Invented spelling as a tool to develop early literacy: The predictive effect on reading and spelling acquisition in Portuguese

Ana Albuquerque & Margarida Alves Martins

Centro de Investigação em Educação (CIE-ISPA),
ISPA - Instituto Universitário | Portugal

Abstract: Phonological awareness and alphabet knowledge are commonly considered the most powerful literacy predictors at the beginning of schooling. Our aim was to analyse the contribution of invented spelling in kindergarten to reading and spelling in Grade 1 beyond the effects of those two variables. Participants were 92 Portuguese 5-year-old children. Phonological awareness, alphabet knowledge, and invented spelling were assessed in kindergarten and were used to predict word reading and spelling at the end of first grade, using correlation statistics, sequential regression analyses and path analysis models. General cognitive ability and parents' educational level were control variables. The results showed that invented spelling predicted reading and spelling performance beyond phonological awareness and alphabet knowledge, with a statistically significant improved prediction in both cases. Alphabet knowledge and phonological awareness influenced invented spelling, which in turn influenced reading and spelling results in the first year of primary school. Additionally, alphabet knowledge directly influenced reading and spelling. Phonological awareness also had a direct influence on spelling but its effect on reading was only mediated by invented spelling. These results are in line with those of other linguistic contexts and provide insightful findings towards the importance of invented spelling at the onset of literacy learning.

Keywords: early literacy, reading acquisition, spelling acquisition, invented spelling, alphabet knowledge, phonological awareness

journal of
WRITING RESEARCH

Albuquerque, A. & Alves Martins, M. (2022). Invented spelling as a tool to develop early literacy: The predictive effect on reading and spelling acquisition in Portuguese Journal of Writing Research, *14*(1), 113-131 - https://doi.org/10.17239/jowr-2022.14.01.04

Contact: Ana Albuquerque, Centro de Investigação em Educação (CIE-ISPA), R. Jardim do Tabaco 34, Lisboa, 1149-041 | Portugal – albuquerque.c.ana@gmail.com - Orcid: 0000-0001-6370-7677

Copyright: Earli | This article is published under Creative Commons Attribution-Noncommercial-No Derivative Works 3.0 Unported license.

Literacy acquisition is still a big challenge for a great number of learners, which unquestionably impacts their academic performance in a global way and strengthens the need for implementing preventive measures aiming at a more successful educational journey. Advances in literacy studies are gradually allowing researchers to acknowledge the significance of children's emergent skills to their reading and spelling performance. A deep focus on these beneficial effects is crucial to understand how to promote literacy acquisition through the most influential skills, and to minimise developmental discrepancies between children at the beginning of schooling.

It is widely accepted that phonological awareness and letter knowledge positively influence literacy acquisition. However, few studies have tested the contribution of invented spelling – i.e., the way preschoolers spell before explicit guidance – on subsequent reading and spelling. In this study, we analysed the potential predictive effect of invented spelling on reading and spelling beyond the influence of phonological awareness and alphabet knowledge, in the context of Portuguese literacy acquisition.

1. Theoretical background

One well-established predictor of reading and spelling is phonological awareness, i.e., the cognitive process of deliberately discriminating and manipulating the sounds of speech – syllables, intra-syllabic units, and phonemes (Gombert, 1990), since learning to read and write in an alphabetical system implies the understanding that phonemes are represented by graphemes – known as the alphabetic principle. Several studies have called attention to this predictive role (e.g., Ball & Blachman, 1991; Bus & van Ijzendoorn, 1999; Castles & Coltheart, 2004; Ehri et al., 2001; Goswami & Bryant, 1990; National Early Literacy Panel, 2008), in languages with diverse levels of consistency (Caravolas et al., 2012; Seymour, 2005; Seymour, Aro, & Erskine, 2003; Ziegler et al., 2010).

The ability to recognise the letters of the alphabet and its matching sounds is also a well-established predictor of reading and spelling in different languages (e.g., Adams, 1998; Ehri, 1997; Levin, Shatil-Carmon & Asif-Rave, 2006; Treiman, 2004).

Furthermore, when combined, phonological awareness and letter knowledge seem to co-determine both the acquisition of the alphabetic principle and further development of reading and spelling skills, as shown by numerous studies (Byrne, 1998; Foorman, et al., 2003; Gentry & Gillet, 1993; National Early Literacy Panel, 2008).

Thus, there is a strong body of research showing that phonological awareness and alphabet knowledge, either isolated or combined, are determinants of the acquisition of the alphabetic principle and are considered the best predictors of reading and spelling. However, when modelling predictors of reading and spelling acquisition, researchers have omitted invented spelling and focused

directly on these precursors (e.g., Caravolas et al., 2012; Lonigan, Burgess, & Anthony, 2000).

Before formal schooling, children apply their informal knowledge about speech and print to build early spelling attempts produced before explicit guidance – i.e., invented spelling. According to Chomsky (1970) and Read (1971), who were the first authors to use the concept of invented spelling, children's invented spellings offer a glimpse into the child's developing knowledge of how spoken language is represented in print. When preschool children spell words, they use the letters they know, namely the letters of their names, to represent those words; progressively they start to know more letters, and so they use them to represent the sounds that they manage to identify in words (for instance, the first sound or the more prominent ones) (Mann, 1993); and gradually they begin to represent all the sounds of the words although they do not yet know the orthographic rules of their language system (Alves Martins, Albuquerque, Salvador, & Silva, 2013; Ferreiro & Teberosky, 1979; Ehri, 2005, 2014).

Several studies have shown that phoneme awareness and letter knowledge explain the variance in children's early invented spelling and strongly predict its accuracy (e.g., Ouellette & Sénéchal, 2008; Tangel & Blachman, 1995). Thus, invented spelling relies upon phonological awareness and letter knowledge but, on the other hand, phonological awareness expands with invented spelling practice and feedback, as documented in studies in English (Ouellette & Sénéchal, 2008; Sénéchal, et al., 2012), French (Rieben et al., 2005), and Portuguese (Alves Martins & Silva, 2006). Invented spelling also contributes to the understanding of the alphabetic principle, since the letters themselves support a more systematic analysis of the sequence of sounds in words.

In this context, several authors refer to the possibility that invented spelling is a strong predictor of reading (McBride-Chang, 1998; Treiman 1998) and, in some cases, a more reliable predictor of reading ability itself than tasks traditionally associated with phonological awareness. According to Adams (1998), when children invent their own spellings before formal instruction and attempt to deduce the alphabetic principle, they are indirectly more likely to be successful readers.

1.1 Intervention and follow-up studies

Developed within this approach, invented spelling activities may therefore facilitate and enhance the cognitive process underlying the understanding of the alphabetic principle, and so they may be extremely relevant activities for the acquisition of reading and spelling. Growing evidence suggests that this process sustains the development of literacy acquisition. Several studies leading children to spell words and to think about their own spellings, using different intervention approaches, have highlighted how these spellings provide a positive input to the acquisition of the alphabetic principle conducting children to better spell and read at the end of kindergarten (Alves Martins, et al., 2013, 2016; Levin & Aram, 2013; Morin &

Montésinos-Gelet 2007; Ouellette & Sénéchal, 2008; Pulido & Morin, 2017; Rieben, et al., 2005; Sénéchal, et al., 2012).

Longitudinal studies developed in different contexts have tested the long-term impact of invented spelling. They revealed a strong relationship between children's invented spelling at the end of kindergarten and reading and spelling performance throughout primary school. Ouellette, Sénéchal, and Haley (2013), who developed a follow-up study with English-speaking Canadian preschoolers, observed that children who underwent an invented spelling programme with feedback in kindergarten had better results in invented spelling and reading at the end of kindergarten and in Grade 1 than children who underwent a phonological training programme.

Alves Martins, Salvador, Albuquerque, and Silva (2016) and Albuquerque & Alves Martins (2019) assessed the long-term effect of invented spelling programmes in Portuguese schools on kindergarteners' literacy skills through primary school, showing that children who had attended those programmes in kindergarten outperformed children from a control group in reading and spelling at the end of kindergarten and throughout primary school until the end of Grade 3.

In a follow-up study with Norwegian preschoolers, Hofslundsengen, Hagtvet, and Gustafsson (2016) showed that children who undertook an invented spelling programme in preschool had better results on phoneme awareness, spelling, and reading on post-test and follow-up tests as compared to control group children.

1.2 Current study

Apart from these intervention and follow-up studies – showing the influence of invented spelling on reading and spelling – a limited number of studies has analysed the impact of invented spelling on learning to read and spell, along with other well-established predictors, such as phonological awareness and letter knowledge.

A three-year longitudinal study by Caravolas, Hulme, and Snowling (2001) explored the role of early reading and preconventional (phonological) spelling skills, together with phonological abilities and letter knowledge as predictors of conventional spelling ability. Children were tested twice in kindergarten (January-February: time 1; June-July: time 2), in the first year of primary school (January-February: time 3), and in the second year of primary school (April: time 4). The results showed that phonological spelling accuracy (i.e., the child's ability to represent the sound structure of the words they are attempting to spell) depended on letter-sound knowledge and phoneme isolation ability. The predictors of conventional spelling accuracy depended on prior reading ability and phonological spelling in the first year of primary school but in the second year, conventional spelling only depended on previous conventional spelling and reading results. The pattern for reading development implies that although it depends to some extent on phonological awareness and phonological spelling, the direct effect of these

skills is shorter and weaker than it is on spelling. The main variables explaining reading were letter-name knowledge and previous reading ability.

A recent study carried out by Ouellette and Sénéchal (2016) with English-speaking Canadian children provided us with insightful findings regarding the predictive effect of oral vocabulary, phonological awareness, and letter knowledge with the addition of invented spelling, on reading and spelling in Grade 1. This study explored the role played by invented spelling in early literacy by modeling paths of influence from kindergarten into the first year of primary school. It was hypothesised that invented spelling complexity in kindergarten would predict conventional spelling and reading in Grade 1, after considering phonological awareness, alphabet knowledge, and oral vocabulary. The measures used were oral vocabulary, phonological awareness, alphabet knowledge, invented spelling, and reading in kindergarten, and reading and conventional spelling in Grade 1. Path analyses revealed a model where invented spelling was influenced by phonological awareness, alphabet knowledge, and oral vocabulary in kindergarten, and it influenced reading and spelling in Grade 1. Phonological awareness showed no direct influence on reading but a direct influence on spelling in Grade 1. Alphabet knowledge presented a direct influence on reading, although its influence on spelling was mediated by invented spelling. Oral vocabulary only influenced reading and spelling indirectly. The authors claimed that invented spelling increased an explanatory variance to reading and spelling performance.

In a longitudinal study, Lin et al. (2010) detected similar evidence on the influence of invented spelling in Pinyin – a phonological coding system for the transcription of Chinese words – on reading. They considered age, nonverbal IQ, invented spelling, word reading, syllable and phoneme deletion, and letter name knowledge in preschool, and word reading 12 months later. Even when controlling for syllable and phoneme deletion, as well as letter-name knowledge, invented spelling was the most important reading predictor along with reading in preschool.

Following these studies, it is important to understand how this impact operates in other orthographies, particularly in Portuguese, which is distinguished by specific features as compared to other languages. Alphabetic orthographies differ in the complexity of their grapheme-phoneme correspondence rules, which has a strong impact on literacy acquisition (Ziegler et al., 2010). In shallow/transparent orthographies, these rules are highly consistent, whereas in deep/opaque orthographies, they are more inconsistent and unpredictable (Tolchinsky, Liberman, & Fradejas, 2015). Portuguese is a semi-transparent orthography: in relation to reading, there are predictable grapheme-phoneme correspondences and stable and contextual rules establishing grapheme-phoneme conversions; in relation to writing, there are more orthographic inconsistencies. Alphabetic orthographies also differ in their syllabic patterns, which influence reading and spelling acquisition. As for syllabic patterns, Portuguese has a simple syllabic

pattern and the most frequent syllables are CV (consonant/vowel), although other less frequent syllabic patterns also exist.

In summary, there is still no data available in the Portuguese context regarding the contribution of invented spelling to reading and spelling beyond other well-established precursors. In our study, we assessed phonological awareness (syllable awareness and phoneme awareness), alphabet knowledge (letter name and letter sound), and invented spelling in kindergarten. These variables were used to predict word reading and spelling at the end of first grade. General cognitive ability and parents' educational level were collected and used as control variables. Two research questions were addressed: 1) Does invented spelling in kindergarten contribute to predicting Grade 1 reading and spelling beyond phonological awareness and alphabet knowledge? 2) How much of the effects of these variables are mediated by invented spelling?

2. Method

2.1 Design

This paper describes a short-term follow-up study that modelled the influence of predictive variables from kindergarten on reading and spelling at the end of Grade 1, using correlation statistics, sequential regression analyses, and path analysis models.

2.2 Participants

The participants were 92 five-year-old Portuguese children (45 female and 47 male) attending four schools in Lisbon. These schools adopted the national curriculum guidelines for preschool education, in which literacy-related activities generally focus on storytelling, dialogic reading, singing nursery rhymes, learning the alphabet sequence, playing oral language games, and writing their own name on drawings and other productions. No direct formal literacy on early spelling nor reading is applied until primary school, where phonics is the main teaching method applied. At the beginning of the study, the participants' mean age in kindergarten was 65.20 months (SD = 3.53). Only schools with a range of education levels from preschool up to primary school were invited to participate in this study. This increased the likelihood that participants would remain in the same school the following year for the follow-up testing. Statements of written informed consent from legally authorised guardians/parents of participants were previously obtained.

2.3 Instruments and measures

Parents' education level

Information regarding the highest level of completed education reached by the children's mother and father was requested, as educational attainment is one of the most common indicators of socioeconomic status. An overall score was computed using the average of both values to estimate parents' global education level.

General cognitive ability

Children's abstract reasoning was measured in kindergarten with the Raven's Progressive Matrices Test – coloured version (Raven, Raven, & Court, 1998). In this non-verbal test, participants are asked to specify the missing piece out of a pattern of six to eight possible options. There are 60 patterns grouped into three sets, representing 60 multiple-choice geometric items (max. score: 36 points – one per correct response).

Phonological awareness: syllable awareness and phoneme awareness

The initial-syllable classification subtest and the initial-phoneme classification subtest of the Battery of Phonological Tests (Silva, 2002) were administered in kindergarten to assess the understanding of short linguistic units in Portuguese. In each trial, children were shown 14 sets of four pictures named by the researcher upon presentation, and they were asked to point out two words that began with the same sound – either syllable or phoneme (max. score in each test: 14 points – one per correct response). The internal consistency using Cronbach's alpha was .89 for the syllabic subtest and .82 for the phonemic subtest. An overall phonological awareness score was calculated with the sum of the values in both subtests, so the total raw score ranged from 0 to 28 points.

Alphabet knowledge: letter name and letter sound

In kindergarten, 23 flashcards were presented in a random order to each child. Each flashcard had the letters of the alphabet printed in uppercase (K, W, and Y were excluded from this test, since they are not integrated in European Portuguese lexicality). They were then asked to name each letter and to pronounce its corresponding sound. Both name verbalisation and sound vocalisation were considered in this assessment measure (max. score: 23 points for name items – one per correct response; and 23 points for sound items – one per correct response). A unique score was created using the sum of the values in both dimensions, so the total raw score ranged between 0 and 46 points. The internal consistency using Cronbach's alpha for this test was .93.

Invented spelling

Children's invented spelling in kindergarten was analysed with an 18-word dictation task outlined using specific linguistic criteria: consistent words with 2 to 4 letters; one-to-one grapheme-phoneme correspondences (3 vowels; 6 consonants); and frequent syllabic structures in Portuguese (CVCV; CVV). These words were presented one by one by the researcher in a fixed random order, and the participants were invited to spell them by themselves with no help from the adult. Spelling outcomes were analysed according to the total raw score of phonetisations, i.e., the number of grapheme-phoneme correspondences spelled correctly (max. score: 68 points – one per correct phonetisation). It is important to note that: 1) only letters that respected the right order inside the word were counted as correct; 2) all phonetically plausible graphemes were counted as correct although they could be orthographically incorrect (e.g., for the word "pato" [duck], the spelling "PT" or "AU" would be assigned two points each, "PAT" would be assigned three points, "PATU" would be assigned four points, and "UOA" would be assigned 0 points). Using this scoring system, two examiners classified the children's responses separately. The inter-scorer agreement using the kappa statistic was 0.96.

Reading in Grade 1

In order to measure children's reading ability, a list of 20 words was created using several linguistic and articulatory characteristics as to frequency, consistency, size, and syllabic structure. They included all the main consonants in Portuguese phonology (words beginning with diverse letters of the alphabet), frequent and less frequent, consistent and less consistent (one-to-one and two-way grapheme-phoneme correspondences), diverse size dimensions regarding the number of letters (from 4 to 8), different syllabic structures (CV – sino [bell], VC – urso [bear], CVC – lençol [sheet], CCV – preto [black], CCVC – flor [flower]), and consonant digraphs (folha [leaf], ninho [nest], bolacha [cookie]). The participants were shown the stimuli, one at a time, presented on small flashcards, in a fixed random order. They were encouraged to read them aloud while their voice was recorded (max. score: 20 points – one per correct response). The internal consistency using Cronbach's alpha for this test was .93.

Spelling in Grade 1

For the assessment of spelling in Grade 1, we applied the same list of 20 words used to assess reading. Children were encouraged to write down each word one by one with no help nor feedback from the experimenter (max. score: 20 points – one per correct response). The internal consistency using Cronbach's alpha was .94.

2.4 Procedure

Children were initially tested in the last year of kindergarten, in January/February, in three sessions that lasted for approximately 30 minutes. In the first phase of the study, data collection and participant assessment at baseline occurred as follows: 1) information regarding the highest level of education reached by the children's parents was requested to control for the influence of parents' education level on children's performance; 2) children's general cognitive ability was assessed [session no.1]; 3) participants were tested on phonological awareness (syllable awareness and phoneme awareness) and alphabet knowledge (letter name and letter sound) [session no.2]; 4) children's invented spelling was assessed [session no.3].

In the second phase, the cohort was assessed in the following year, at the end of Grade 1 (May), to determine reading and spelling outcomes in two separate sessions. In the first one, children were asked to spell the list of 20 words in a fixed random order; in the second one, one week later, children were asked to read the list of 20 words also in a fixed random order. Spelling was applied before reading, to prevent visual learning memory effects, so this week separation was very important.

All assessment measures were administered individually in a silent room outside the students' regular classroom and were carried out by two psychologists who are well-trained researchers in this scientific field.

2.5 Data analysis

The first step was to compute descriptive statistics and correlations between all variables. To test whether invented spelling in kindergarten contributed to predicting Grade 1 reading and spelling beyond phonological awareness and alphabet knowledge (first research question), we performed sequential regression analyses. To analyse how much of the effects of these variables were mediated by invented spelling (second research question), path analysis models were executed, due to the ability of this method to examine complex relationships between multiple measures. For the statistical analyses, we used R (R Core Team, 2020) with the 'lavaan' package (Rosseel, 2012), a package for latent variable modelling that can be used to estimate a large variety of multivariate statistical models, namely path analysis. In all regression analyses, we used ML estimators requesting robust standard errors (bootstrap with 10,000 draws).

3. Results

3.1 Descriptive statistics

Table 1 presents the descriptive statistics concerning parents' education level, general cognitive ability, phonological awareness, alphabet knowledge, invented spelling, and reading and spelling in Grade 1.

Table 1. Descriptive statistics for all measures

	M	*SD*	Min. score	Max. Score	Reference values
Parents' education level	14.96	2.06	7	20	No. school years
General cognitive ability	17.22	4.78	6	28	0-36
Phonological awareness	10.53	6.80	1	28	0-28
Alphabet knowledge	34.96	9.51	14	46	0-46
Invented spelling	35.54	23.54	0	68	0-68
Reading in Grade 1	9.18	6.28	0	20	0-20
Spelling in Grade1	4.85	4.27	0	17	0-20

Regarding parents' education level, mothers reported 7 to 20 years of schooling and fathers stated 6 to 18 years of schooling. The results regarding phonological awareness were relatively low, and the mean for syllabic awareness (M = 6.23) was higher than for phonemic awareness (M = 4.30). The participants had good results in alphabet knowledge, and the mean for letter names (M = 19.51) was higher than for letter sounds (M = 15.45). There was a considerable variability in invented spelling, as shown in Table 1. As expected, since reading is easier than spelling, children presented higher scores on reading performance as compared to spelling.

3.2 Correlation statistics, regression analysis, and path analysis models

Table 2 presents the correlation matrix between parents' education level, general cognitive ability, phonological awareness, alphabet knowledge, invented spelling, and reading and spelling in Grade 1.

The results presented in Table 2 show that the correlations between parents' education level and the remaining variables were very close to 0. As for general cognitive ability, the correlations with the other variables were all significant but lower than the correlations among the other skills. The correlations among the three literacy measures in kindergarten were all about .500. The correlations of those three skills with later reading and spelling ranged from .517 to .598 except for invented spelling and reading at .698, which is descriptive evidence of the importance of invented spelling for reading. Invented spelling was the variable that demonstrated the highest correlations with reading in Grade 1. As expected, reading exhibited high correlations with spelling.

To explore our first research question, i.e., to test whether invented spelling had a predictive effect on reading results beyond those of other variables, we performed sequential regression analysis using general cognitive ability, phonological awareness, and alphabet knowledge as predictors of reading ability in the first model, and the same predictive variables as well as invented spelling in the second model. Parents' education level was not included as predictor due to its

weak correlation with other variables. The results for this sequential regression analysis are reported in Table 3.

Table 2. Correlation statistics for all measures.

	Parents' education level	General cognitive ability	Phonological awareness	Alphabet knowledge	Invented spelling	Reading in Grade 1
General cognitive ability	-.040					
Phonological awareness	.010	.342**				
Alphabet knowledge	.019	.229*	.466**			
Invented spelling	.011	.279*	.507**	.499**		
Reading in Grade 1	-.010	.319**	.517**	.598**	.698**	
Spelling in Grade1	-.003	.325**	.602**	.591**	.577**	.807**

Note. **p<.01; *p<.05

Table 3. Sequential regression analysis predicting reading in Grade 1 from general cognitive ability, phonological awareness, alphabet knowledge, and invented spelling

	Model 1				Model 2			
	B	*Std error*	*beta*	*p*	*B*	*Std error*	*beta*	*p*
Constant	-6.77	2.56		.009	-5.81	2.15		.009
General cognitive ability	.18	.12	.14	.148	.17	.10	.13	.086
Phonological awareness	.25	.08	.24	.003	.09	.08	.10	.251
Alphabet knowledge	.29	.05	.44	.000	.19	.06	.28	.002
Invented spelling					.13	.02	.48	.000
	$R^2 = .45$, $F(3,88) = 23.65$, $p < .001$				$R^2 = .60$, $F(4,87) = 32.18$, $p < .001$			
	$\Delta R^2 = .15$, $\Delta F(1,87) = 32.44$, $p < .001$							

According to Table 3, adding invented spelling in the second model improved the overall R^2 from .45 to .60. This improved prediction was statistically significant. Invented spelling predicted reading performance beyond the other variables.

Regarding the predictive effect of invented spelling on spelling results in Grade 1 beyond those of other variables, we also performed a sequential regression analysis using general cognitive ability, phonological awareness, and alphabet knowledge as predictors of spelling ability in the first model, and the same predictive variables as well as invented spelling in the second model. Parents' education level was again excluded due to its weak correlations with the remaining variables. The results for this sequential regression analysis are described in Table 4.

Table 4. Sequential regression analysis predicting spelling in Grade 1 from general cognitive ability, phonological awareness, alphabet knowledge, and invented spelling.

	Model 1				Model 2			
	B	*Std error*	*beta*	*p*	*B*	*Std error*	*beta*	*p*
Constant	-5.57	1.43		.000	-5.22	1.32		.000
General cognitive ability	.10	.08	.12	.180	.10	.07	.11	.166
Phonological awareness	.24	.06	.38	.000	.19	.07	.30	.006
Alphabet knowledge	.17	.03	.39	.000	.14	.04	.30	.000
Invented spelling					.05	.02	.25	.006
	$R^2 = .50$, $F(3,88) = 28.95$, $p < .001$				$R^2 = .54$, $F(4,87) = 25.42$, $p < .001$			
	$\Delta R^2 = .04$, $\Delta F(1,87) = 7.95$, $p = .006$							

The results presented in Table 4 showed that adding invented spelling in the second model improved the overall R^2 from .50 to .54. This improved prediction was also statistically significant. Thus, invented spelling predicted spelling performance in Grade 1 beyond the other variables.

To explore our second research question, i.e., to test how much of the effects of these variables were mediated by invented spelling, two path analyses were performed disregarding parents' education level due to its weak correlations. Data concerning reading in Grade 1 is reported in Figure 1.

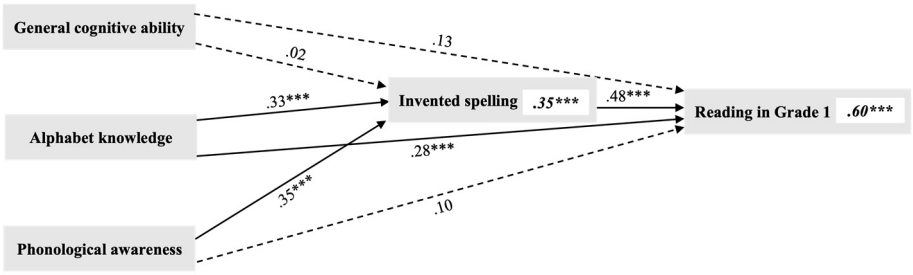

Figure 1: Path analysis for reading in Grade 1. Standardised path coefficients representing the direct effects are shown. R^2 values for invented spelling and reading in Grade 1 are in italics. Dashed lines display non-significant paths. *Note:* *** p < .001.

As shown in Figure 1, general cognitive ability did not show statistically significant effects neither on children's spelling in kindergarten nor on their reading results in Grade 1. Alphabet knowledge and phonological awareness explained 33% and 35% of the variability of invented spelling, which in turn influenced reading results in the first year of primary school. Additionally, alphabet knowledge directly influenced reading, and phonological awareness had no direct influence on reading. The results concerning spelling in Grade 1 are described in Figure 2.

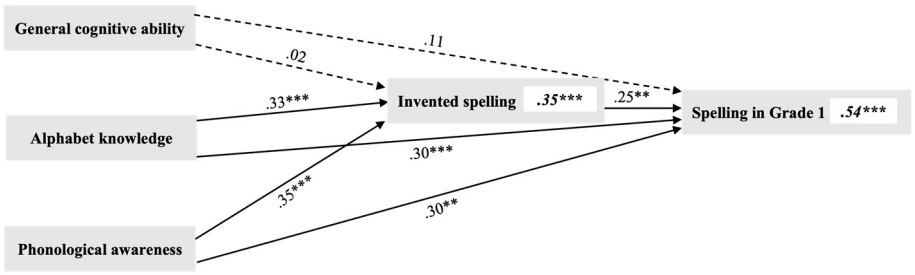

Figure 2: Path analysis for spelling in Grade 1. Standardised path coefficients representing the direct effects are shown. R^2 values for invented spelling and spelling in Grade 1 are in italics. Dashed lines display non-significant paths. *Note:* *** p < .001; ** p < .01.

Figure 2 demonstrates that no statistically significant effects were found for general cognitive ability on invented spelling nor on spelling outcomes in Grade 1. Alphabet knowledge and phonological awareness explained 33% and 35% of the variability of invented spelling, which in turn influenced spelling results in the first year of primary school. Also, alphabet knowledge and phonological awareness had similar direct effects on spelling in Grade 1.

4. Discussion

The aim of this study was to analyse the contribution of invented spelling in kindergarten to reading and spelling acquisition in Grade 1 beyond the effects of phonological awareness and alphabet knowledge. Two research questions were formulated: 1) Does invented spelling contribute to predicting Grade 1 reading and spelling beyond phonological awareness and alphabet knowledge? 2) How much of the effects of these variables are mediated by invented spelling?

The results in our study showed that parents' education level had no statistically significant correlations with the other variables and general cognitive ability had no statistically significant impact on invented spelling nor on reading and spelling.

Regarding our first research question, the sequential regression analyses indicated that invented spelling predicted reading and spelling performance beyond phonological awareness and alphabet knowledge, with a statistically significant improved prediction in both cases. These findings show the relevance of invented spelling for reading and spelling beyond the role of phonological awareness and alphabet knowledge, as it was also verified by Ouellette and Sénéchal (2016) with English-speaking Canadian children and by Lin et al. (2010), who also detected similar evidence concerning the impact of invented spelling in Pinyin on Chinese children's reading results. Additionally, our results go in the same direction as the study conducted by Caravolas, Hulme, and Snowling (2001) with British children who also showed that phonological spelling in kindergarten, which was influenced by phonological awareness and alphabet knowledge, was a strong predictor of reading and spelling outcomes in the first year of primary school. Furthermore, our results show that the predictive role of invented spelling on reading was stronger as compared to spelling, which was a predictable finding since the process of reading is easier than the process of writing.

When reflecting upon our findings, it seems important to acknowledge that whilst measures of phonological awareness relate to the ability to analyse oral language, and letter knowledge is a measure that allows us to understand the graphic elements that enable reading and spelling, invented spelling is already a skill in which these two dimensions are not only articulated, but importantly they are together in action. Thus, invented spelling boosts the access to the alphabetic principle, and it also allows children to establish memory links between phonological and orthographic representations, contributing to predict reading and spelling abilities. The findings reported in this study provided support for this interpretation.

This view is also supported by various experimental studies that have called attention to the way in which invented spelling produces a beneficial input to metalinguistic reasoning procedures and to developing emergent reading and writing skills (Alves Martins, et al., 2016; Hofslundsengen, Hagtvet, & Gustafsson, 2016; Levin & Aram, 2013; Morin & Montésinos-Gelet, 2007; Ouellette, Sénéchal, & Haley, 2013; Rieben, et al., 2005). Through diverse intervention and mediation

approaches, it has become progressively clearer that the thinking mechanisms that lie under the invented spelling process mobilise valuable cognitive and metalinguistic skills that boost the advance of phonological and orthographic knowledge, contributing to literacy development (e.g., Albuquerque, & Alves Martins, 2019; Levin & Aram, 2013).

Considering our second research question, the path analysis regarding reading showed that phonological awareness and alphabet knowledge had an indirect effect on reading results through invented spelling. However, whilst alphabet knowledge also had a direct influence on reading, phonological awareness exposed no such effect. The path analysis for spelling also provided support for the proposed contribution of invented spelling, showing indirect effects of phonological awareness and alphabet knowledge through invented spelling. Both variables also had direct effects on spelling at the end of first grade. These results are similar to those found by Ouellette and Sénéchal (2016) except for the influence of alphabet knowledge on spelling, which only occurred through invented spelling in their study. However, it is important to highlight that we did not assess reading in kindergarten as it was the case in their study.

The direct effects of alphabet knowledge on reading and spelling obtained in this study may be explained by the characteristics of the Portuguese orthography. In Portuguese, a more transparent orthography than English, the familiarity with the names and sounds of the letters of the alphabet facilitates coding and decoding processes, since there are many cases in which grapheme-phoneme correspondences are one-to-one. This situation is rarer in English, as the correspondences between phonemes and graphemes are mostly inconsistent and unpredictable. Additionally, the letter names in the Portuguese alphabet also comprise one of the sounds they represent (except for the letter H), so this knowledge also contributes to reading and spelling accuracy in Portuguese. Therefore, it would be expected that the knowledge of letter names and sounds would have a direct influence on later reading and spelling outcomes.

The closeness of the explanatory models of reading and spelling found in our study may be perceived considering the strong supported connection between writing and reading mechanisms, in an interdependent and mutually facilitative process (Ehri, 1997). According to Rieben et al. (2005), spelling is a tool that boosts reading processes, given that they both depend on the same cognitive and memory source. It is noteworthy to emphasise that conventional spelling extends invented spelling itself, with a more consistent knowledge of grapheme-phoneme correspondence rules and a more robust word set stored in memory.

As to limitations and suggestions for future research, various control variables to draw causal conclusions are missing in our study. On the one hand, reading in kindergarten is a significant variable to incorporate in upcoming studies. On the other hand, other well-established precursors of reading and spelling that have been thoroughly documented in scientific literature were also not included. For

instance, it would be valuable to integrate diverse predictive measures in the statistical analysis, such as oral vocabulary, verbal working memory, rapid automatised naming, and morphological awareness. It would also be valuable to use not only a receptive phonological test, but also a productive one that would require the ability to produce the relevant sounds of speech, which is one of the abilities involved in invented spelling. Additionally, with respect to parents' education, the minimum value completed in our sample was not very low, and both the maximum value and the mean level were considered above-average degrees. Therefore, it would be recommended to explore if our findings are preserved in low socioeconomic status environments. Finally, it would be interesting to analyse whether invented spelling continues to explain reading and writing results following the first year of primary school.

In summary, the current study shows the relevance of considering invented spelling as predictor of reading and spelling skills in the first year of primary school, along with other well-known precursors, such as phonological awareness and alphabet knowledge. The analytical process that invented spelling implies may explain its valuable role on literacy development in Portuguese and extends the results obtained in more opaque orthographies like English. Thus, our results provide insightful empirical findings towards the compelling significance of early literacy skills, particularly invented spelling, to boost and strengthen reading and spelling abilities at the onset of literacy acquisition.

Acknowledgments

This research was funded by the Portuguese funding agency for science, research, and technology (FCT – Fundação para a Ciência e a Tecnologia), under CIE-ISPA projects UIDP/04853/2020 and UIDB/04853/2020, through national funds of FCT/MCTES-PT.

References

Adams, M. J. (1998). Beginning to read: Thinking and learning about print. Cambridge, MA: MIT Press.

Alves Martins, M. & Silva, C. (2006). The impact of invented spelling on phonemic awareness. Learning and Instruction, 16, 41-56. doi:10.1016/j.learninstruc.2005.12.005.

Alves Martins, M., Albuquerque, A., Salvador, L., & Silva, A. C. (2013). The impact of invented spelling on early spelling and reading. Journal of Writing Research, 5(2), 215-237. doi:10.17239/jowr-2013.05.02.3.

Alves Martins, M., Salvador, L., Albuquerque, A., & Silva, C. (2016). Invented spelling activities in small groups and early spelling and reading. Educational Psychology: An International Journal of Experimental Educational Psychology, 36 (4), 738-752. doi: 0.1080/01443410.2014.950947.

Albuquerque, A. & Alves Martins, M. (2019). Enhancing children's literacy learning: From invented spelling to effective reading and writing. L1-Educational Studies in Language and Literature, 19, 1-24. doi:10.17239/L1ESLL-2019.19.01.02.

Ball, E. W. & Blachman, B. A. (1991). Does phoneme awareness training in kindergarten make a difference in early word recognition and developmental spelling? Reading Research Quarterly, 26(1), 49-49. doi:10.1598/RRQ.26.1.3.

Bus, A. G. & van Ijzendoorn, M. H. (1999). Phonological awareness and early reading: A meta-analysis of experimental training studies. Journal of Educational Psychology, 91(3), 403-414. doi:10.1037/0022-0663.91.3.403.

Byrne, B. (1998). The foundation of literacy: the child's acquisition of the alphabetic principle. Hove, UK: Psychology Press.

Caravolas, M., Hulme, C., & Snowling, M. J. (2001). The foundations of spelling ability: Evidence from a 3-year longitudinal study. Journal of Memory and Language, 45, 751-774. doi:10.1006/jmla .2000.2785.

Caravolas, M., Lervåg, A., Mousikou, P., Efrim, C., Litavský, M., Onochie-Quintanilla, E., Salas, N., Schöffelová, M., Defior, S., Mikulajová, M., Seidlová-Málková, G., & Hulme, C. (2012). Common patterns of prediction of literacy development in different alphabetic orthographies. Psychological Science, 23(6), 678-686. doi:10.1177/0956797611434536.

Castles, A. & Coltheart, M. (2004). Is there a causal link from phonological awareness to success in learning to read? Cognition, 91(1), 77-111. doi:10.1016/S0010- 0277(03)00164-1.

Chomsky, C. (1970). Reading, writing and phonology. Harvard Educational Review, 40, 287-309.

Ehri, L. C. (1997). Learning to read and learning to spell are one and the same, almost. In C. Perfetti, L. Rieben, & M. Fayol (Eds.), Learning to spell – research, theory, and practice across languages (pp. 237-269). Mahwah, New Jersey: Erlbaum.

Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. Scientific Studies of Reading, 9(2), 167-188. doi:10.1207/s1532799xssr0902_4.

Ehri, L. C. (2014). Orthographic mapping in the acquisition of sight word reading, spelling memory, and vocabulary learning. Scientific Studies of Reading, 18(1), 5-21. doi:10.1080/10888438.2013.819356.

Ehri, L. C., Nunes, S. R., Willows, D. M., Schuster, B. V., Yaghoub-Zadeh, Z., & Shanahan, T. (2001). Phoneme awareness instruction helps children learn to read: Evidence from the National Reading Panel's meta-analysis. Reading Research Quarterly, 36(3), 250–287. doi:10.1598/RRQ.36.3.2.

Ferreiro, E., & Teberosky, A. (1979). Los sistemas de escritura en el desarrollo del niño. México: Siglo XXI. [Trans. 1982. Literacy before schooling. Exeter, NH: Heineman Educational Books].

Foorman, B. R., Chen, D.-T., Carlson, C., Moats, L., Francis, K. D., & Fletcher, J. M. (2003). The necessity of the alphabetic principle to phonemic awareness instruction. Reading and Writing: An Interdisciplinary Journal, 16(4), 289-324. doi:10.1023/A:1023671702188.

Gentry, J. R. & Gillet, J. W. (1993). Teaching kids to spell. Portsmouth, NH: Heinemann.

Gombert, J.-É. (1990). Le développement métalinguistique [Metalinguistic development]. Paris: P.U.F.

Goswami, U. & Bryant, P. (1990). Phonological skills and learning to read. Hove: Lawrence Erlbaum Associates Publishers.

Hofslundsengen, H., Hagtvet, B. E., & Gustafsson, J. E. (2016). Immediate and delayed effects of invented writing intervention in preschool. Reading and Writing: An Interdisciplinary Journal, 29(7), 1473-1495. doi:10.1007/s11145-016-9646-8.

Levin, I. & Aram, D. (2013). Promoting early literacy via practicing invented spelling: A comparison of different mediation routines. Reading Research Quarterly, 48(3), 221-236. doi:10.1002/rrq.48.

Levin, I., Shatil-Carmon, S., & Asif-Rave, O. (2006). Learning of letter names and sounds and their contribution to word recognition. Journal of Experimental Child Psychology, 93(2), 139-165. doi:10.1016/j.jecp.2005.08.002.

Lin, D., McBride-Chang, C., Shu, H., Zhang, Y., Li, H., Zhang, J., Aram, D., & Levin, I. (2010). Small wins big: analytic pinyin skills promote Chinese word reading. Psychological Science, 21(8), 1117-1122. doi:10.1177/0956797610375447.

Lonigan, C. J., Burgess, S. R., & Anthony, J. L. (2000). Development of emergent literacy and early reading skills in preschool children: Evidence from a latent-variable longitudinal study. Developmental Psychology, 36(5), 596-613. doi:10.1037/0012-1649.36.5.596.

Mann, V. A. (1993). Phoneme awareness and future reading ability. Journal of Learning Disabilities, 26(4), 259-269. doi:10.1177/002221949302600404.

McBride-Chang, C. (1998). The development of invented spelling. Early Education and Development, 9, 147-160.

Morin, M.-F. & Montésinos-Gelet, I. (2007). Effet d'un programme d'orthographes approchées en maternelle sur les performances ultérieures en lecture et en écriture d'élèves à risque. Revue des Sciences de l'Education, 33, 663683. doi:10.7202/018963ar.

National Early Literacy Panel. (2008). Developing early literacy: Report of the National Early Literacy Panel. Washington, DC: National Institute for Literacy.

Ouellette, G. & Sénéchal, M. (2008). Pathways to literacy: A study of invented spelling and its role in learning to read. Child Development, 79, 899-913. doi:10.1111/j.1467-8624.2008.01166.x.

Ouellette, G. & Sénéchal, M. (2016). Invented spelling in kindergarten as a predictor of reading and spelling in Grade 1: A new pathway to literacy, or just the same road, less known? Developmental Psychology. doi:10.1037/dev0000179.

Ouellette, G., Sénéchal, M., & Haley, A. (2013). Guiding children's invented spellings: A gateway into literacy learning. Journal of Experimental Education, 81, 261-279. doi:10.1080/00220973 .2012.699903.

Pulido, L. & Morin, M.-F. (2017). Invented spelling: What is the best way to improve literacy skills in kindergarten?, Educational Psychology. doi:10.1080/01443410.2017.1414155.

R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL:www.R-project.org/.

Raven, J., Raven, J. C., & Court, J. H. (1998). Manual for Raven's progressive matrices and vocabulary scale. Section I. General overview. Oxford, UK: Oxford Psychologists Press.

Read, C. (1971). Pre-school children's knowledge of English phonology. Harvard Educational Review, 41, 1-34. doi:10.17763/haer .41.1.91367v0h80051573.

Rieben, L., Ntamakiliro, L., Gonthier, B., & Fayol, M. (2005). Effects of various early writing practices on reading and spelling. Scientific Studies of Reading, 9(2), 145-166. doi:10.1207/s1532799xssr0902_3.

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. Journal of Statistical Software, 48(2), 1-36. doi:jstatsoft.org/v48/i02/.

Sénéchal, M., Ouellette, G., Pagan, S., & Lever, R. (2012). The role of invented spelling on learning to read in low-phoneme-awareness kindergartners: A randomized-control-trial study. Reading and Writing, 25, 917-934. doi:10.1007/s11145-011-9310-2.

Seymour, P. (2005). Early reading development in European orthographies. In M. J. Snowling & C. Hulme (Eds.), The science of reading: A handbook (pp. 296-315). Oxford: Blackwell.

Seymour, P., Aro, M., & Erskine, J. (2003). Foundation literacy acquisition in European orthographies. British Journal of Psychology, 94(2), 143-174.

Silva, C. (2002). Bateria de provas fonológicas [Battery of phonological tests]. Lisboa, Portugal: ISPA.

Tangel, D. M. & Blachman, B. A. (1995). Effect of phoneme awareness instruction on the invented spelling of first grade children: A one-year follow-up. Journal of Reading Behavior, 27(2), 153-185. doi:10.1080/10862969509547876.

Tolchinsky, L., Liberman, G, & Alonso-Cortés Fradejas, M. D. (2015). Explaining first graders' achievements in spelling and word separation in shallow orthographies. Journal of Writing Research, 6(3), 279-316. doi:10.17239/jowr-2015.06.03.3.

Treiman, R. (1998). Why spelling? The benefits of incorporating spelling into beginning reading instruction. In J. L. Metsala & L.C. Ehri (Eds.), Word recognition in beginning literacy (pp. 289-313). Mahwah, NJ: Erlbaum.

Treiman, R. (2004). Phonology and spelling. In P. Bryant & T. Nunes (Eds.), Handbook of children's literacy (pp. 31-42). Dordrecht: Kluwer.

Ziegler, J. C., Bertrand, D., Tóth, D., Csépe, V., Reis, A., Faísca, L., Saine, N., Lyytinen, H., Veassen, A., & Blomert, L. (2010). Orthographic depth and its impact on universal predictors of reading: A cross-language investigation. Psychological Science, 20(10), 1-9. doi:10.1177/0956797610363406.