possible score of 18) was counted. Cronbach's alpha was .82.

Word writing. An ad-hoc task was used that consisted of writing single words from dictation without a sentence context. The task was composed of 50 words of different length (disyllabic, trisyllabic, and tetrasyllabic words), stress (antepenultimate, penultimate, or final), and stress mark (present or absent). 10 of these words were obtained from the PEREL reading test (Soto et al., 1992). This test is composed of 100 words, and the last 10 are used to evaluate the children's ability to read words assigning the correct stress. These words are tetrasyllables (1 word) and trisyllables (9 words), and had antepenultimate (5 words) and final stress (5 words).

To have a more complete set of stimuli, including words of different length (disyllables and trisyllables) and stress (antepenultimate, penultimate, and final), we selected 40 more words from the Martínez Martín and García Pérez (2004) dictionary, with a mean frequency of 85.65 occurrences (SD= 164.64) for a counting of 2.6 million words (accumulated frequencies up to sixth grade). 12 of these selected words had antepenultimate stress (all trisyllables), 16 had penultimate stress (6 trisyllables and 10 disyllables), and 12 had final stress (4 trisyllables and 8 disyllables). There were different types of syllabic structures, but mainly CV-CV, CV-CVC, and CV-CV-CV.

The final list of 50 words included 17 with antepenultimate stress (1 tetrasyllable and 16 trisyllables), 16 with penultimate stress (6 trisyllables and 10 disyllables), and 17 with final stress (9 trisyllables and 8 disyllables). Most of these words had stress mark. Only 15 words had not stress mark (9 with penultimate stress, and 6 with final stress).

Words were recorded (female voice) and then played back twice through loud speakers. The sound quality was high and children listened the words in a quiet room. Children were asked to write down the words they heard on an answer sheet. The number of correct responses (a maximum possible score of 50) was counted. Cronbach's alpha was .9.

Phoneme and stress errors were analyzed. Phoneme errors concerned to word grapheme decoding; the following error types were observed: replacing one grapheme with another—e.g., *lá**c**rima* instead of *lá**g**rima* (tear); additions—e.g., *fisica**l*** instead of *física* (physics); and omissions—e.g., *sólio* instead of *sóli**d**o* (solid). Stress errors were registered when the stress mark was not written (e.g., *petalo* instead of *pétalo* [petal]), or when the mark was written in the wrong place, both when the word had a stress mark (e.g., *petálo* instead of *pétalo*) and when it did not (e.g., *militár* instead of *militar* [military]). In those cases where phoneme and stress errors were found (e. g., *solio* instead of ***sólido***), both types of errors were counted.

Sentence writing. The *PROESC'*s sentence writing subtest (*Writing processing assessment – Evaluación de los procesos de escritura*, Cuetos, Ramos & Ruano, 2002) was used. This subtest is composed of six sentences that include words with stress marks. These words were different from those used in the word writing task.

A trained collaborator pronounced (female voice) these sentences for sound recording. All participants listened to the same sound files. The children's tasks consisted of listening to each sentence twice and writing it down on an answer sheet. Only words with a stress mark were considered target words and then scored, resulting in a total of 15 words across six sentences. As not all the participants wrote all of the target words, accuracy percentages were calculated; the number of correct targets (e.g., 10) was divided by the total targets written either correctly or incorrectly (e.g., 14). Cronbach's alpha was .83.

Lastly, stress and phoneme errors were counted as they were in the word writing task. In these cases, error percentages were calculated by dividing the number of errors (e.g., 2) by the number of written targets (e.g., 14).

Procedure

Children were assessed at the end of the first semester of the school year. Testing was mainly performed in three collective sessions (approximately one week between sessions). The duration of these sessions ranged from 20 to 30 minutes. In the first session, non-verbal intelligence (henceforth, NI) and vocabulary (henceforth, V) tests were carried out. In the second session, PA (oddity) and writing (sentence) tests were completed. SA and writing (words) tests were conducted in the third session. The PA (segmenting) test was taken individually (about 10 minutes).

RESULTS

Correct responses were registered for all tests, and percentages were calculated for sentence writing. Additionally, phoneme and stress errors in word writing were counted, and percentages of these errors were computed when writing words in a sentence. Table 1 shows descriptive statistics for all variables.

[Please insert Table 1 about here]

The skewness and kurtosis values were between the acceptable range of -2 and +2 (Field, 2009), except for the measure of PAo (phonological awareness, oddity). However, the two measures of PA were significantly correlated (Person's *r* = .35, p<.01), and then were converted into z scores and averaged (M = 0, SD = .82, Skewness = -1.42, Kurtosis = 1.77).

An initial correlation analysis was performed to obtain a general idea of the relationship among all the variables included in the study (see table 2). Word writing (accuracy) was related to all the relevant variables; in particular, it was highly correlated with SA. As expected, the correlation between SA and phoneme-to-grapheme errors was very low and non-significant. On the contrary, the correlation with stress errors was very high and significant. In the case of PA, there was a significant correlation with phoneme errors, and only a moderate correlation with stress errors.

[Please insert Table 2 about here]

To analyze further these relationships, a hierarchical linear regression analysis was carried out with NI, V, PA and SA as predictor variables. These variables were included in the following order: first, NI, as a general cognitive measure; second V, given its role in PA development; third PA, because of its relationship with literacy acquisition; finally, SA. Moreover, SA was also introduced in the third step to examine further its role as a predictor of word writing irrespectively of PA. Consistent with this study's hypothesis, results show that SA is a significant predictor. In fact, SA is the only significant predictor of word writing when beta coefficients are considered, probably because most errors are stress errors. In line with this hypothesis, PA is related to phoneme errors but not to stress errors, while SA is related to stress errors but not to phoneme errors (see table 3).

[Please insert Table 3 about here]

A more complete analysis includes word writing in a sentence context. Again, SA is mainly related to writing the stress mark, but not to a phoneme-to-grapheme measure. On the contrary, PA was not related to any type of errors (see table 4).

[Please insert Table 4 about here]

Finally, as the PAo measure was nearly to a ceiling effect, instead of using the PA averaged measure (with z scores), we repeated all these analyses using the PAs (phonological awareness, segmenting) measure, and the results were the same (see tables 5 y 6).

[Please insert Table 5 about here]

[Please insert Table 6 about here]

DISCUSSION

The main aim of this study was to investigate the role of Lexical Stress Awareness (SA) in word writing. The hypothesis was that SA and PA may affect different components of word processing. Spanish offers a very good opportunity to test this hypothesis as it includes the use of a stress mark in some words. Specifically, the prediction was that SA should be mainly related to stress mark errors, while PA should be mainly related to phoneme-to-grapheme errors. This is exactly what was found. Moreover, SA and PA were dissociated when writing words in a sentence context. In this case, SA was related to stress errors but not to phoneme errors, whereas PA was not related to any type of errors. It could be argued that we only have used a measure of phonemic awareness, and that other results would have been found if other measures of PA had been used. However, phonemic awareness can be seen as the most difficult level of PA, and thus as a more appropriate and sensitive measure PA.

To our knowledge, this is the first study to investigate the role of SA in word writing in the context of a sentence. Moreover, it is also the first study to find such a clear dissociation between SA and PA. Although it has been argued that PA may include SA (Goodman et al., 2010), the present results suggest some independence, at least for 3rd grade children.

Previous studies have also found that SA is related to phoneme errors (Defior et al., 2012), but among older participants (5th graders). There are several differences between 3rd and 5th grade students that may explain these results. On the one hand, it is in 5th grade when children are penalized if they commit stress errors in writing, which probably leads them to make use of SA daily. Therefore, they may be more capable of paying attention to stress. Since deciding whether to use a stress mark requires one to think about stress and final phonemes at the same time, it is possible that 5th graders develop a mixed phonological awareness (stress and phonemes) ability that may be particularly predictive. On the other hand, SA may help children to pay attention to final phonemes, and in so doing to identify some sounds (Wood et al., 2009). Although the awareness of final phonemes is predictive starting in kindergarten (Carrillo, 1994), it continues to develop through higher grades (Scarborough, Ehri, Olson, & Fowler, 1998). SA may facilitate this learning and subsequent writing performance. For all these reasons, it is necessary to study the role of SA in word writing before and after children are required to think about stress. One contribution of this paper is to study of the role of SA among 3rd graders, i.e., just before children receive intensive teaching on how to apply orthographic stress rules. Once children are fluent stress mark users SA may be less relevant, as probably they are able to recover the whole orthographic representation, i.e., including the stress mark.

Beyond Spanish, the dissociation between SA and PA should be present in other languages as well. It should be found for reading, as stress assignment is necessary for reading aloud. SA should also be expected to be related to the stress-processing component, and PA to the use of grapheme-to-phoneme conversion rules. Similarly, they might be dissociated in writing. In the particular case of English, Kelly, Morris and Verrekia (1998) found that double letters indicate final stress (e.g., *discuss*, or *giraffe*). Errors in writing these double letters might be related to SA in words with final stress, while other phoneme-to-grapheme errors may be related to PA. However, English does not mark stress orthographically, which would suggest that SA should have a stronger role in reading (where stress is necessary) than in writing. To test this hypothesis, Holliman, Gutiérrez-Palma, Critten, Wood, Cunnane, and Pillinger (2017), used a global measure of prosodic sensitivity (including SA tasks) and found that prosodic sensitivity accounted for unique variance in word reading (not in word spelling), even when vocabulary, PA, and morphology were controlled.

As far as we know, the relationship between PA or SA and word writing has not been investigated in a sentence context. However, individual differences due to low PA or SA skills might be less evident when writing a word in a sentence, because certain factors may facilitate lexical access in this context. This may be the case of word meaning, which is linked to phonology and orthography and might be more activated in a sentence as compared to single word reading. Supporting this possibility, in this study no differences due to PA were found in either word writing accuracy or in phonological spelling errors. On the contrary, SA still accounted for a significant (and similar) amount of the writing variance. A possible explanation for this result is that the stress mark might not be part of the orthographic representation for 3rd grade children, and therefore SA is still necessary for the correct writing of the stress mark. SA seems to be necessary for writing the stress mark whatever the context.

A limitation of this study is that no working memory measures were controlled for. There is evidence that working memory plays an important role in writing (e.g., Berninger & O'Malley May, 2011), and this lack of control may have obscured the data. However, in spite of this limitation, SA still accounted for significant variance in sentence writing. Therefore, the relation between SA and word writing can be generalized to the more natural context of writing sentences.

To sum up, the main finding is that SA makes a unique contribution to spelling acquisition, in particular to the use of the stress mark. This metalinguistic skill plays a role in word writing that can be dissociated from the role of PA. Moreover, the role of SA is still important when writing words in a sentence context. These present results extend previous research in Spanish (Defior et al., 2012), as they include children at the first stages of spelling acquisition (3rd graders) and the study of spelling in the context of sentence writing. Finally, as word writing skills are related to SA, future research should explore the possibility that children with word writing difficulties would have poor SA and problems in other stress related skills, paralleling previous findings with reading (Goswami et al, 2002; Holliman et al, 2012; Jiménez-Fernández et al., 2015; Muneaux, Ziegler, Truc, Thomson, & Goswami, 2004; Wood & Terrell, 1998).

The results of the present study contribute to a better understanding of literacy in languages other than English, and in that sense to a general science of reading and writing (Share, 2008). However, this research is correlational and no causal relations between SA and word writing can be concluded. Training and longitudinal studies are required. Despite this limitation, the present results suggest that stress awareness may be included as part of training on metalinguistic awareness for writing without stress mark mistakes. In the same vein, given the relationship between stress awareness and word writing, some measures of stress processing (e.g., stress awareness and stress writing) would be included in the diagnosis and intervention in children with writing difficulties, although more research is needed.

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Table 1

Descriptive statistics, mean, (standard deviation), skewness, kurtosis.

NI (*Max*=60)	V (*Max*=28)	PAo (*Max*=28)	PAs (*Max*=14)	SA (*Max*=18)	WW (*Max*=50)	PE	SE	SW	SWpe	SWse
33.2	18.4	25.1	10.7	10.9	20.2	8	25.2	21.1	8.2	70.4
(8.7)	(3.8)	(4)	(3.1)	(4.1)	(7.9)	(2.7)	(8.1)	(22.2)	(8.2)	(22.8)
-.58	-.54	-2.11	-1.11	.08	1.21	.09	-1.15	1.46	.69	-1.03
.44	.43	4.6	.98	-.98	1.06	-.58	.65	1.95	-.49	.73

Note. Max= Maximum possible; NI= Non-verbal Intelligence; V= Vocabulary; PAo= Phonological Awareness (oddity); PAs= Phonological Awareness (segmenting); SA= Stress Awareness; WW= Word writing; PE= Phoneme errors; SE= Stress errors; SW= Sentence Writing (accuracy percentage); SWpe= Sentence Writing (percentage of phoneme errors); SWse (percentage of stress errors).

Table 2

Pearson correlations.

	1	2	3	4	5	6	7	8	9
1. SA	-								
2. PA	.31**	-							
3. NI	.25*	.41**	-						
4. V	.19	.39**	.41**	-					
5. WW	.56**	.31**	.34**	.34**	-				
6. PE	-.13	-.43**	-.41**	-.36**	-.39**	-			
7. SE	-.54**	-.27*	-.25*	-.27*	-.95**	.27*	-		
8. SW	.56**	.18	.27*	.27*	.83**	-.3**	-.79**	-	
9. SWpe	-.11	-.17	-.16	-.17	-.38**	.43**	.33**	-.33**	-
10. SWse	-.51**	-.15	-.24*	-.18	-.76**	.31**	.73**	-.93**	.39**

Note. SA= Stress awareness; PA= Phonological awareness; V= Vocabulary; NI= Non-verbal Intelligence; WW= Word writing; PE= Phoneme errors; SE= Stress errors; SW= Sentence writing; SWpe= Sentence writing (phonological errors); SWse= Sentence writing (stress errors).

* $p < 0.05$ (two-tailed). ** $p < 0.01$ (two-tailed).

Table 3

Hierarchical linear regression analyses predicting word writing, phoneme and stress errors.

Step	Predictor	WW		PE		SE	
		R^2 change	Final β	R^2 change	Final β	R^2 change	Final β
1	NI	.12**	.14	.17**	-.24**	.06*	-.06
2	V	.05*	.18	.04*	-.16	.03	-.13
3	PA	.02	.03	.06*	-.29*	.02	-.05
4	SA	.2**	.48**	.002	.05	.21**	-.49**
3	SA	.22**	.48**	.0	.05	.23**	-.49**
4	PA	.001	.03	.06*	-.29*	.002	-.05
Total R^2		.39		.28		.33	
Total adjusted R^2		.36		.24		.3	

Note. NI= Non-verbal Intelligence; V= Vocabulary; PA= Phonological Awareness; SA= Stress Awareness; WW= Word writing accuracy; PE= Phoneme errors; SE= Stress errors.

* $p < 0.05$. ** $p < 0.01$

Table 4

Hierarchical linear regression analyses predicting word writing (accuracy, phoneme errors, and stress errors) in a sentence context.

		SW		SWpe		SWse	
Step	Predictor	R^2 change	Final β	R^2 change	Final β	R^2 change	Final β
1	NI	.08*	.12	.03	-.07	.06*	-.12
2	V	.03	.15	.01	-.1	.01	-.07
3	PA	.001	-.1	.01	-.09	.001	.08
4	SA	.24**	.53**	.002	-.04	.22**	-.49**
3	SA	.24**	.53**	.003	-.04	.21**	-.49**
4	PA	.001	-.1	.01	-.09	.001	.08
Total R^2		.35		.05		.28	
Total adjusted R^2		.32		-.002		.25	

Note. NI= Non-verbal Intelligence; V= Vocabulary; PA= Phonological Awareness; SA= Stress Awareness; SW= Sentence Writing (word writing accuracy); SWpe= Sentence Writing (phoneme errors); SWse= Sentence Writing (stress errors).

* $p < 0.05$. ** $p < 0.01$

Table 5

Hierarchical linear regression analyses predicting word writing, phoneme and stress errors.

Step	Predictor	WW		PE		SE	
		R^2 change	Final β	R^2 change	Final β	R^2 change	Final β
1	NI	.12**	14	.17**	-.3**	.06*	-.07
2	V	.05*	.18	.04*	-.19	.03	-.13
3	PAs	.02	.04	.05*	-.24*	.02	-.06
4	SA	.21**	.48**	.001	.03	.21**	-.49**
3	SA	.22**	.48**	.000	.03	.23**	-.49**
4	PAs	.001	.04	.05*	-.24*	.003	-.06
Total R^2		.39		.26		.33	
Total adjusted R^2		.36		.22		.3	

Note. NI= Non-verbal Intelligence; V= Vocabulary; PAs= Phonological awareness, segmenting; SA= Stress Awareness; WW= Word writing accuracy; PE= Phoneme errors; SE= Stress errors.

* $p < 0.05$. ** $p < 0.01$

Table 6

Hierarchical linear regression analyses predicting word writing (accuracy, phoneme errors, and stress errors) in a sentence context.

Step	Predictor	SW		SWpe		SWse	
		R^2 change	Final β	R^2 change	Final β	R^2 change	Final β
1	NI	.08*	.1	.03	-.09	.06*	-.11
2	V	.03	.14	.01	-.1	.01	-.06
3	PAs	.000	-.08	.01	-.1	.003	.04
4	SA	.24**	.52**	.002	-.04	.21**	-.48**
3	SA	.24**	.52**	.003	-.04	.21**	-.48**
4	PAs	.005	-.08	.01	-.1	.001	.04
Total R^2		.35		.05		.28	
Total adjusted R^2		.31		.001		.24	

Note. NI= Non-verbal Intelligence; V= Vocabulary; PAs= Phonological awareness, segmenting; SWpe= Sentence Writing (phoneme errors); SWse= Sentence Writing (stress errors).

* $p < 0.05$. ** $p < 0.01$

HIGHLIGHTS

What is already known about this topic:

- There is a relationship between prosodic sensitivity and reading and spelling ability.
- This relationship has been found for English and for Spanish.
- Lexical stress awareness makes a unique contribution to literacy skills in Spanish (5^{th} graders).

What this paper adds:

- Lexical stress awareness makes a unique contribution to spelling kills in Spanish 3^{rd} graders.
- Phonemic and stress awareness make different contribution to single-word writing.
- Lexical stress awareness is a significant predictor of spelling even in a sentence context.

Implications for practice and/or policy:

- Stress processing tasks could perhaps be used for diagnosis and intervention in reading difficulties.
- Stress awareness training could be useful for teaching to write without stress mark mistakes.