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Phonological abilities and writing among Portuguese preschool children

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The objective of this study was to identify causal relationships between the development of phonological abilities and progress in writing in preschool children. The participants were 44 children, with an average age of 5 years and 6 months, and whose writing was syllabic with phonetization. The children were divided into three groups. They were subjected to a pre-test and a post-test that were intended to evaluate both their writing and their phonological skills. In between the two tests experimental group 1 underwent a writing training program designed to lead them to produce syllabic-alphabetic/alphabetic writing, while experimental group 2 was subjected to a phonological training program designed to work on phonetic units. The third group served as a control group. The number of letters known and the level of intelligence were controlled. The children in the two experimental groups achieved results that revealed a similar degree of progress (greater than the control group) in both their writing and their phonological abilities.

While still at kindergarten, many children who possess some degree of phonemic awareness and are familiar with a few letters spontaneously begin to invent writing in which they use conventional letters to represent some of the sounds in words. Ferreiro (1984, 1988) and Ferreiro and Teberosky (1986) were among the first researchers to study children's early ideas about written language, prior to formal education. Their work suggests that children's knowledge of written language evolves along a path over the course of which children think about the nature of writing and build up conceptual hypotheses that reflect an active reconstruction of the logic of the units that are represented by written language.

This evolutionary path has been identified for a wide range of languages, including French (Besse, 1996; Chauveau & Rogovas-Chauveau, 1994; Fijalkow, 1993), Portuguese (Alves Martins, 1993), Italian (Pontecorvo & Orsolini, 1996), Hebrew (Tolchinsky, 1995) and English (Sulzby, 1989). Albeit there are some differences in the manner in which these authors define the number and characteristics of the levels of written language development, there are certain similarities in their positions.

Generically speaking, in their attempts at writing children begin by using sequences of letters that imitate words by allocating them a communicational meaning. In this level children

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acquire several principles and concepts concerning the written code, as Clay (2000) suggests, such as the principle of directionality, or the production of words with a limited number of letters. This first level, can be characterised by the search for criteria that make it possible to differentiate between drawings and written language, and by the perception that a sequence of letters constitutes an object that stands in for the real thing. In this level writing still represents the semantic properties of words.

Subsequently children begin to establish a relationship between the graphic and the phonological forms of words. In the case of languages like Spanish and Portuguese, where polysyllabic words are very common, children start by using syllabic units as the basis for co-ordinating both the phonological structure of words and the activity of writing itself. At first they do so without any concern as to which letters they should employ (syllabic writing without phonetization), and then, from their repertoire of letters they begin to mobilise those which best enable them to represent some of the sounds they have identified in each word (syllabic writing with phonetization).

The transition to types of writing in which children conduct an analysis that goes beyond the syllable – that is to say, in which they write in a syllabic-alphabetic and alphabetic manner and seek to represent all or almost all the phonemes in words – may possibly be facilitated by the very activity of writing, in a process gradually leading to a deeper comprehension of the nature of grapho-phonemic relationships and to an understanding of the alphabetic principle.

Recent literature began to look at the relationships between invented writing and the development of abilities involving the analysis of the sounds in speech.

Various authors (Adams, 1998; Treiman, 1998) point out the benefits of invented writing as a way in which children can acquire the alphabetic principle and phonological awareness can be fostered. According to this point of view, a close link has been identified between the nature of pre-school-age children writing and their performance in phonemic segmentation or initial-phoneme deletion tasks (Alvarado, 1998; Ferreiro, 2002; Vernon, 1998; Vernon & Ferreiro, 1999), since only the children who began to mobilise conventional letters in their invented writing had some degree of success in these phonemic tasks. Along the same lines, research by Silva and Alves Martins (2003) has established explicit causal links between evolution in the nature of children's invented writing and the progress of their performance in phonological tasks.

One of the fundamental questions about the evolution of children's representations about the nature of the alphabetic code precisely concerns the way in which children begin to mobilise conventional letters in their attempts at writing.

The use of conventional letters appears to be related to the phonological characteristics of the words concerned (Mann, 1993; Quintero, 1994; Treiman, 1994; Treiman & Cassar, 1997). When they try to write, it seems that pre-school-age children are more easily induced to select a letter that is appropriate to the sounds they have identified when they are dealing with words that contain phonetic sequences, which represent letter names. However this use only occurs as of the moment at which the child already sees writing as a way of coding oral segments of words. In effect, phonetization processes seems to take place as of the point at which a child begins to understand that letters represent phonological structures like the syllable (in the case of Portuguese) or the phonemes and do not think anymore that writing represents the semantic properties of words.

All this information clearly indicates that for children – above all from the moment at which they begin to phonetize their writing – the activity of writing is an instrument that enhances their capacity to conduct a deeper phonological analysis of spoken words. This effect is probably a consequence of the mobilisation of letters during the activity of writing – letters that will serve as a concrete support for grasping intrinsically abstract units like phonemes (Stahl & Murray, 1998).

Ouzoulias (2001) shares this point of view when he says that "in five-year-old children a high degree of phonemic awareness reveals a greater level of development in terms of initial knowledge about written language" (p. 119).

All the positions mentioned above end up agreeing with Byrne's (1997, 1998) point of view as to the conditions that lead children to comprehend the alphabetic principle. Byrne argues that children may possess an adequate notion of the phonemic structure of oral speech without

necessarily understanding the alphabetic nature of written language. This understanding requires that children possess not only phonemic analysis skills, but also a concept of writing, which refers them to the representation of the phonemic structure of words. Within the overall context of this concept of writing it is the co-ordination of letters and phonemic awareness that is crucial to the discovery of the alphabetic principle.

In summary, it is plausible to suggest that engaging in invented writing leads to the appropriation of the alphabetic principle because invented writing is an activity that provides an interaction between a child's capacity to segment words into phonemes and his/her use of the graphic support offered by letters with which to represent them.

If is true that various researchers have shown that invented writing fosters phonemic awareness, there is also some data that suggests that this relationship may be reciprocal. Indeed, some studies prove that phonological training leads to progress in children's invented writing (Manrique, 1997; Silva & Alves Martins, 2002; Tangel & Blachman, 1992). Tangel and Blachman (op. cit.), for example, conducted a phonological intervention program with a preschool class. At the end of the year 65% of the children had not only evolved significantly in terms of their phonological skills, but were also able to write words and texts according to alphabetic criteria.

However, studies of this kind that assess the impact of phonological training programs on the way in which pre-school-age children look upon written language and the contribution that such programs can make to helping children grasp the alphabetic principle are few. The fact is that most of the empirical research in the phonological awareness field has concentrated on demonstrating the effects that this skill has on progress in acquiring the ability to read (Bryant & Bradley, 1987; Perfetti, Beck, Bell, & Hughes, 1987; Wagner, Torgesen, & Rashotte, 1994) and on establishing causal links between training this skill and successfully learning to read (Byrne & Fielding-Barnsley, 1991, 1993; Lundberg, Frost, & Peterson, 1988).

However, in these theoretical approaches children are dichotomously classified as readers or non-readers without any additional analyses of the extent of their knowledge about written language; reading measures, but rarely writing measures are used (Ferreiro, 2002; Vernon & Ferreiro, 1999) and the relation between phonological awareness and reading acquisition is usually seen as a linear one (as a cause or a consequence), the processes by which children understand written language are not taken into account. Within the overall framework of this kind of study there is a little data (Torgesen & Davis, 1996), which reveals that some pre-school-age children display little progress in their ability to become aware of phonetic units as a result of the training they have received. These data point to the possible existence of an interrelation between evolution in phonemic awareness and the way in which children grasp the nature of the written code. This inference gained in plausibility with Torgesen and Davis' (1996) work, inasmuch as they found that the best predictor of the impact of a phonological training program was the level of children's invented writing.

However, the literature on this subject does not include any empirical study that has conducted comparative research on the consequences of writing and undergoing phonemic training, either in terms of the quality of children's written output, or as regards their phonological skills. These kind of studies have been conducted separately, without comparing possible mutual effects, namely on the phase of transition from a syllabic invented writing to an alphabetic invented writing in pre-school children. This was the objective of the empirical work that we shall now describe.

Research questions

We formulated the following research questions:

1) When children whose writing is guided by syllabic criteria with phonetization take part in a writing training program (designed to lead them to use syllabic-alphabetic/ alphabetic criteria instead), or in a phonological training programme (aimed at phonetic units) will their conceptual hypotheses about writing evolve?

2) When children whose writing is guided by syllabic criteria with phonetization take part in a writing training program (designed to lead them to use syllabic-alphabetic/ alphabetic criteria instead), or in a phonological training program (aimed at phonetic units), will their phonological skills evolve?
3) Are there any differences between the two types of training in terms of the effects they have on conceptual hypotheses about writing and on phonological skills?

Methods

Participants

The participants were 44 Portuguese children, with an average age of 5 years and 6 months and a standard deviation of 3 months, a minimum age of 5 years and 1 month and a maximum age of 6 years and 1 month. They attended various different kindergartens and had received no formal teaching about reading and writing.

None of the children knew how to read – a fact that was verified in an individual word reading test which had been devised for the Portuguese population (Sim-Sim & Ramalho, 1993). All the children were able to identify their name.

Only children whose writing in the pre-test was syllabic with phonetization were chosen to take part in the study.

They were randomly divided up between the two experimental groups (N=15 for each group) and the control group (N=14). The experimental group 1 had 8 girls and 7 boys, the experimental group 2 had 7 girls and 8 boys and the control group had 8 girls and 6 boys.

Given the fact that the knowledge of letters can serve as an intermediary and an instrument that makes it easier to become aware of phonemic entities (Stahl & Murray, 1998; Treiman & Cassar, 1997), we checked how many letters the children were familiar with. We also determined the level of their intelligence.

We carried out two ANOVAs with the group as the independent variable and either the number of letters known or the level of intelligence as the dependent variable. We obtained a figure of $F(2,41)=2.48$, $p=.097$ for the number of letters known and $F(2,41)=1.48$, $p=.241$ for the level of intelligence. There were no statistically significant differences between the three groups.

Table 1 shows the mean scores and standard deviations for the number of letters known by the members of the different groups and for their level of intelligence.

Table 1

Mean scores and standard deviations of the letters known and the levels of intelligence at the pre-test in function of the groups

	Letters		Intelligence	
	M	*SD*	*M*	*SD*
Exp. G.1	19.87	3.62	17.87	2.72
Exp. G.2	18.00	4.07	19.67	2.90
Cont. G.	16.57	4.31	19.14	3.23

Note. G.1=writing training program; G.2=phonological training program.

The experimental design

This was an experimental study in which children were subjected to a pre-test and a post-test that were intended to evaluate both their writing and their phonological skills. In between

the two tests experimental group 1 underwent a writing training program designed to induce a restructuring of their writing, while experimental group 2 was subjected to a phonological training program designed to work on phonetic units. The control group took part in exercises involving the categorisation of geometric figures in accordance with criteria such as shape, size and colour.

Tasks and procedure

Evaluating the children's writing

In order to assess the children's writing we asked them to spell their name and then to spell a set of words to the best of their ability. After writing each word they were asked to read what they had spelled.

We dictated 20 words beginning with different consonants: 4 dissyllabic words with a CVCV structure; 4 dissyllabic words with a CVCCV structure; 4 trisyllabic words with a CVCVCV structure; 4 trisyllabic words, two with a CVCVCCV structure and two with a CVCCVCV structure; and 4 tetrasyllabic words (see Appendix A).

Our classification of the children's responses was inspired by the classification grids drawn up by Alves Martins (1996), Besse (1996), and Ferreiro (1988). We employed the following categories: pre-syllabic; syllabic without phonetization; syllabic with phonetization; syllabic-alphabetic/alphabetic.

Pre-syllabic writing: writing in which the children made no attempt to establish letter-sound correspondences of any kind, either when they wrote, or when they read their own written productions. They wrote several letters and then read the written string globally.

Syllabic writing without phonetization: writing in which the correspondence between oral and written language was based on syllabic units. Children made a strict one-to-one correspondence between the oral syllables and the letters they wrote. Each syllable was represented by a random letter. They read the words syllabically.

Syllabic writing with phonetization: this category was reserved for writing in which the correspondence between oral and written language is based on syllabic units, but in which the children phonically analyse part of the spoken words in such a way as to select a letter from their repertoire which adequately represents the sounds they have identified.

Syllabic-alphabetic writing/alphabetic writing: writing in which children represent all the phonemes in some of the syllables of a word, while continuing to use single letters to denote other syllables in the same word (syllabic-alphabetic writing), or writing in which the phonetic structure of the word is fully learnt and codified, even though not all the applicable orthographic conventions are respected (alphabetic writing). In both cases children use conventional letters to represent sounds

We classified each child in a level according to the following procedure: we analysed the way she/he spelled and read each word; this analysis was made by three independent judges. The interrate agreement in what concerns the classification of the words was Kappa=.95.

We then calculated the number of words that fitted each type of spelling. In order to classify a child in a certain level he/she should write at least 90% of the words (18) according to the criteria defined for that level.

Only children whose writing in the pre-test was syllabic with phonetization were chosen to take part in the study. In order to select 44 children, we evaluated 82 protocols.

In the post-test we used the same procedure. The interrate agreement in what concerns the classification of the words was Kappa=.94.

Only syllabic writing with phonetization and syllabic-alphabetic writing/alphabetic writing were present. Figure 1 and Figure 2 illustrate these two categories of writing.

AC	Vaca	GO	Galo
AU	Sapo	AU	Rato
UA	Pulga	OA	Mosca
IE	Tigre	VA	Vespa
AUL	Cavalo	ROZA	Raposa
AAU	Macaco	GAA	Girafa
GIA	Galinha	ARU	Lagarto
UIA	Formiga	AIA	Sardinha
IOZU	Dinossauro	UBLT	Borboleta

Figure 1. Example of syllabic writing with phonetization

VACA	Vaca	GALU	Galo
CAPU	Sapo	RATU	Rato
PUGA	Pulga	MOCA	Mosca
TIG	Tigre	VPA	Vespa
CAVALU	Cavalo	RAPZA	Raposa
MACU	Macaco	GIRFA	Girafa
GAIA	Galinha	LAGATU	Lagarto
FOMIGA	Formiga	SAIA	Sardinha
DIOSAU	Dinossauro	BUBULTA	Borboleta
IOPATU	Leopardo	GAFAOTO	Gafanhoto

Figure 2. Example of syllabic-alphabetic/alphabetic writing

Evaluating the children's phonological awareness

In order to evaluate the children's phonological awareness we set them a battery of phonological tests composed of three sub-tests with differing levels of difficulty (so as to address the heterogeneous nature of this particular ability). When we created this battery of tests we sought to take account of the phonological properties of the initial phonemes in each of the words.

The battery included a classification test, a deletion test and an analysis test (see Appendix B).

The initial-phoneme classification test was composed of 14 items preceded by 2 training items. In this test four words were presented to the children in an illustrated format. In each item two of the words began with the same phoneme while the others began with different phonemes and the children were asked to identify the matching pair.

In the initial-phoneme deletion test the children were asked to pronounce in isolation each of the phones in words that were presented to them in an illustrated format, and to say what remained of the word without the initial segment (the deletion of which resulted in something that is not a word in terms of the Portuguese language). The test was made up of 24 items (also preceded by two training items), half of which were composed of monosyllabic words and the remainder of disyllabic words. The phoneme that had to be deleted always coincided with the onset of the syllable.

In the phonemic analysis test the children were asked to pronounce in isolation each of the phones in words that were presented to them in figurative form. Each word contained between 2 and 4 phones. The test was made up of 14 items, again preceded by two training items that modelled the division of two words into their phonemic segments.

In all the tests 1 point was awarded for each correct answer.

Evaluating the children's knowledge of letters

In order to determine how many and which letters the children were familiar with, they were given a set of cards bearing the letters of the alphabet in capitals (K, W and Y were excluded, inasmuch as they are not formally part of the Portuguese alphabet), which they were asked to name. After having identified the letters, they were asked to write down the letters they had recognised. The total possible score in this test thus ranged from 0 to 23. We considered that a child knew a letter when she/he correctly named it and wrote it down.

Evaluating the children's intelligence

The level of the children's intelligence was evaluated using the coloured version of Raven's Progressive Matrices test (Raven, 1956). We used this test because it is not very dependent on verbal aspects.

The writing training program

The writing training program was organised around situations that led the child to think about the rules of writing from two points of view: his/hers; and that of a hypothetical boy/girl of the same age, whose writing was alphabetic.

The objective of these sessions was to lead children to move from syllabic writing with phonetization to syllabic-alphabetic/alphabetic writing.

The list of the words to be written varied from child to child, depending on the letters with which each was familiar.

In each session we asked the children to write 10 words. After writing each word, the children were shown one spelled by a hypothetical child of the same age who used alphabetic

writing, even though not all the applicable orthographic conventions were respected. In the face of this they were then asked to say which of the two they thought was best. Before deciding, they had to slowly read both what they had written and the hypothetical child's word and to name the letters that each of them had employed to spell that specific word. They then had to try to justify why they had spelled the word in their way and why the other child had spelled it differently. From the second session onwards the children were told to think of the letters that went best with the sounds of each of the words they spelled. No explicit feedback was given.

In the two initial sessions we used words beginning with vowels – e.g., ave [avə] (bird), uva [uvɑ] (grape) Eva [ɛvɑ] (a child's name), Ivo [ivu] (a child's name). This choice was based on the fact that it is easier for children to mobilise conventional letters when the initial syllable contains the letter's name (Mann, 1993; Quintero, 1994; Treiman & Cassar, 1997). In the case of Portuguese language there are many words that begin with open vowels which coincide with the name of the letter. After that, the sessions involved writing words that began with consonants; in each session the words began with the same consonant. In these sessions the first syllable in the first word coincided with a letter name, so as to facilitate the use of that letter – for example, rede [Redə] (net), in which the syllable re[Re] coincides with the name of the letter R [Re] (Alves Martins & Silva, 1999). After we presented words that partially shared identical sound sequences – e.g., ri [Ri] (smiles), rio [Riw] (river), words where that same consonant was followed by other vowels – e.g., rói [Rɔj] (gnaws) Rui [Ruj] (a child's name), rua [Ruɑ] (street), and words with a CVCV structure – e.g., Roda [Rɔdɑ] (wheel), rola [Rɔlɑ] (rolls), or a CVCVCV structure – e.g., rodela [Rudɛlɑ] (round slice).

We used words in which the graphic-phonetic equivalencies were as simple as possible.

In summary, we created the conditions that would arouse a cognitive conflict in the children and acted in their zone of proximal development, inasmuch as the situation itself led them to think about ways of spelling that were not very distant from their own one.

The phonological training program

The tasks that formed part of the training program basically involved the segmentation of monosyllabic words in onset and rhyme, the identification of the same initial phonemes in different words, phonemic segmentation and initial-phoneme deletion.

The following tasks were performed over the course of the 8 sessions that comprised the training program:

- Segmenting monosyllabic words into onset and rhyme: the children had to try to divide monosyllabic words with CVV, CVC and CV structures into two "little bits". In each session the first ten words were accompanied by an illustrated support, but the remaining ten were not. When a child failed to complete a task successfully, the experimenter modelled the segmentation of the units concerned, called the child's attention to the nature of the ways in which the initial sounds articulated with one another and led him/her to reproduce the segmentation operation that had just been modelled.
- Identifying the same initial phonemes in different words: from a choice of four words that were shown to them in an illustrative form, the children had to identify two that began with the same phoneme. This task was split into various series, which were divided up in accordance with the initial phoneme of each of the words. Each series was made up of 6 four-word items. In the first series the common initial phonemes were vowels, while in the rest they were consonants. The games were played as follows: each child was asked to indicate the initial sound of each of four words in such a way as to identify those which had the same "little bit" at the beginning. When he/she found this operation difficult, the experimenter began by modelling the first sound, called his/her attention to the way in which to articulate it and then asked him/her to repeat it. When he/she was able to isolate the initial phoneme, he/she was

asked to point to each word and to indicate only the "first little bit" in such a way as to identify the words that shared a common initial segment.

– Phonemic segmentation: these exercises were organised into various series. Each series was made up of three words that began with the same phoneme. In each one the words formed a sequence based on a progressive increase in the number of component phonemes, and whenever possible the words shared a succession of identical phonemes. The games were played according to the following instructions: first the children were told the number of sounds in each word; then they were asked to pronounce the various "little bits" while simultaneously holding up one finger per sound. When the children's attempts were unsuccessful, the experimenter modelled the segmentation operation and then asked them to look at her own mouth while she pronounced the different sounds. The children had to reproduce the "little bits" at the same time as the experimenter spoke them. They were then asked to try on their own once more. If they were still unable to do so, the experimenter modelled the operation again.
– Initial-phoneme deletion: the children were asked to pronounce each of the phonemes of 20 words in isolation and to say what remained of the word without the initial segment. It should be noted that in order to facilitate the children's task, the deletion of the first phoneme in the words that we used always gave rise to a new word. For ten of the words we used a game with an illustrated support; for the remaining ten the words were presented orally

The control group program

We organised a set of exercises with the control group using material of the logical blocks type. The children were asked to classify geometric shapes in accordance with criteria such as identical shape, size, or colour.

The three programs involved eight sessions that lasted approximately fifteen-minutes each and were individually conducted by us with the children over the course of a fortnight.

Results

The impact of the two types of training on children's conceptual hypotheses about writing

In order to assess the effect of the two types of training on children's conceptual hypotheses about writing we looked at the number of children in the three groups who continued to produce syllabic with phonetization writing or moved to syllabic-alphabetic/alphabetic writing at the post-test.

Table 2

Number of children whose writing was syllabic with phonetization and syllabic-alphabetic or alphabetic at the post-test

	Children with syllabic with phonetization writing	Children with syllabic-alphabetic and alphabetic writing
Exp. G. 1 (*n*=15)	0	15
Exp. G. 2 (*n*=15)	0	15
Control G. (*n*=14)	12	2

Note. G.1=writing training program; G.2=phonological training program.

Table 2 suggests that both forms of training contributed to an expansion of the children's knowledge about written code, inasmuch as the post-test writing of all the children in both the experimental groups was syllabic-alphabetic/alphabetic, while only two children of the control group produced this type of writing. When we look at this table we do not need a statistical procedure to tell us that the two types of training had an impact in the progress of the children's writing.

After this first global analysis and in order to deepen the understanding of the performances of the children in the two experimental groups, we looked at their word spellings in the pre- and the post-test. We performed an ANOVA with repeated measures using the number of words whose writing was syllabic-alphabetic in the pre- and the post-test as dependant variable. The results of the ANOVA show that the children's spellings evolved significantly between the pre- and the post-test $F(1,28)=283.02$, $p=.000$ and that there are no significant differences between the groups $F(1,28)=.69$, $p=.412$ and the moment x group interaction $F(1,28)=.09$, $p=.768$. We can thus say that the two types of training had similar impact on children's writing.

Table 3 shows the mean scores and standard deviations for the words whose writing was syllabic with phonetization, syllabic-alphabetic and alphabetic at the pre- and post-tests.

Table 3

Mean scores and standard deviations of words whose writing was syllabic with phonetization, syllabic-alphabetic and alphabetic at the pre- and post-tests

	Pre-test				Post-test					
	Syllabic with phonetization		Syllabic-alphabetic		Syllabic with phonetization		Syllabic-alphabetic		Alphabetic	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Exp.G.1	19.13	.92	.87	.92	0	0	14.27	4.06	5.73	4.06
Exp.G.2	19.47	.83	.53	.83	0	0	13.47	3.78	6.53	3.78

Note. G.1=writing training program; G.2=phonological training program.

The impact of the word's size and complexity on children's writing

An analysis of the individual protocols of the children in the two experimental groups at the post-test provided us with some clues which suggested that a child's (in)ability to analyse all the phonemic components of the words was linked to the latter's size and complexity.

We performed a Paired-Samples T test where we contrasted the alphabetic spellings in the post-test by the members of the two experimental groups in function of the words size (dissyllabic/trisyllabic). We obtained figures of $t(29)=7.13$; $p=.000$.

Table 4 shows the mean scores and standard deviations of the number of dissyllabic and trisyllabic words spelled according to alphabetic criteria.

Table 4

Mean scores and standard deviations of the alphabetic spellings in function of the dimension of the words for the two experimental groups at the post-test

	M	*SD*
2 syllables	4.03	1.81
3 syllables	1.83	1.95

As we can see, children write dissyllabic words more alphabetically than trisyllabic ones.

In order to analyse the impact of the word's complexity on children's writing, we performed two Paired-Samples T tests where we contrasted the alphabetic spellings in the post-test by the members of the two experimental groups in function of the characteristics of dissyllabic (CVCV/CVCCV) or trisyllabic words (CVCVCV/CVCVCCV and CVCCVCV). We obtained figures of $t(29)=9.09$; $p=.000$ for the dissyllabic words and $t(29)=4.65$; $p=.000$ for the trisyllabic ones. There are statistically significant differences between the spellings of the two types of words.

Table 5 shows the mean scores and standard deviations of the number of simple and complex disyllabic and trisyllabic words spelled according to alphabetic criteria. Children write simple words more alphabetically than complex ones.

Table 5

Mean scores and standard deviations of alphabetic spellings in function of the characteristics of the dissyllabic and trisyllabic words for the two experimental groups at the post-test

	M	*SD*
CVCV (4 words)	3.20	1.24
CVCCV (4 words)	.83	1.05
CVCVCV (4 words)	1.43	1.45
CVCVCCV/CVCCVCV (4 words)	.40	.72

We can illustrate some of these tendencies with examples taken from the children's protocols, as shown in Figure 2.

Irina, who was in experimental group 1, illustrates some of the qualitative issues that we have just been talking about – the tendency not to represent some of the phonemes in complex syllables. As we can see, when Irina writes dissyllabic words such as vaca [vakɑ] / galo [galu] / sapo [sapu] / rato [Ratu] she employs an alphabetic notation. When she writes words like pulga [pulgɑ] / mosca [moʃkɑ] / tigre [tigrə] / vespa [veʃpɑ], her spellings are syllabic-alphabetic as she simplifies the representation of complex syllables.

The impact of the two types of training on children's phonological skills

In order to assess the effect of the two types of training on the children's phonological skills we used an ANOVA with repeated measures to compare the children's performance in the various phonological tasks that the children were set at the pre and post-test. In order to deepen our understanding of the differences between the groups we subsequently carried out a post-hoc analysis using a version of the Tukey test that applies to situations involving different-sized groups.

The results of the ANOVA concerning the initial-phoneme classification test, show that the moment $F(1,41)=159.13$, $p=.000$, the group $F(2,41)=8.08$, $p=.001$, and the group x moment interaction $F(2,41)=35.44$, $p=.000$ variables produced statistically significant effects.

The post hoc procedure revealed that both types of training led to significant effects on the children's performance in this phonological task, inasmuch as there were significant differences between the results achieved by experimental group 1 and the control group ($p=.001$), experimental group 2 and the control group ($p=.013$), whereas there were no differences between the results of the experimental groups themselves.

The descriptive statistics included in Table 6 enable us to see that the mean scores which the two experimental groups obtained at the second evaluation moment are very close to one another and are higher than those of the control group, thereby revealing a substantial evolution in the two experimental groups (there had not been much difference between the mean scores achieved by the three groups in the pre-test.)

Table 6

Mean scores and standard deviations at the initial-phoneme classification test

	Pre-test		Post-test	
	M	*SD*	*M*	*SD*
Exp. G. 1	7.93	2.54	12.73	1.70
Exp. G. 2	6.80	2.39	12.60	1.35
Control G.	7.35	2.61	7.57	2.44

Note. This test was composed of 14 items; G.1=writing training program; G.2=phonological training program.

The results of the ANOVA concerning the initial-phoneme deletion test, show that the children's results in this test evolved significantly between the pre-test and the post-test $F(1,41)=143.17$, $p=.000$. They also show that there are significant differences depending on the group $F(2,41)=4.28$, $p=.020$ and the moment x group interaction $F(2,41)=18.65$, $p=.000$.

Post-hoc analysis showed that both types of training had an impact, inasmuch as we recorded significant differences between experimental group 1 and the control group ($p=.039$), experimental group 2 and the control group ($p=.037$)on the other, but not between the two experimental groups.

We can see from Table 7 that experimental group 1's results in the pre-test were slightly superior to those of either of the other two groups. Both experimental groups obtained much better results at the post-test than did the control group.

Table 7

Mean scores and standard deviations at the initial-phoneme deletion test

	Pre-test		Post-test	
	M	*SD*	*M*	*SD*
Exp. G. 1	8.13	5.99	18.46	7.25
Exp. G. 2	5.06	6.39	21.60	3.22
Control G.	6.35	5.74	10.07	7.03

Note. This test was composed of 24 items; G.1=writing training program; G.2=phonological training program.

When it comes to the phonemic analysis test, the results of the ANOVA show that the children's performance in the phonemic analysis test evolved significantly between the pre-test and post-test $F(1,41)=291.30$, $p=.000$. The group $F(2,41)=23.83$, $p=.000$ and the moment x group interaction $F(2,68)=56.85$, $p=.000$ variables also produced substantial effects.

Subsequent analysis shows that this difference in evolution is due to the impact of the two training programs, inasmuch as the mean scores which the members of the two experimental groups obtained in this test differ significantly from those obtained by the control group ($p=.000$, in both cases), whereas there were no differences between the results of the experimental groups themselves.

We can see from Table 8 that the mean scores attained by the three groups in the pre-test were practically identical, and that there was a considerable evolution between the two evaluation moments in the two experimental groups. The mean scores attained by the control group were practically identical at the pre-test and post-test.

Table 8

Mean scores and standard deviations at the phonemic analysis test

	Pre-test		Post-test	
	M	*SD*	*M*	*SD*
Exp. G. 1	1.40	1.50	10.00	3.07
Exp. G. 2	1.20	1.65	10.93	2.28
Control G.	1.28	1.72	2.00	2.82

Note. This test was composed of 14 items; G.1=writing training program; G.2=phonological training program.

Discussion

One of the aspects we sought to assess in this study was the extent to which pre-school children who are subjected to a writing training program evolve, not only as regards their conceptualisations of writing, but also in terms of their phonological skills.

Our data confirm that not only the writing training program helped the children to progress in their writing, but their phonological skills also evolve. The children's performance in phonological tasks at the post-test did indeed improve significantly from a statistical point of view, both in terms of their awareness of the presence of common phonemic elements in different words (shown by the results of the initial-phoneme classification test) and as regards their manipulation of phonemic units (as we can see from the results they obtained in the initial-phoneme deletion tests and the phonemic analysis test).

Our results thus indicate that when we induce children to write in a way in which all or almost all the phonemes are represented, the metalinguistic practise that underlies the act of writing in accordance with this principle is reflected in substantial advances in the completion of phonemic tasks. The results that demonstrated the children's progress in these tasks at the post-test point in the same direction as those obtained by both Vernon (1998) and Alvarado (1998), who showed that phonological abilities gradually improve until children finally understand writing alphabetically.

At the same time these results confirm the view that has been put forward by various authors (Pontecorvo & Orsolini, 1996; Vernon, 1998) – that the development of phonological skills (particularly phonemic abilities) and the construction of alphabetic knowledge about written language are interrelated. Various opinions suggest that the use of conventional letters in invented writing promotes the development of phonemic awareness (Stahl & Murray, 1994, 1998; Treiman, 1998) and that children's progress in the appropriation of the alphabetic structure of writing conditions their evolution towards an awareness of phonemic segments (Ouzoulias, 2001; Vernon, 1998).

We also sought to investigate whether children with syllabic writing with phonetization who underwent a phonological training program would evolve, not only in terms of their phonological abilities, but also as regards their conceptualisations of writing. The data we obtained indicate that the phonological training program not only led to statistically significant progress in the children's phonological skills (as may be seen from the results they obtained in the initial-phoneme classification, initial-phoneme deletion and phonemic analysis tests), but also in the characteristics of their writing. Thus, when we conducted phonemic training with children who were already producing phonetized syllabic writing, we found that they made use of the resulting advances in their phonemic skills when they analysed words during their writing, thereby leading to written output of a syllabic-alphabetic and alphabetic type.

These results permit us to conclude that the introduction of phonemic training programs could improve the quality of children's pre-conventional writing, in the sense that when they were asked to write words "in their own way", the children would be able to make use of their new abilities to express the phonetic speech units that they had rehearsed. However, this effect would probably only come about when prior to the training, the children had already been at a level at which their attempts at writing displayed some phonetization procedures, albeit not yet complying with the alphabetic principle. Our data tend to match those produced by other research projects, which indicate that phonemic training impacts the quality of children's invented writing (Manrique, 1997; Tangel & Blachman, 1992).

We sought to investigate whether the two types of training would have identical effects on both children's conceptualisations of writing and their phonological skills. As far as the way in which the children represented writing is concerned, the data show that the two types had equivalent effects. At the post-test all the children in both experimental groups were producing writing of syllabic-alphabetic and alphabetic types in equal proportion, and all displayed a degree of evolution in the various phonemic tests that was both significant and similar.

Inter-coordination of the data produced by these two forms of experimental intervention confirms on the one hand that the evolution of phonemic analysis abilities occurs as a

consequence of the development of children's conceptualisations towards a grasping of the alphabetic structure of writing, and on the other that metalinguistic advances achieved at the phonemic level are then mobilised for writing, thereby leading to a conceptual progression that is oriented towards the alphabetic principle (at least in children who already phonetize words within the overall framework of the syllabic hypothesis).

Inasmuch as studies that imply the use of intervention methods enable us to more reliably identify causal links, when taken as a whole the data presented above permit us to establish reciprocal causal links between speech analysis skills and the appropriation of the way in which written language works from pre-alphabetic levels onwards. Various authors have taken the standpoint that there is a complex interaction between the evolution of phonological abilities and the development of knowledge about the written system (Stahl & Murray, 1998; Treiman, 1998), but the results of this research project lends some more precise outlines to this point of view.

Another interesting aspect of our results derives from the fact that in the post-test the writing of the children in the two experimental groups was distributed between the syllabic-alphabetic and the alphabetic categories. This suggests that children's development up until the point at which they understand the alphabetic principle and regularly represent grapheme/phoneme correspondences may be seen as a path that is influenced by the contextual characteristics of words. The children's difficulties in achieving the correspondences between letters and sounds in larger words is probably due to the fact that it may represent a bigger burden to memory as children have to keep in mind the units that were already analysed and those not yet analysed. This kind of effect was already found on children's ability to analyse spoken words. Treiman and Weatherston (1992) refer that preschoolers have more difficulty in isolating the initial consonant of a long word than the initial consonant of a short one. The complexity of the phonological structure of words can have the same kind of outcomes because some sequences of phonemes are more difficult to segment than others. Our results confirm Treiman's (1991) point of view that children have more difficulty in segmenting and spelling syllables of words that contain clusters. So it seems that the understanding of the alphabetic principle can not be described in discrete terms but as a process that is built up over time according to the nature of the words.

As an overall theoretical conclusion we can say that our study reinforces the proposition that there is an interaction between metalinguistic processes and the development of knowledge about writing.

From an educational point of view our research emphasises the importance that children's involvement in invented writing activities may possess as a pedagogical practise which simultaneously favours both an understanding of the alphabetic principle and the development of phonemic awareness (Adams, 1998; Ouzoulias, 2001; Treiman, 1998). It would seem that at least where children who have already begun to phonetize their writing are concerned, this kind of activity is as effective as phonological training when it comes to conceptually grasping the alphabetic nature of writing – perhaps because, to quote Tolchinsky and Teberosky (1998), "it is easier to imagine a word and name the letters than to segment a word with no internal or external support" (p. 16).

At the same time, bearing in mind the effectiveness of a relatively small number of phonemic training sessions, it would appear to us to be important to highlight both the sequence in which the various games that were included in the training were played and a few criteria that we obeyed when we outlined the activities themselves – conditions which are probably associated with the effectiveness that we recorded. Thus, working on the onset/rhyme division and phonemic identification before moving onto segmentation and the deletion operations (Byrne, 1998; Treiman, 1992), starting those exercises with phonemes that are easier to isolate from an acoustic point of view (Content, Kolinsky, Morais, & Bertelson, 1986), beginning segmentation activities with words that contain just two phonemes (Uhry & Ehri, 1999) and explicitly modelling sounds in such a way as to make it easier for the children to extract clues to articulation (Morais, 1994) were some of the principles on which we based the organisation of the various activities. It is probably important to ensure that these criteria

(among others) are also taken into account when programs of this type are designed as part of any intervention aimed at the prevention of reading and writing learning difficulties.

The results we obtained in this study give rise to interesting possibilities in terms of new research. Future research should take a more in-depth look at the relationships between the characteristic of the words and children's writing, by exploring more systematically the accentuation features of syllables (stress syllables *vs.* unstressed ones) and the phonological differences in the clusters inside the syllables.

Appendix A

Words used to evaluate children's conceptual levels

vaca [vakɑ] (cow)
galo [galu] (cock)
sapo [sapu] (toad)
rato [Ratu] (mouse)
pulga [pulgɑ] (flea)
mosca [moʃkɑ] (fly)
tigre [tigrə] (tiger)
vespa [veʃpɑ] (wasp)
cavalo [kɑvalu] (horse)
raposa [Rɑpozɑ] (fox)
macaco [mɑkaku] (monkey)
girafa [ʒirafɑ] (giraffe)
galinha [gɑliɲɑ] (hen)
lagarto [lɑgartu] (lizard)
formiga [furmigɑ] (ant)
sardinha [sɑrdiɲɑ] (sardine)
dinossauro [dinɔsawru] (dinosaur)
borboleta [burbuletɑ] (butterfly)
leopardo [liupardu] (leopard)
gafanhoto [gɑfɑɲotu] (grasshopper)

Appendix B

Battery of phonological tests

Initial-phoneme classification test
Cards with drawings representing

Examples:

Colher [kuʎɛr] / chave [ʃavə] (key) / chuva [ʃuvɑ] (rain) / bola [bɔlɑ] (ball)
Jóia [ʒɔjɑ] (jewel) / nó [nɔ] (knot) / jipe [ʒip] (jeep) / pá [pa] (shovel) ?

Items:

Alce [alsə] (moose) / urso [ursu] (bear) /arca [arkɑ] (arch) / ovo [ovu] (egg)
Orelha [orɑʎɑ] (ear) / alface [alfasə] (lettuce) / árvore [arvurə] (tree) / igreja [igrɑjʒɑ] (church)
Raposa [Rɑpozɑ] (fox) / [Rəgɑdor] (watering-pot) / viola [viɔlɑ] (guitar) /boneca [bunɛkɑ] (doll)
Mala [malɑ] (bag) / peixe [pəjʃə] (fish) / chucha [ʃuʃɑ] (baby's dummy) / mota [mɔtɑ] (motorcycle)
Sumo [sumu] (juice) / gola [gɔlɑ] (coller) /leite [lɑjtə] (milk) / gato [gatu] (cat)
Buzina [buzinɑ] (horn) / cegonha [səgoɲɑ] (stork) / vassoura [vɑsorɑ] (broom) / veado [viadu] (deer)
Serra [sɛRɑ] (saw) / copo [kɔpu] (glass) /cama [kɑmɑ] (bed) /lupa [lupɑ] (magnifying glass)
Fivela [fivɛlɑ] (buckle) /telhado [təʎadu] (roof)/ gaivota [gajvɔtɑ] (seagull) / fogueira [fugɑjrɑ] (bonfire)
Boca [bokɑ] (mouth) / tigre [tigrə] (tiger) / selo [selu] (stamp) /tacho [taʃu] (pot)
Pato [patu] (duck) /pêra [perɑ] (pear) / milho [miʎu] (corn) /chuva [ʃuvɑ] (rain)
Tijolo [tiʒolu] (brick) /bolacha [bulaʃɑ] (biscuit) /seringa [sərĩgɑ] (seringe) /banana [bɑnɑnɑ] (banana)
Cebola [səbolɑ] (oignon) /toalha [twaʎɑ] (towel) /gaveta [gɑvetɑ] (drawer) /cigarro [sigaRu] (cigarett)
Lata [latɑ] (can) /luva [luvɑ] (glove) /roda [Rɔdɑ] (wheel) /fita [fitɑ] (ribben)
Desenho [dəzɑɲu] (drawing) /camisa [kɑmizɑ] (shirt) / dominó [dɔminɔ] (domino) /novelo [nuvelu] (ball of wool)

Initial-phoneme deletion test
Cards with drawings representing

Examples:

noz [nɔʃ] (nut)
[bóia [bɔjɑ] (life buoy)

Items:

rio [Riw] (river)
rosa [Rɔzɑ] (rose)
mel [mɛl] (honey)
mola [mɔlɑ] (clothespin)
gás [gaʃ] (gas)
galo [galu] (cock)
vale [valə] (valley)
vila [vilɑ] (village)
cão [kɑ̃w] (dog)
capa [kapɑ] (overcoat)
fio [fiw] (thread)
fava [favɑ] (broad bean)
torre [toRə] (tower)
telha [tɑλɑ] (tile)
pão [pɑ̃w] (bread)
pipa [pipɑ] (barrel)
boi [boj] (ox)
bolo [bolu] (cake)
sal [sal] (sault)
sumo [sumu] (juice)
lua [luɑ] (moon)
lula [lulɑ] (squid)
dente [dẽtə] (tooth)
dedo [dedu] (finger)

Phonemic analysis test
Cards with drawings representing

Examples:

chá [ʃa] (tea)
osso [osu] (bone)

Items:

asa [azɑ] (wing)
avô [ɑvo] (grandfather)
rua [Ruɑ] (street)
mar [mar] (sea)
gorro [goRu] (cap)
vila [vilɑ] (village)
carro [kaRu] (car)
figo [figu] (fig)
taça [tasɑ] (cup)
pá [pa] (shovel)
bule [bulə] (teapot)
sol [sɔl] (sun)
lã [lɑ̃] (whool)
dia [diɑ] (day)

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L'objectif de cette étude a été d'identifier des relations de causalité entre le développement d'habilités phonologiques et les progrès en écriture d'enfants de maternelle. Les participants ont été 44 enfants, avec une moyenne d'âge de 5 ans et 6 mois, dont l'écriture était syllabique avec phonétization. Les enfants ont été divisés en trois groupes. Leur écriture et leur habilités phonologiques ont été évalués au cours d'un pré-test et d'un post-test. Entre ces deux moments, les enfants du groupe expérimental 1 ont été soumis à un programme

d'entraînement centré sur l'écriture, dont l'objectif était de les faire évoluer pour une écriture syllabico-alphabétique/alphabétique, tandis que le groupe expérimental 2 a été soumis à un entraînement phonologique centré sur des phonèmes. Le troisième groupe a été un groupe de contrôle. Le nombre de lettres connues et le niveau d'intelligence ont été contrôlés. Les enfants des deux groupes expérimentaux ont progressé plus que ceux du groupe de contrôle. Les progrès des enfants des deux groupes expérimentaux ont été équivalents, soit au niveau de l'écriture, soit au niveau des habilités phonologiques.

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Current theme of research:

The acquisition of written language.

Most relevant publications in the field of Psychology of Education:

Alves Martins, M., & Silva, C. (2001). Letter names, phonological awareness and the phonetization of writing. *European Journal of Psychology of Education, XVI*(4), 605-617.

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The acquisition of written language.

Most relevant publications in the field of Psychology of Education:

Alves Martins, M., & Silva, C. (2001). Letter names, phonological awareness and the phonetization of writing. *European Journal of Psychology of Education, XVI*(4), 605-617.

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