Do young children spell words syllabically? Evidence from learners of Brazilian Portuguese

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ABSTRACT

The theory that learners of alphabetic writing systems go through a period during which they treat writing as representing syllables is highly influential, especially as applied to learners of Romance languages. The results of Study 1, a 2-year longitudinal study of 76 Portuguese speakers in Brazil from 4 to 6 years of age, did not support this theory. Although most children produced some spellings of words in which the number of letters matched the number of syllables, few children produced significantly more such spellings than expected on the basis of chance. When such spellings did occur, they appeared to reflect partially successful attempts to represent phonemes rather than attempts to represent syllables. Study 2, with 68 Brazilian 4- and 5-year-olds, found similar results even when children spelled words that contained three or four syllables in which all vowels are letter names—conditions that have been thought to favor syllabic spelling. The influential theory that learners of Romance languages go through a period during which they use writing to represent the level of syllables appears to lack a solid empirical foundation.

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Introduction

To use an alphabetic writing system, children must understand that letters stand for phonemes. This insight is not easy to acquire (Byrne, 1998; Foorman et al., 2003). Before children grasp that

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writing is alphabetic, according to one influential theory (e.g., Ferreiro, 2009), they believe that writing represents the level of syllables. Children must abandon this syllabic hypothesis to grasp the true nature of an alphabetic writing system. The current study was designed to test the theory that young children go through a period during which they treat writing as syllabic. Taking the approach that children's invented spellings provide a window into their ideas about language and writing (e.g., Read, 1975; Sénéchal, Ouellette, Pagan, & Lever, 2012), we examined children's spellings for what they reveal about the use of syllables.

The concept of a syllabic stage grew out of the idea that children construct their own hypotheses or theories about the nature of writing (e.g., Ferreiro, 2009; Ferreiro & Teberosky, 1982). When children grasp that writing stands for language, according to this constructivist view, they take it to represent the syllable. The syllable is an accessible unit of spoken language, and perhaps especially so in Romance languages (Tolchinsky, 2003). During the syllabic period, "the child will come to . . . the syllabic hypothesis, according to which every written letter corresponds to a syllable of the word" (Ferreiro, 1983, p. 287). To spell a word, Ferreiro (1985) explained, a child starts by counting the number of syllables in the word and then writes as many letters as syllables. Thus, Brazilian children may produce ⟨UUU⟩ for *urubu* 'vulture' (Carraher & Rego, 1984), Portuguese children may write ⟨FIS⟩ for *cavalo* 'horse' (Martins & Silva, 2001), French-speaking Canadian children may write ⟨IPPM⟩ for *hippopotame* 'hippopotamus' (Sirois, Boisclair, & Giasson, 2008), Argentinean children may write ⟨PA⟩ for *oso* 'bear' (Ferreiro & Teberosky, 1982), and Mexican children may write ⟨PIO⟩ for *perico* 'parrot' (Vernon, Calderón, & Castro, 2004). (Here and throughout this article, we show children's spellings in uppercase letters.) Support for the idea that children pass through a syllabic stage comes from studies showing relatively high proportions of syllabic spellers among learners of Romance languages who are around 4 and 5 years of age. For example, more than half of the Portuguese kindergartners tested by Martins and Silva (2006b) were identified as syllabic spellers.

According to researchers in the constructivist tradition initiated by Ferreiro and Teberosky (1982), children enter into a syllabic–alphabetic stage after the syllabic stage. Children in the syllabic–alphabetic stage produce spellings such as ⟨PAL⟩ for *palo* 'stick' in which some letters stand for phonemes and others stand for syllables. Ferreiro (2009) described the syllabic–alphabetic stage as a transition period that reflects the difficulties that children face in leaving aside the syllabic hypothesis. Eventually, after sufficient exposure to an alphabetic writing system, children abandon the hypothesis that the letters in written words stand for syllables and move into the alphabetic stage.

The theory that children go through a syllabic stage in the development of literacy plays a central role in research and pedagogy in a number of Latin American and European countries that use Romance languages (Castedo & Torres, 2011). Thus, researchers often compare instructional methods for helping children to move from one stage of literacy development to the next (Martins & Silva, 2006a, 2006b; Silva & Martins, 2002) and study how children in different stages perform in various tasks (Ettore, Mangueira, Dias, Teixeira, & Nemr, 2008; Gindri, Keske-Soares, & Mota, 2007; Vernon et al., 2004). Teachers in many Latin American countries see their job as identifying a child's stage of literacy development—presyllabic, syllabic, syllabic–alphabetic, or alphabetic—and helping the child to move to the next stage (Albuquerque, Morais, & Ferreira, 2008). The idea that children develop through these stages forms the basis for tests of writing and reading development that are used by government authorities (Oliveira & Silva, 2011).

The theory that children pass through a syllabic stage in the development of literacy receives some support from studies of speakers of non-Romance languages (Tolchinsky & Teberosky, 1998; Vernon, 1993). The results, however, are mixed for English (Kamii, Long, Manning, & Manning, 1990). Researchers have suggested that certain features of English may make the syllabic hypothesis less widespread or less visible in learners of English than in learners of Romance languages. One consideration is that English contains many one- and two-syllable words. According to researchers in the constructivist tradition, young children go through a period during which they believe that written words should contain a minimum of three letters. Because syllabic spellings of one- and two-syllable words conflict with the minimum length hypothesis, children avoid them in some situations (Vernon, 1993). Another consideration is that many English words include unstressed syllables in which the vowel is reduced to schwa (/ə/). This phonological feature of the language, it has been suggested, works against syllabic spelling (Kamii et al., 1990).

Although many researchers and educators endorse the idea of a syllabic stage, doubts have arisen even in some studies of learners of Romance languages. Whereas one study that reported longitudinal data on 17 Italian children, beginning at the age of 4;4 (years;months), supports the idea that children pass through a syllabic stage on the way to alphabetic spelling (Pontecorvo & Zucchermaglio, 1988), findings from two longitudinal studies with Brazilian children suggest that many children do not do so. In one of these studies (Cardoso-Martins, Corrêa, Lemos, & Napoleão, 2006, Study 1), 20 Brazilian children were tested five times between approximately four and a half to six and a half years of age. Although 7 children were classified as syllabic spellers at some point during the study, the remaining 13 children did not appear to go through a syllabic stage. In another study (Cardoso-Martins et al., 2006, Study 2), 124 Brazilian children were tested twice 6 months apart. Only 12 of the children were classified as syllabic spellers at one or both time points. Moreover, children who were not yet spelling alphabetically did not produce significantly longer spellings for words with more syllables than for words with fewer syllables. Such a result would be expected under a weaker version of the syllabic hypothesis according to which children sometimes misidentify the number of syllables in a spoken word or fail to make the number of letters that they use match exactly to it. Although the results of Cardoso-Martins and colleagues (2006) provide little support for the idea of a syllabic stage in the development of spelling, the number of children in their Study 1 was rather small and the tests were far enough apart in their Study 2 that the researchers may have missed a syllabic stage in many children. We rectified these limitations in the current Study 1, which was carried out with young speakers of Brazilian Portuguese. This study allowed us to address our first research question: Do learners of Brazilian Portuguese pass through a stage in the development of spelling during which they consistently produce spellings that have the same number of letters as syllables?

Our second research question was whether misspellings that have the same number of letters as syllables truly result from the idea that writing represents speech at the level of syllables. Many of these spellings could alternatively be explained by suggesting that children attempt to represent the phonemes in words but are not able to represent them all (Cardoso-Martins et al., 2006). For example, the Spanish-speaking child who wrote ⟨PIO⟩ for perico 'parrot' /peˈriko/ (Vernon et al., 2004) may have been trying to represent the phonemes in the spoken word but may have managed to isolate and spell only /p/, /i/, and /o/. On this view, it is a coincidence that the number of letters that the child produced matched the number of syllables in the spoken word. Such spellings, which are often called syllabic spellings with phonetization (Martins & Silva, 2006a, 2006b), might not be good evidence that children hold a syllabic hypothesis. Better evidence comes from what are called syllabic spellings without phonetization—spellings such as ⟨FIS⟩ for the Portuguese cavalo 'horse' /kaˈvalu/ (Martins & Silva, 2001) and ⟨AI⟩ for the Spanish néne 'baby' /ˈnene/ (Yaden & Tardibuono, 2004). A child who consistently produces such spellings, in which the letters are not plausible representations of the phonemes, would appear to be following the procedure described by Ferreiro (1985) of counting the number of syllables in words and writing as many letters as there are syllables. A number of researchers have reported finding many children who write this way. Martins and Silva (2001), for example, identified 80 Portuguese 5-year-olds who consistently wrote using what appeared to be random letters—as many letters as there were syllables in the corresponding spoken words. Tolchinsky and Teberosky (1998) reported that approximately a quarter of the Spanish and Israeli 5-year-olds in their study produced many spellings of this type. However, Molinari and Ferreiro (2007) did not identify any such children in a group of Argentinean 5-year-olds, and Cardoso-Martins et al., 2006 found very few in their studies in Brazil. As we describe below, these previous studies have some methodological weaknesses. We attempted to overcome these weaknesses in addressing our second research question: Do some learners of Brazilian Portuguese who do not yet use phonetically plausible letters consistently produce spellings of words that contain the same number of letters as syllables?

Our third research question concerns the role that children's knowledge of letter names may play in the production of spellings that are classified as syllabic. In many of the examples that are cited in the literature, including ⟨EIO⟩ for the Spanish perico 'parrot' /peˈriko/ (Vernon et al., 2004), children who produce as many letters as syllables may be symbolizing vowel phonemes that are the names of letters with the corresponding letters. Thus, the /e/, /i/, and /o/ phonemes in the Spanish word perico are the Spanish names of the letters e, i, and o, respectively. Many studies confirm that children who know the names of letters often use them as guides to spelling (e.g., Cardoso-Martins & Batista, 2005;

Treiman, Tincoff, & Richmond-Welty, 1996). In Romance languages, many words contain the same number of letter names as syllables, and these letter names are often vowels (see Pollo, Kessler, & Treiman, 2005, for evidence from Brazilian Portuguese). For example, all of the vowels in the Portuguese word *primavera* 'spring' /prima'vɛra/ are letter names—in order, the names of *i*, *a*, *e*, and *a*. Children who write the letter names they hear will produce spellings that contain the same number of letters as syllables for many words, but these spellings may be a side effect of children's letter name use rather than a result of the belief that writing represents speech at the level of syllables (Cardoso-Martins et al., 2006). We examined the role of letter names in syllabic spelling in the current Study 2.

In addressing our three research questions, we sought to overcome some methodological and statistical issues that have arisen in previous studies of syllabic spelling. The authors of some research reports (e.g., Silva & Martins, 2003) have not presented the full lists of words that children were asked to spell, making it impossible to know, for example, how many contain letter names. In other studies, researchers have made decisions about children's stage of literacy development based on their spelling and reading of as few as five or six words (Ettore et al., 2008; Vernon et al., 2004). Some researchers provide little information about how children are classified as being in the syllabic stage, instead presenting examples of children's spellings (e.g., Pontecorvo & Zucchermaglio, 1988). Questions arise, however, about the typicality of the examples. When quantitative procedures are used, they differ in many ways from one study to another. For example, Cardoso-Martins et al. (2006) classified children as syllabic spellers if more than half of their spellings had the same number of letters as syllables, Tolchinsky and Teberosky (1998) classified children according to the most frequent type of spelling they produced whether or not it constituted the majority of their spellings, and Silva and Martins (2003) used a more stringent cutoff such that approximately 90% of children's spellings needed to fit the criteria for syllabic spelling for children to be classified as syllabic spellers. To acknowledge the inconsistency that children may show in spelling, as in other areas, and to avoid an arbitrary cutoff, we developed an alternative approach that involved comparing the number of syllabic spellings that children produce with the number that would be expected to occur by chance.

Methodological issues also arise in determining whether a child uses letters that are plausible representations of a word's phonemes. A speaker of Brazilian Portuguese who writes *barata* 'cockroach' /ba'rata/ as ⟨BABATO⟩ and *lobo* 'wolf' /'lobu/ as ⟨LOBU⟩ is clearly selecting letters based on the phonemes in the words, but what about the child who writes ⟨TAHAM⟩ for *telefone* 'telephone' /tele'fõni/ and ⟨LVZA⟩ for *pé* 'foot' /pɛ/? Is the child's initial ⟨T⟩ for *telefone* a lucky guess, or does the child have some beginning ability to use letters to represent phonemes? To address this question, we compared the number of plausible matches that the child produced with the number that would be expected to occur by chance, as was done by Pollo, Kessler, and Treiman (2009) and Kessler, Pollo, Treiman, and Cardoso-Martins (2013).

Still another methodological issue is whether researchers should focus on the spellings that a child produces or whether a child should be classified as a syllabic speller based in part on the spellings that the child produces and in part on how the child reads the spellings and responds to adults' questions about them. Some studies have used the spellings alone (Cardoso-Martins et al., 2006; Tolchinsky & Teberosky, 1998), and others have combined information from spelling and reading (e.g., Vernon et al., 2004). We believe that if a child considers letters to symbolize syllables, this idea should be reflected in the child's spellings. It should not require the intervention of an adult, whose questions could potentially bias the child. Thus, we did not ask children to read their spellings or to answer questions about them.

In the two studies reported here, we used new methodological tools to explore questions about the existence and nature of syllabic spellings. The studies were carried out with Brazilian Portuguese-speaking children because many previous studies of syllabic spelling have been done with Portuguese speakers (Cardoso-Martins et al., 2006; Martins & Silva, 2006a, 2006b) and because much pedagogical and theoretical importance has been attached to the syllabic stage in Brazil (e.g., Albuquerque et al., 2008; Ettore et al., 2008; Oliveira & Silva, 2011).

Before presenting our studies, it is important to provide some information about early education in Brazil. Both of our studies were carried out with children in private schools. Children from middle- and upper-class families in Brazil generally attend private schools, whereas children from poor families attend public schools. Although school attendance is not obligatory in Brazil until 6 years of age,

children from middle- and upper-class families typically attend preschool for several years before this age. Children in preschool classes designed for 4- and 5-year-olds receive little or no formal literacy instruction. However, children are read to, learn to write their names, and learn about the alphabet. Extensive formal literacy instruction begins at the 6-year-old level.

Study 1

Study 1 was a longitudinal test of a central claim of the constructivist theory of literacy development—the idea that children pass through a syllabic stage. As we have discussed, the few previous longitudinal studies of this claim are limited because they have a small number of participants or a small number of test points (Cardoso-Martins et al., 2006) or because they provide little information on how children were classified as syllabic (Pontecorvo & Zucchermaglio, 1988). To overcome these problems, we analyzed spellings from 76 Brazilian children that were collected at three points during the 4-year-old preschool year and at three points during the 5-year-old year; the large majority of these children were also tested at the beginning of the 6-year-old year. A recent study reported on the relationships between these children's spellings at the first test point of the 4-year-old year and their spellings in primary school (Kessler et al., 2013), but it did not address the issue of syllabic spelling. We do so here, presenting analyses of the children's performance on the spelling tests and on several other tests that are relevant to interpretation of the spelling data.

Method

Participants

We report data from 76 children who, at the beginning of the study, were in 4-year-old classes in private schools in Belo Horizonte, Minas Gerais, Brazil. Children were tested near the beginning of the first semester of the school year, near the end of the first semester, and toward the end of the second semester. Testing occurred at the same three points when children were in the 5-year-old class. An additional 27 children who began the study were not available for testing at all six of these time points, and their data were not included in the analyses. The final session reported here was near the beginning of the 6-year-old year, and 69 children contributed data at this point. Table 1 provides background information about the children.

Table 1
Participant characteristics and performance on background measures and spelling measures in Study 1.

Measure	Time 1 (N = 76)[a]	Time 2 (N = 76)[a]	Time 3 (N = 76)[a]	Time 4 (N = 76)[a]	Time 5 (N = 76)[a]	Time 6 (N = 76)[a]	Time 7 (N = 69)[b]
Mean age	4;3 (0;4)	4;6 (0;4)	4;10 (0;4)	5;3 (0;4)	5;6 (0;4)	5;10 (0;4)	6;3 (0;4)
Mean proportion correct on reading task (SD)	.04 (.15)	.07 (.20)	.10 (.23)	.23 (.32)	.47 (.38)	.62 (.38)	.77 (.29)
Mean proportion correct on letter name task (SD)	.55 (.34)	–[c]	.83 (.24)	.93 (.13)	.97 (.06)	.98 (.04)	.99 (.04)
Mean proportion correct on letter sound task (SD)	.45 (.22)	–[c]	.63 (.22)	.75 (.19)	.85 (.16)	.91 (.10)	.94 (.09)
Mean proportion correct spellings (SD)	.01 (.07)	.03 (.12)	.06 (.17)	.12 (.24)	.32 (.35)	.42 (.31)	.49 (.31)
Mean proportion syllabic spellings (SD)	.15 (.12)	.13 (.12)	.18 (.20)	.11 (.14)	.08 (.16)	.07 (.14)	.03 (.11)
Proportion of children who were prephonological spellers	.63	.50	.29	.20	.04	.03	.00

[a] 44 girls and 32 boys.
[b] 40 girls and 29 boys.
[c] Not administered at this time point.

Stimuli and procedure

The task of primary interest here, spelling to dictation, was given at each of the seven time points under consideration. At Time 1 through Time 5, the test consisted of 12 words, and 4 words were added to the end of the list for the Time 6 and Time 7 spelling tests. The words, which are shown in Appendix A, were chosen to vary in the number of syllables that they contained. We selected content words that are familiar to young Brazilian children in oral contexts but that are not overwhelmingly frequent in books designed for children. We avoided words like *mamãe* 'mom' that young children might have already learned to spell. The words were dictated one at a time. The same order, the order in which the words appear in Appendix A, was used for all participants. Children were asked to try to write each word as best as they could. They were told that it was okay if they made mistakes.

For background information, Table 1 reports children's performance on several other tests that were given repeatedly throughout the study. A reading task included 15 content words that frequently occur in books for Brazilian children, as shown in Appendix A. These words were intermixed with 15 infrequent words at Times 4 to 7, but we report the results on the frequent words that were given at all points. To allay frustration, six readily recognizable logos, such as that of Coca Cola, were included as fillers. At each time point except Time 2, children were given a letter name and letter sound task. In the letter name task, children were asked to provide the names of 23 uppercase letters (*K*, *W*, and *Y* were not included because they are rare in Portuguese). The letters were arranged in a random order on a chart. In the letter sound task, children were asked on each trial to point to the letter that corresponded to a specified sound. This task also included 23 test items. On each trial, children were asked to choose from 6 uppercase letters that were displayed horizontally on a chart. Thus, the proportion of correct responses on the letter sound task would be approximately .17 if children responded randomly.

Scoring

The letters in each production were transcribed. When no letters could be identified, as with the scribbles that some children produced during the early sessions, the production was coded as not containing any recognizable letters. In some cases, particularly during the first few sessions, some letters were difficult to identify. Reliability was adequate, however, in that two judges who independently transcribed 120 of the productions from the first session agreed on their interpretation of 88% of the productions.

Spellings that contained letters were scored as syllabic if the number of letters matched the number of syllables in the spoken word and were scored as not syllabic if this was not the case. For example, one child's ⟨MURL⟩ for the four-syllable word *tartaruga* 'turtle' /tahta'ruga/ was scored as a syllabic spelling because it contains four letters. This child's ⟨TOMNNV⟩ for the two-syllable word *bico* 'beak' /'biku/ was not counted as a syllabic spelling. Children used digits in a few instances when spelling, and these were counted as letters for the purpose of identifying spellings as syllabic. Thus, a spelling such as ⟨88⟩ for *lobo* 'wolf' /'lobu/ was considered syllabic.

Each spelling was also scored as correct or incorrect. In scoring correctness, we ignored diacritics and the distinction between uppercase and lowercase letters. Thus, a spelling that was correct in all respects except that it omitted a required diacritic was counted as correct.

For some of our analyses, we were interested in determining whether a child was a prephonological speller, that is, one who did not use letters that were plausible renditions of the phonemes in the corresponding spoken word to a greater degree than expected by chance. To make this determination, we adopted a technique used by Pollo and colleagues (2009) and Kessler and colleagues (2013). We scored the spellings produced during each test session for their plausibility, finding the best possible match between the phonemes and the letters. We used the correspondences shown in Appendix B, assigning a score of 0 to spellings in which all phonemes were represented with plausible letters and assigning 1 penalty point to omissions, 1 penalty point to insertions, and 1.4 penalty points for substitutions. Insertions of *h* were not penalized because this letter is often silent in Portuguese. The penalty value for substitutions was chosen because it approximates the Euclidean distance between the omission of the plausible letter and the insertion of the implausible one. Matches between spellings and pronunciations were required to be in the correct sequence. We randomly rearranged the spellings with respect to the target words and scored again, repeating this procedure

10,000 times. Using this Monte Carlo procedure, we computed the proportion of rearranged spellings p for which the score was at least as good as the original score. To isolate participants for whom there was no convincing evidence that the spellings reflected the phonemes in the words, we required that the p value when the spellings were scored in this way was greater than .20. By using a p value cutoff of .20, we can say that any apparent resemblances between a child's spellings and phonologically plausible spellings were due to chance with a higher degree of confidence than if we had used a cutoff of, for example, .05. A potential problem with the sole use of the whole-word criterion, however, would be that children occasionally produced spellings such as ⟨PNALMNLUOLELA⟩ for *pé* 'foot' /pɛ/ where the first letter was a plausible representation of the word's first phoneme but was followed by a long string of letters that did not appear to reflect the sounds in the word. If a child produced a number of such spellings, the p value might exceed .20 even though the child showed some ability to represent at least the first phonemes of spoken words with appropriate letters. To be more confident in our identification of children as prephonological spellers, we reran the analyses of plausibility based on the first phoneme of the target words' pronunciations and the first letter of children's spellings. We considered that a child was a prephonological speller if the p value exceeded .20 both according to this first-letter analysis and according to the whole-word analysis. Previous studies (Kessler et al., 2013; Pollo et al., 2009) did not include a first-letter analysis, but children in the current study were older at the later test points than children in the previous studies and the first-letter analysis is helpful in distinguishing children who have some ability to represent at least the first phoneme of words from those who do not. Children who did things such as producing unrecognizable scribbles when asked to write the words were classified as prephonological spellers.

Results

Table 1 shows the proportion of spellings at each time point that were correct and syllabic and also the proportion of children at each time point who were classified as prephonological spellers. Our main interest is in syllabic spellings, and we carried out a series of analyses to determine whether children could be identified at particular test points as producing significantly more syllabic spellings than expected by chance. The first set of analyses that we report used data from all test sessions in which children spelled using recognizable letters. A second set of analyses used data just from sessions in which children were classified as prephonological spellers. We also asked whether the prephonological spellers produced longer spellings for words that contained more syllables than for words that contained fewer syllables. A third analysis was carried out with children who progressed from prephonological spellers to rather advanced phonological spellers during the course of the study, asking how many of these children had at least one test point during which they could be identified as syllabic spellers.

Analyses involving all children

Averaging over all children and all sessions, the mean proportion of syllabic spellings was fairly low at .10. However, all but 3 of the children showed at least one syllabic spelling over the course of the study. When children are asked to spell a list of words, and especially when they are asked to do this on a number of occasions, we would expect to see some cases in which the number of letters in the spelling matched the syllables in the word purely by chance. To determine whether the number of syllabic spellings at each test point for each child was greater than expected by chance, we randomly matched the child's spellings to the target words and rescored the spellings as if they had been attempts to spell those words. For example, one random rearrangement for the child mentioned above might treat ⟨MURL⟩ as if it had been an attempt to spell *bico* 'beak' /ˈbiku/ rather than the actual *tartaruga* 'turtle' /tahtaˈruga/ and might treat ⟨TOMNNV⟩ as if it had been an attempt to spell *tartaruga* 'turtle' rather than the actual *bico* 'beak'. Using a computer program, we performed this rearranged scoring 10,000 times. We calculated the proportion of rearrangements p in which the number of syllabic spellings was lower than in the original arrangement. If p is small, this means that chance rearrangements rarely produce as many syllabic spellings as the child did. Such an outcome encourages us to accept the hypothesis that the child was a syllabic speller. If p is large, this means that many of the

chance rearrangements yield as many or more syllabic spellings as the child. This outcome suggests that the child was not a syllabic speller.

Because each child was tested multiple times, normally seven times, it would be inappropriate to use a *p* value of .05 or less for any one test to conclude that the child was a syllabic speller on some test. We used the false discovery rate procedure (Benjamini & Hochberg, 1995) to control for the use of multiple tests per child. This procedure is designed to control for the fact that, given a series of tests where the null hypothesis could be rejected, some of the statistically significant findings could have occurred by chance. We applied the false discovery rate procedure across all of the tests for each child, eliminating any tests on which a child did not produce at least eight scorable spellings (e.g., if the child declined to write some words or produced unrecognizable scribbles). Correcting in this way for the fact that each child had multiple tests, we found that 12 of the 76 children produced significantly more syllabic spellings than expected by chance at the *p* < .05 level at some time point during the study. In all cases, this occurred at only one time point.

To confidently identify a specific child as a syllabic speller, it is necessary to adjust the *p* value to control for the fact that we are performing a test 76 times, that is, once for each child in the study. We did so by running the false discovery rate procedure again across participants. This correction reduced the number of children who showed significant evidence of syllabic spelling at some point to 7, which is 9% of the total group of 76 children. That is, 7 specific children could be identified as showing syllabic spelling at some point during the study.

The 7 cases in which syllabic spelling could be confidently identified occurred near the end of the 4-year-old year (2 children), during the 5-year-old year (1 child at the beginning, 2 children in the middle, and 1 child at the end), and at the beginning of the 6-year-old year (1 child). At the point that syllabic spelling occurred, the children could read few of the frequent words on the reading task, showing a mean proportion correct of .10. The mean proportion of correct responses on the letter name task at these times was a high .93. The mean proportion of correct responses on the letter sound task was .66, well above the level of .17 that would be expected by random guessing. Although none of the children produced any correct spellings of words in any of the sessions in which syllabic spelling was identified, the children did not fit the criteria for prephonological spelling. Using the whole-word scoring, the mean proportion of improvement over the score expected on the basis of random rearrangements of children's spellings and the target words was a reasonably high .29 (range = .10–.39). That is, children who could be confidently identified as syllabic spellers appeared to be syllabic spellers with phonetization rather than syllabic spellers without phonetization. This outcome suggests that spellings with the same number of letters as syllables arise when children attempt to represent the phonemes in words but do not succeed in representing all of the phonemes.

Analyses involving only prephonological spellers

The results presented so far suggest that a minority of children, at some point between approximately 4 and 6 years of age, produce significantly more spellings in which the number of letters matches the number of syllables than expected by chance. The results further suggest that such spellings occur among children who represent some of the phonemes in words in a plausible manner and not among prephonological spellers. As a further test of whether any prephonological spellers could be identified as using the same number of letters as syllables to a greater degree than expected by chance, we ran another analysis that was restricted to the time points at which children were classified as prephonological spellers. Because this analysis does not include all children or all sessions, there is a smaller correction for multiple tests and so more chance of identifying a child as a syllabic speller. Even according to this more lenient test, no prephonological speller could be identified as producing significantly more syllabic spellings than expected by chance. That is, there were no sessions in which a child could be confidently classified as a syllabic speller without phonetization.

Although we could identify no prephonological speller who produced more spellings in which the number of letters matched the number of syllables in the corresponding spoken words than would be expected by chance, it is possible that prephonological children produced longer spellings for words with more syllables than for words with fewer syllables. However, we did not observe such a trend. The mean spelling lengths were 5.3 letters for one-syllable words, 5.2 for two-syllable words, 5.1 for three-syllable words, and 4.8 for four-syllable words. The results go in the opposite direction of

what the weak version of the syllabic hypothesis predicts, although the counter-hypothesis—that children produce fewer symbols for words with more syllables—was not quite significant according to a mixed-model analysis (Bates, Maechler, & Bolker, 2011) using participants and items as random factors and a syllable count as a fixed factor and using a log transform of spelling length because the untransformed distribution was positively skewed ($\beta = -.032$, $SE = .014$, $p = .051$). Note that for this and the other mixed-model analyses that we report that have a continuous outcome variable, we used the languageR package (Baayen, 2011) to estimate p values using Markov chain Monte Carlo sampling.

Analyses involving children who progressed from prephonological spellings to highly phonological spellings

The final analysis was carried out with the 27 children who did not represent phonemes in their spelling at an above-chance level at Time 1 and who, at their final test, showed a mean distance score of less than 1.0 between their spellings and the correct spellings according to the whole-word criterion. Recall that our metric gave 1 penalty point to deletions and additions and 1.4 penalty points to insertions. Thus, an average distance score of less than 1.0 indicates spellings that are rather complete renditions of target words. For example, 1 child went from ⟨BEH⟩ for *cavalo* 'horse' /ka'valu/ and ⟨EPE⟩ for *chá* 'tea' /ʃa/ at Time 1 to ⟨CAVALO⟩ and ⟨XA⟩, respectively, at Time 7. Analyses that are restricted to this group of children arguably provide the best test of the idea that children pass through a syllabic stage during the development of spelling. Such analyses help to counter the potential objection that we did not begin the testing at an early enough point in children's development or that we stopped before children had reached the syllabic stage. Of the 27 children, 2 (7%) could be confidently identified according to the procedures described earlier as showing significant evidence of syllabic spelling during the course of the study.

Discussion

The idea that children pass through a syllabic stage during the development of literacy is a centerpiece of the constructivist theory of literacy development and plays a central role in current research and pedagogy in many countries that use Romance languages (e.g., Castedo & Torres, 2011; Ferreiro, 2009). One longitudinal study of Italian children supported this idea (Pontecorvo & Zucchermaglio, 1988). That study was methodologically weak, however, in that it presented data from only 17 children and provided little information about how spellings were classified as syllabic. Two other studies found that many Brazilian children from public and private schools did not pass through a syllabic stage (Cardoso-Martins et al., 2006), but these studies had either a small number of children or a small number of test points. We corrected these problems in the current study. Our results suggest that a syllabic stage of spelling development is not obligatory. During the course of their early spelling development, less than 10% of the Brazilian children in Study 1 could be confidently identified as syllabic spellers at some time point. With regard to our first research question—do most children pass through a stage during which they consistently produce spellings with the same number of letters as syllables in the corresponding spoken words?—the answer in Study 1 is *no*.

Spellings of words in which the number of letters matches the number of syllables did occur in our study, as in previous studies. Indeed, some children at some time points produced many spellings of this sort. Our next research question was about why children sometimes write this way. Some spellings with the same number of letters as syllables, such as ⟨TEOE⟩ for *telefone* 'telephone' /tele'fõni/, may arise when children attempt to represent a word's phonemes. In this case, the child represented some of the phonemes in /tele'fõni/ but not all of them. Better evidence for the theory that children attempt to represent syllables would come from spellings in which the number of letters matches the number of syllables but the letters are not phonetically motivated. Some researchers have reported identifying many children who consistently produce syllabic spellings without phonetization (e.g., see Martins & Silva, 2001, for Portuguese speakers; Vernon et al., 2004, for Spanish speakers). However, we did not find a single child who consistently produced spellings of this sort. Although we found a number of spellings that did not appear to reflect the sounds in words but had the same number of letters as syllables, including ⟨SRBA⟩ for *telefone* 'telephone', no prephonological speller could be confidently identified as producing more such spellings than expected by chance. In fact, the prephonological spellers did not even show a tendency to use more letters to spell words with

more syllables than to spell words with fewer syllables. The results suggest that spellings in which the number of letters matches the number of syllables reflect children's beginning attempts to represent phonemes, not their attempts to represent syllables.

One potential objection to our study, as well as to the studies reported by Cardoso-Martins et al. (2006), stems from the idea mentioned earlier that children follow a minimum quantity principle in their spelling (e.g., Vernon, 1993). According to this view, children should produce syllabic spellings primarily for words of three or more syllables, where there is no conflict between minimum quantity and syllabic spelling. Approximately 40% of the words used in Study 1 were mono- or bisyllabic, and we might have seen more syllabic spellings if such words had not been included in the study. This potential objection is substantially weakened by the fact that we found little evidence for the minimum quantity hypothesis in Study 1. At those time points where children were classified as not representing phonemes in a plausible manner, 19% of their spellings were either one or two letters long. This figure, which is close to the value of 22% reported by Pollo and colleagues (2009) for a similar group of children, suggests that children do not avoid short spellings nearly as often as the minimum quantity hypothesis suggests. Even though the current findings and those of Pollo and colleagues (2009) do not support the idea that children follow a minimum quantity principle in their spelling, we used only three- and four-syllable words in Study 2 to avoid this possible objection.

Study 2

Study 2 focused on the third research question that we raised in the Introduction—the role of children's knowledge about letter names in the production of spellings that contain the same number of letters as syllables. In Portuguese, as mentioned earlier, many words have one vowel letter name in each syllable (Pollo et al., 2005). Examples include *amarelo* 'yellow' /ama'rɛlu/ (/a/ is the name of *a*, /ɛ/ is the name of *e*, and /u/ is the name of *u* in the dialect of the children in the current study) and *cigarro* 'cigarette' /si'gahu/ (which contains the names of *i*, *a*, and *u*). Children who write one letter for each vowel letter name that they hear in a word will produce spellings that have the same number of letters as syllables for these words, and their spellings of such words will contain all vowel letters. Children who use this letter name strategy will produce few spellings that have the same number of letters as syllables for words such as *professora* 'teacher' /profe'sora/, which contains fewer letter names than syllables. (The letters *o* and *e* have the names /ɔ/ and /ɛ/ rather than /o/ and /e/ in the region of Brazil where we tested.) We could not test these ideas in Study 1 because that study did not include words with the same number of letter names as syllables or words with fewer letter names than syllables that were similar in other respects. For Study 2, we selected three- and four-syllable words in which all of the vowel phonemes are the names of letters in the children's dialect. For example, all the vowels in *primavera* 'spring' /prima'vɛra/ are letter names. We also selected three- and four-syllable words in which only the last vowel phoneme is a letter name, such as *professora* 'teacher' /profe'sora/. Few common three- and four-syllable words in Brazilian Portuguese have no vowels that are letter names, and so we could not include words of this type. If spellings that have the same number of letters as syllables arise primarily when children transcribe the vowel letter names that they hear in words, we should find many spellings with the same number of letters as syllables for words such as *primavera* 'spring' /prima'vɛra/, in which all vowels are letter names, and few spellings with the same number of letters as syllables for words such as *professora* 'teacher' /profe'sora/, in which only the last vowel is a letter name.

Method

Participants

Participants attended private preschools in the same Brazilian city as Study 1 and were tested during the first semester of the school year. A total of 68 participants, 29 children from classes for 4-year-olds and 39 children from classes for 5-year-olds, completed the study. Table 2 provides background information about the children.

Table 2
Participant characteristics and performance on background measures and spelling measures in Study 2.

	4-year-old class (*n* = 29)[a]	5-year-old class (*n* = 39)[b]
Mean age (*SD*)	4;3 (0;3)	5;3 (0;3)
Mean proportion correct on reading task (*SD*)	.00 (.00)	.14 (.28)
Mean proportion correct on letter name task (*SD*)	.68 (.25)	.93 (.14)
Mean proportion correct spellings (*SD*)	.00 (.00)	.09 (.20)
Mean proportion syllabic spellings (*SD*)	.13 (.13)	.16 (.21)
Proportion of children who were prephonological spellers	.44	.10

[a] 10 girls and 19 boys.
[b] 15 girls and 24 boys.

Stimuli and procedure

The 16 three- and four-syllable words shown in Appendix A were used for the spelling task. For half of the words of each length, all of the vowel phonemes were the names of letters. For the others, only the final vowel phoneme was the name of a letter. None of the words contained the entire name of a consonant letter. The words were chosen such that it would be possible to portray them in a picture and they would be familiar to young children in oral contexts.

Children spelled words in response to a picture so as to avoid the possibility that they would be biased by an adult's pronunciation of the words. Thus, the first session of the study was a picture recognition task that familiarized children with the pictures that would be used in the spelling task and their intended labels. Children participated in the first session in groups of three. The experimenter asked children whether they recognized each picture. If none of the children produced the intended name, the experimenter asked questions that led to it. For a picture that was intended to be labeled as a teacher, for example, the experimenter asked what the woman in the picture was doing and what her job might be. The experimenter said the name of the picture only if the children did not produce the intended name. The experimenter then asked one more question about the picture before presenting the next picture.

The spelling task was administered to children individually. Half of the spelling items were given during the second session of the study, and the other half were given during a third session. The order of the words was randomly chosen for each child. For each item, the child was asked to name the picture and then write the word. If the child did not use the intended label, the experimenter encouraged the child to provide a different label, using questions similar to those used in the picture recognition task of the first session to lead to the intended label. On 84% of the trials, children provided the intended label. In the other cases, as when a child started becoming frustrated, the experimenter said the word. After the child wrote each word, the researcher asked which letter the child intended for every letter that was not clearly written. This was accepted as the child's spelling even in the few cases where it appeared to deviate from the forms the child produced.

A 23-item letter name task like that in Study 1 was given after the spelling task in the second session. After the spelling task in the third session, children were asked to read 22 content and function words that are common in books for Brazilian children. The words, which are shown in Appendix A, were written in uppercase letters. Pictures were also presented to make the task less frustrating for children who could not read.

Scoring

The spellings were transcribed and scored as syllabic or not syllabic and as correct or not correct following the same procedures as in Study 1. The procedures for classifying children as prephonological spellers were also the same as in Study 1.

Results

Of the 68 children, 44 produced at least one syllabic spelling. The mean proportion of syllabic spellings, averaging over the 4- and 5-year-old groups, was .15. Using the same procedures described in

Study 1 to test whether each child produced significantly more syllabic spellings than expected by chance, we found no child who could be confidently identified as a syllabic speller. When we reran the analyses over just those children who were classified as prephonological spellers, we did not identify any prephonological speller who produced significantly more syllabic spellings than expected by chance. The prephonological spellers' productions of three- and four-syllable words averaged 3.04 and 2.95 symbols, respectively. A mixed-model analysis on spelling length (log transformed) using the random factors of participants and items and the fixed factor of syllable count showed no significant effect of syllable count ($\beta = -.028$, $SE = .045$, $p = .55$).

To test the hypothesis that children produce some spellings in which the number of letters matches the number of syllables for words in which all of the vowel phonemes are letter names but produce few such spellings for words in which only one vowel is a letter name, we carried out a mixed-model analysis on syllabic spellings using participants and items as random factors and syllable count (three vs. four) and letter name status (all-letter names vs. one-letter names) as fixed factors. The data from the 17 prephonological spellers were omitted from this analysis because these children should not be influenced by letter names. Despite the reduced sample size, we found a significant effect of syllable count such that syllabic spellings were more common for four-syllable words than for three-syllable words (.19 vs. .13, $\beta = .56$, $SE = .22$, $p = .01$). Of primary interest, the proportion of syllabic spellings was not influenced by letter name status ($\beta = .002$, $SE = .22$, $p = .99$). The proportion of syllabic spellings was the same, at .16, for both the all-letter-name items and the one-letter-name items. The lack of influence of number of vowel letter names on the proportion of syllabic spellings is of particular interest given that these children had a mean proportion correct of .96 on vowel letters in the letter name task. The proportion of syllabic spellings remained very similar for all-letter-name items and one-letter-name items when we eliminated from the analyses the data from those 7 children who did not provide the correct names for all of the vowel letters.

Although the number of letters in the children's spellings was no more likely to match the number of syllables in the target word when all of the vowels in the target word were letter names than when only one vowel was a letter name, children's spellings of the two types of words did differ in the proportion of vowel letters they contained. Using the same group of children as in the preceding analysis, the proportion of letters in children's spellings that were *a*, *e*, *i*, *o*, or *u* was .49 for the words in which all vowel phonemes were letter names as compared with .44 for the words in which only the last vowel phoneme was a letter name. A mixed-model analysis of the number of vowel letters in children's spellings using the factors of syllable count and letter name status showed a significant effect of letter name status ($\beta = .26$, $SE = .10$, $p = .02$), with more vowels for all-letter-name words. Another mixed model analysis found that letter name status was not a significant predictor of the length of these children's spellings ($\beta = .07$, $SE = .12$, $p = .61$). Although children used a significantly higher proportion of vowels for all-letter-name words such as *martelo* 'hammer' /mah'tɛlu/ than for one-letter-name words such as *morango* 'strawberry' /mo'rãgu/, the proportion of spellings of all-letter name words that consisted only of vowels, with no consonants at all, was a relatively low .12.

Discussion

As in Study 1, we did not identify any children who produced spellings that did not represent the phonemes in the target words but who used, more often than expected by chance, as many letters as the words had syllables. That is, no children fell into the category of syllabic spellers without phonetization. Further speaking against the idea that prephonological spellers use letters to stand for syllables, these children did not use more letters to spell four-syllable words than to spell three-syllable words.

In Study 1, a small proportion of the children were classified as syllabic spellers with phonetization, but never on more than one of their multiple test sessions. According to constructivist researchers (e.g., Ferreiro & Teberosky, 1982; Vernon, 1993), we should have found more syllabic spellers when using a list of three- and four-syllable words than when using a list that also contained one- and two-syllable words, as we did in Study 1. However, we did not find any children in Study 2 who could be confidently classified as syllabic spellers with phonetization.

If spellings in which the number of letters matches the number of syllables arise when children transcribe the letter names that they hear, we should have found more such spellings for words in which all of the vowel phonemes were the name of a letter than for words in which only one of the vowel phonemes was the name of a letter. However, the proportion of spellings that had the same number of letters as syllables was virtually identical for the two types of words. We found a similar result when we reanalyzed the spelling data that Pollo and colleagues (2005) collected from 49 Brazilian children in a 5-year-old class. In that study as well, the proportion of two-letter spellings was virtually identical for two-syllable words in which both vowel phonemes were letter names and for words in which only the last vowel phoneme was a letter name, being .10 in both cases. Children in both the current study and that of Pollo and colleagues (2005) did appear to use their knowledge of vowel letter names in spelling in that they used a significantly higher proportion of vowel letters when all of the vowel phonemes in a word were the name of a letter than when this was not the case. Pollo and colleagues found this result for two-syllable words, and we extended it here to three- and four-syllable words. Although the difference in proportion of vowel letters was small, it appears in two different studies. Of primary importance here, however, is the finding that spellings with the same number of letters as syllables were not significantly more common for words in which all vowels were letter names than for words in which this was not the case. That is, we find little evidence for syllabic spellings even for words that have been thought to favor their use—words such as *primavera* 'spring' / prima'vɛra/ in which all vowel phonemes are the names of letters.

General discussion

Children's early attempts to write words are a foundation stone for later literacy development, and invented spellings provide a window into children's ideas about how writing represents language (e.g., Read, 1975; Sénéchal et al., 2012). According to some researchers and educators, these early spellings reveal that children who are exposed to alphabetic writing systems go through a period during which they believe that letters stand for syllables (e.g., Ferreiro, 2009). In this view, children must abandon this syllabic hypothesis before they can spell and read alphabetically. The theory that children pass through a syllabic stage during the development of literacy is very influential in teaching and research in many countries that use Romance languages (e.g., Castedo & Torres, 2011; Martins & Silva, 2006a, 2006b), in part because the theory has the potential to help explain why some children have difficulty in grasping the alphabetic principle and what can be done to help them.

The current study addressed several questions about the existence and nature of the postulated syllabic stage. Our first question was whether children generally go through a period during which they spell words with the same number of letters as syllables to a greater degree than would be expected by chance. Longitudinal studies are well-suited for addressing this question. However, the few previous longitudinal studies in this area had small numbers of participants, small numbers of testing sessions, and/or methodological weaknesses (Cardoso-Martins et al., 2006; Pontecorvo & Zuccchermaglio, 1988). We attempted to correct for these problems in Study 1, which examined 76 Brazilian children from private schools over a 2-year period. During this time, a number of the children progressed from spellings of words that did not represent phonemes to spellings that symbolized all or nearly all of the phonemes with phonetically appropriate letters. We observed many spellings like those cited by advocates of the syllabic hypothesis, including the four-letter ⟨MURL⟩ for the four-syllable word *tartaruga* 'turtle' /tahta'ruga/ and the three-letter ⟨AAO⟩ for the three-syllable word *cavalo* 'horse' /ka'valu/. However, fewer than 10% of the children could be confidently identified as syllabic spellers at some test point. The results of Study 1, together with those of Cardoso-Martins et al., 2006, suggest that few Brazilian children from either public or private schools go through a period during which they consistently write syllabically. The low proportion of children who were classified as syllabic spellers in one of the sessions of Study 1 does not appear to reflect the fact that this study included some mono- and bisyllabic words because we did not find evidence of syllabic spelling in Study 2, which included only longer words. That is, we found little evidence of syllabic spelling even under circumstances that have been thought to encourage it.

Ferreiro (1985) discussed syllabic spelling as occurring when a child counts the number of syllables in a word and then writes as many letters as syllables. Thus, our analyses, and those of many other researchers, focused on spellings that contain the same number of letters as syllables. According to a weaker version of the syllabic hypothesis, children sometimes misidentify the number of syllables in a spoken word or do not make the number of letters that they use match exactly to it. On this more lenient view, children should use more letters to spell words that contain more syllables than to spell words that contain fewer syllables. We did not find evidence for such a pattern among the prephonological spellers of either Study 1 or Study 2, and Cardoso-Martins et al., 2006 and Pollo and colleagues (2009) did not find this pattern either. Thus, our results speak against both strong and weak forms of the syllabic hypothesis for learners of Brazilian Portuguese.

The first reports of syllabic spelling came from learners of Spanish (Ferreiro & Teberosky, 1982). It has been suggested that certain linguistic features of Spanish, including the relatively large number of words containing more than one syllable and the fact that vowels are not subject to reduction to schwa, promote syllabic spelling in this language (Kamii et al., 1990; Vernon, 1993). Brazilian Portuguese shares these characteristics. However, other features of the Spanish language, including the fact that it has fewer vowel phonemes than Portuguese, might promote syllabic spelling. Educational practices in Spanish-speaking countries might also be important. It would be valuable to carry out studies like the current one in Spanish to determine whether the results for Spanish in fact differ from those for Brazilian Portuguese.

Another potential reason why we may have found little evidence for syllabic spelling in our experiments, in addition to the language that we studied, is that we limited our analyses of syllabic spelling to children who wrote using letters or digits. Ferreiro and Teberosky (1982) suggested that some children who produce graphic forms that do not resemble conventional letters produce one such form for each syllable in a spoken word. Further research will be needed to determine whether, in such children, productions that contain the same number of visual units as syllables occur significantly more often than expected by chance. Although it could be challenging to reliably determine the number of visual units in such children's productions, the results could shed light on whether a syllabic hypothesis is widespread among children who are even less knowledgeable about writing than the children whose productions we analyzed here.

Some of the children in our Study 1, albeit a small minority, did produce significantly more spellings with the same number of letters as syllables than would be expected by chance at one of their test points. Our second research question was whether, as advocates of the syllabic hypothesis (e.g., Ferreiro, 2009) argue, children spell words in this way because they hypothesize that the letters in written words stand for syllables in spoken words. An alternative explanation is that children produce spellings such as ⟨CAU⟩ and ⟨AAO⟩ for *cavalo* 'horse' /ka'valu/ because they think that letters stand for phonemes but have difficulty in isolating and representing all of the phonemes in a word. Better evidence for the idea that children hypothesize that letters stand for syllables would be spellings such as ⟨DRE⟩ for *cavalo* that contain the same number of letters as syllables but in which the letters are not plausible representations of the phonemes. Across our two studies, we could not confidently identify a single child who produced more syllabic spellings without phonetization than would be expected by chance. We also failed to identify any syllabic spellers without phonetization when we used the procedures employed in the current study to reanalyze the data from a previous study with 124 participants, Study 2 of Cardoso-Martins et al., 2006. This outcome suggests that children who produce spellings in which the number of letters matches the number of phonemes take letters to represent phonemes but can represent only approximately half of the phonemes in words. Supporting this interpretation, much evidence shows that learners of Portuguese, English, and other languages produce spellings that represent some of the phonemes in a word, sometimes called partial alphabetic spellings, before they produce spellings that represent all of the phonemes (e.g., Cardoso-Martins et al., 2006; Ehri, 1997).

Our third research question was whether most spellings with the same number of letters as syllables are like ⟨AEU⟩ for *martelo* 'hammer' /mah'tɛlu/—spellings that arise when children write each letter name that they hear. Although we found some spellings of this sort, we also found spellings such as ⟨MAR⟩ and ⟨MEU⟩. Children did not produce significantly more spellings in which the number of letters matched the number of syllables for words in which all vowels were letter names, such as

martelo 'hammer' /mah'tɛlu/, than for words in which only the last vowel was a letter name, such as *morango* 'strawberry' /mo'rãgu/. This result, which also appeared in our reanalyses of the data from Pollo and colleagues (2005), speaks against the idea that spellings with the same number of letters as syllables are purely a side effect of exact matches to vowel letter names. Further research would be needed to examine the role of consonant letter name use in the production of spellings with the same number of letters as syllables, but Portuguese words contain many fewer consonant letter names than vowel letter names (Pollo et al., 2005).

Overall, our results suggest that most children learning to spell in Portuguese do not go through a period during which they produce many spellings of words that contain the same number of letters as syllables. When children do produce some spellings of this type, they appear to do so because they are trying to spell words at the level of phonemes but are unable to do so fully. Children do not produce spellings with the same number of letters as syllables because they write down all of the vowel letter names they hear in words, and they do not produce these spellings because they believe that writing represents the level of syllables.

Researchers such as Vernon (1993), who support the idea that learners of Romance languages go through a stage during which they take writing to represent the level of syllables, have suggested that the apparent lack of support for the syllabic hypothesis in some studies of English-speaking children (Kamii et al., 1990) reflects specific characteristics of the English language such as the frequent reduction of vowels. Our results suggest that no such explanations are needed. Literacy learning is more similar cross-linguistically, in this respect, than constructivist researchers believe.

Whereas our findings speak against a constructivist view of literacy development, they support a statistical learning view. Children in literate societies, who are surrounded by writing from an early age, learn about some of its salient properties from exposure as well as from formal teaching (Deacon, Conrad, & Pacton, 2008; Pollo et al., 2009; Sandra, 2011). Children do not adhere strongly to hypotheses that are drastically inconsistent with the input they receive such as the hypothesis that all four-syllable words should be written with four letters.

Although our conclusions regarding the syllabic stage are similar in many ways to those of Cardoso-Martins et al. (2006), they differ from those of a number of other studies with learners of Portuguese and other Romance languages (e.g., Martins & Silva, 2006a, 2006b; Vernon et al., 2004; Yaden & Tardibuono, 2004). Many of these differences, we believe, reflect the power of anecdotes. Children sometimes produce spellings such as ⟨UEUL⟩ for *primavera* 'spring' /prima'vɛra/, which fit the description of syllabic spellings without phonetization, and ⟨AEU⟩ for *martelo* 'hammer' /mah'tɛlu/, in which all vowels are spelled with letter names. We saw such spellings in the current study, and others have seen them too. Research shows, however, that presentation of concrete and vivid examples can lead people to think that the examples are typical (Borgida & Nisbett, 1977; Hamill, Wilson, & Nisbett, 1980). The statistical tests that we applied here show that syllabic spellings without phonetization and spellings in which all vowels are written with letter names are not very typical.

Our findings underline the need for methodological and statistical care in the study of children's spelling. The idea that learners of Romance languages generally go through a period during which they take writing to represent the level of syllables—an idea that has been highly influential in many countries for theories of literacy development, teaching, and testing (e.g., Castedo & Torres, 2011; Ferreiro, 2009)—appears to lack a solid empirical foundation.

Acknowledgments

Appendix A.

Words used in spelling and reading tasks of Studies 1 and 2.

Spelling task, Study 1

Time 1 through Time 5: *barata* 'cockroach' /ba'rata/, *bicicleta* 'bicycle' /bisi'klɛta/, *bico* 'beak' /'biku/, *cavalo* 'horse' /ka'valu/, *chá* 'tea' /ʃa/, *cigarro* 'cigarette' /si'gahu/, *dedo* 'finger' /'dedu/, *flor* 'flower' /floh/, *lobo* 'wolf' /'lobu/, *pé* 'foot' /pɛ/, *tartaruga* 'turtle' /tahta'ruga/, *telefone* 'telephone' /tele'fõni/

Time 6 and Time 7: same as Time 1 plus *dragão* 'dragon' /dra'gãw/, *espada* 'sword' /is'pada/, *lagartixa* 'lizard' /lagah'tiʃa/, *véu* 'veil' /vɛw/

Spelling task, Study 2

Three syllables, all letter names: *gravata* 'tie' /gra'vata/, *martelo* 'hammer' /mah'tɛlu/, *privada* 'toilet' /pri'vada/, *urubu* 'vulture' /uru'bu/

Three syllables, one letter name: *âncora* 'anchor' /'ãkora/, *morango* 'strawberry' /mo'rãgu/, *represa* 'dam' /he'preza/, *torneira* 'faucet' /toh'nera/

Four syllables, all letter names: *amarelo* 'yellow' /ama'rɛlu/, *bicicleta* 'bicycle' /bisi'klɛta/, *primavera* 'spring' /prima'vɛra/, *tartaruga* 'turtle' /tahta'ruga/

Four syllables, one letter name: *borboleta* 'butterfly' /bohbo'leta/, *cronômetro* 'stopwatch' /kro'nometru/, *elefante* 'elephant' /ele'fãti/, *professora* 'teacher' /profe'sora/

Reading task, Study 1

casa 'house', *chuva* 'rain', *mamãe* 'mommy', *papai* 'daddy', *vovó* 'grandma', *gato* 'cat,' *água* 'water', *bola* 'ball', *rato* 'mouse', *cola* 'glue', *sala* 'room', *caixa* 'box', *faca* 'knife', *carro* 'car', *macaco* 'monkey'

Reading task, Study 2

alto 'high', *amarelo* 'yellow,' *azul* 'blue', *bola* 'ball', *chuva* 'rain', *comeu* 'ate', *em* 'in', *eu* 'I', *gato* 'cat', *joga* 'plays, *livro* 'book', *não* 'no', *nós* 'we', *olhe* 'look', *pula* 'jumps', *sou* 'am', *três* 'three', *um* 'a', *vai* 'go', *vamos* 'let's go', *verde* 'green', *você* 'you'

Appendix B.

Spellings accepted as phonologically plausible.

Phoneme	Spelling
a	a
ã	a, am, an
b	b
d	d
e	e, ei
ɛ	e
f	f
g	g, gu
h	r, rr
i	e, i
ĩ	i, im, in
k	c, q, qu
l	l
m	m

Appendix B. (*continued*)

Phoneme	Spelling
n	n
o	o, ou
õ	o, om, on
p	p
r	r
s	c, s, sc, ss, x, z
ʃ	ch, x
t	t
u	o, u
v	v
w	l, m, o, u
z	s, x, z
ʒ	g, j

References

Albuquerque, E. B. C., Morais, A. G., & Ferreira, A. T. B. (2008). As práticas cotidianas de alfabetização: O que fazem as professoras? [Daily practices of literacy: What do teachers do?]. *Revista Brasileira de Educação, 13*, 252–264.

Baayen, R. H. (2011). *languageR: Data sets and functions with 'Analyzing Linguistic Data: A Practical Introduction to Statistics.'* R package Version 1.2. Retrieved from <http://CRAN.R-project.org/package=languageR>.

Bates, D., Maechler, M., & Bolker, B. (2011). *lme4: Linear mixed-effects models using S4 classes.* Retrieved from http://cran.r-project.org/package=lme4.

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society B, 57*, 289–300.

Borgida, E., & Nisbett, R. E. (1977). The differential impact of abstract vs. concrete information on decisions. *Journal of Applied Social Psychology, 7*, 258–271.

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

Cardoso-Martins, C., & Batista, A. C. E. (2005). O conhecimento do nome das letras eo desenvolvimento da escrita: Evidência de crianças falantes do português [Letter name knowledge and writing development: Evidence from Portuguese-speaking children]. *Psicologia: Reflexão e Crítica, 18*, 330–336.

Cardoso-Martins, C., Corrêa, M. F., Lemos, S., & Napoleão, R. F. (2006). Is there a syllabic stage in spelling development? Evidence from Portuguese-speaking children. *Journal of Educational Psychology, 98*, 628–641.

Carraher, T. N., & Rego, L. L. B. (1984). Desenvolvimento cognitivo e alfabetização [Cognitive development and literacy]. *Revista Brasileira de Estudos Pedagógicos, 65*, 38–55.

Castedo, M., & Torres, M. (2011). Panorama das teorias de alfabetização na América Latina nas últimas décadas (1980–2010) [An overview of literacy theories in Latin American over the last decades (1980–2010)]. *Cadernos Cenpec, 1*, 87–126.

Deacon, S. H., Conrad, N., & Pacton, S. (2008). A statistical learning perspective on children's learning about graphotactic and morphological regularities in spelling. *Canadian Psychology, 49*, 118–124.

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

Ettore, B., Mangueira, A. S. C., Dias, B. D. G., Teixeira, J. B., & Nemr, K. (2008). Relação entre consciência fonológica e os níveis de escrita de escolares da 1ª série do ensino fundamental de escola pública do município de Porto Real-RJ [Relation between phonological awareness and writing levels in first grade students in a public school]. *Revista CEFAC, 10*, 148–157.

Ferreiro, E. (1983). Development of literacy: A complex psychological problem. In F. Coulmas & K. Ehlich (Eds.), *Writing in focus* (pp. 277–290). Berlin: Walter de Gruyter.

Ferreiro, E. (1985). Literacy development: A psychogenetic perspective. In D. R. Olson, N. Torrance, & A. Hildyard (Eds.), *Literacy, language, and learning: The nature and consequences of reading and writing* (pp. 217–228). Cambridge, MA: Cambridge University Press.

Ferreiro, E. (2009). The transformation of children's knowledge of language units during beginning and initial literacy. In J. V. Hoffman & Y. Goodman (Eds.), *Changing literacies for changing times: An historical perspective on the future of research reading research, public policy, and classroom practices* (pp. 61–75). New York: Routledge.

Ferreiro, E., & Teberosky, A. (1982). *Literacy before schooling.* New York: Heinemann.

Foorman, B. R., Chen, D., Carlson, C., Moats, L., Francis, D. J., & Fletcher, J. M. (2003). The necessity of the alphabetic principle to phonemic awareness instruction. *Reading and Writing, 16*, 289–324.

Gindri, G., Keske-Soares, M., & Mota, H. B. (2007). Memória de trabalho, consciência fonológica e hipótese de escrita [Working memory, phonological awareness, and spelling hypothesis]. *Pró-Fono Revista de Atualização Científica, 19*, 313–322.

Hamill, R., Wilson, T. D., & Nisbett, R. E. (1980). Insensitivity to sample bias: Generalizing from atypical cases. *Journal of Personality and Social Psychology, 39*, 578–589.

Kamii, C., Long, R., Manning, A., & Manning, G. (1990). Spelling in kindergarten: A constructivist analysis comparing Spanish-speaking and English-speaking children. *Journal of Research in Childhood Education, 4*, 91–97.

Kessler, B., Pollo, T. C., Treiman, R., & Cardoso-Martins, C. (2013). Frequency analyses of prephonological spellings as predictors of success in conventional spelling. *Journal of Learning Disabilities, 46*, 252–259.

Martins, M. A., & Silva, C. (2001). Letter names, phonological awareness, and the phonetization of writing. *European Journal of Psychology of Education, 16*, 605–617.

Martins, M. A., & Silva, C. (2006a). The impact of invented spelling on phonemic awareness. *Learning and Instruction, 16*, 41–56.

Martins, M. A., & Silva, C. (2006b). Phonological abilities and writing among Portuguese preschool children. *European Journal of Psychology of Education, 21*, 163–182.

Molinari, C., & Ferreiro, E. (2007). Identidades y diferencias en las primeras etapas del proceso de alfabetización: escritura realizadas en papel y en computadora [Similarities and differences in the early stages of literacy: Writing on paper and on the computer]. *Lectura y Vida: Revista Latinoamericana de Lectura, 28*, 18–30.

Oliveira, J. B. A., & Silva, L. C. F. (2011). Para que servem os testes de alfabetização? [What is the purpose of literacy tests?]. *Públicas em Educação, 19*, 827–840.

Pollo, T. C., Kessler, B., & Treiman, R. (2005). Vowels, syllables, and letter names: Differences between young children's spelling in English and Portuguese. *Journal of Experimental Child Psychology, 92*, 161–181.

Pollo, T. C., Kessler, B., & Treiman, R. (2009). Statistical patterns in children's early writing. *Journal of Experimental Child Psychology, 104*, 410–426.

Pontecorvo, C., & Zucchermaglio, C. (1988). Modes of differentiation in children's writing construction. *European Journal of Psychology of Education, 3*, 371–384.

Read, C. (1975). *Children's categorization of speech sounds in English*. Urbana, IL: National Council of Teachers of English.

Sandra, D. (2011). Spelling strategies in alphabetic scripts: Insights gained and challenges ahead. *The Mental Lexicon, 6*, 110–140.

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.

Silva, C., & Martins, M. A. (2002). Phonological skills and writing of presyllabic children. *Reading Research Quarterly, 37*, 466–483.

Silva, C., & Martins, M. A. (2003). Relations between children's invented spelling and the development of phonological awareness. *Educational Psychology, 23*, 3–16.

Sirois, P., Boisclair, A., & Giasson, J. (2008). Understanding of the alphabetic principle through invented spelling among hearing-impaired children learning to read and write: Experimentation with a pedagogical approach. *Journal of Research in Reading, 31*, 339–358.

Tolchinsky, L. (2003). *The cradle of culture and what children know about writing and numbers before being taught*. Mahwah, NJ: Lawrence Erlbaum.

Tolchinsky, L., & Teberosky, A. (1998). The development of word segmentation and writing in two scripts. *Cognitive Development, 13*, 1–24.

Treiman, R., Tincoff, R., & Richmond-Welty, E.-D. (1996). Letter names help children to connect print and speech. *Developmental Psychology, 32*, 505–514.

Vernon, S. A. (1993). Initial sound/letter correspondences in children's early written productions. *Journal of Research in Childhood Education, 8*, 12–22.

Vernon, S. A., Caldéron, G., & Castro, L. (2004). The relationship between phonological awareness and writing in Spanish-speaking kindergartners. *Written Language and Literacy, 7*, 101–118.

Yaden, D. B., & Tardibuono, J. M. (2004). The emergent writing development of urban Latino preschoolers: Developmental perspectives and instructional environments for second-language learners. *Reading & Writing Quarterly, 20*, 29–61.