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How do prephonological writers link written words to their objects?



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ABSTRACT

Two experiments studied prephonological writers, namely children who do not yet use letters to represent phonemes. The experiments tested the hypothesis that these children link elements of writing not to the phonological forms of spoken words but to physical characteristics of the words' referents. In Experiment 1, prephonological spellers ($n = 36$, mean age 4 years, 3 months) used more elements on average to write plural nouns such as *cows* than singular nouns such as *cow*. Prephonological spellers in Experiment 2 ($n = 42$, mean age 4 years, 4 months) did not use more elements to write longer verbs such as *buying* than shorter ones such as *buy*. Thus, the results of Experiment 1 suggest that prephonological spellers are sensitive to the quantity of the referent rather than the number of phonemes, syllables, or morphemes in the word. That is, prephonological spellers have some tendency to treat writing as iconic.

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1. Introduction

Writing is an important symbol system that children in modern societies need to master. Children begin learning about some aspects of writing well before they receive formal instruction in school (Puranik & Lonigan, 2014; Treiman & Kessler, 2014). Consider Fig. 1, the production of a U.S. five-year-old who was asked to try to write the word *dot*. In its *outer form*, this production looks rather similar to an English word that an adult would write. For example, it is composed of separate shapes that are identifiable as letters of the Latin alphabet and that are arranged along a horizontal line. The letters bear no relation to the sounds in *dot*, however. Even children who are not yet able to produce identifiable letters make somewhat different sorts of productions when asked to write than when asked to draw (Brenneman, Massey, Machado, & Gelman, 1996; Rowe, 2008; Treiman & Yin, 2011). Some of these differences are illustrated in Fig. 2, which shows a U.S. four-year-old's picture of the sun and her attempt to write the word *sun*. Although the written word does not include any identifiable letters, it is smaller and denser than the drawing.

Although young children may produce writing-like marks, a true grasp of how writing works requires them to learn about the *inner structure* of writing, that is, about how written words symbolize their objects. For example, learners of English must understand that each letter in the written word *dog* stands for a phoneme in the spoken form of the word that means 'dog'.

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Fig. 1. Production of a US 5-year-old who was asked to write the word *dot*.

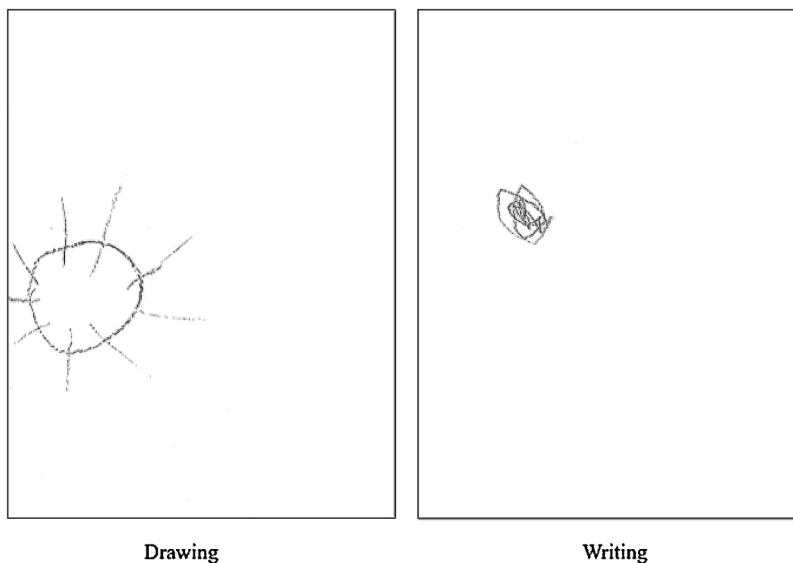


Fig. 2. Productions of a US 4-year-old in response to requests to draw a picture of the sun (left panel) and to write the word *sun* (right panel).

Prephonological writers like those who made the productions in Figs. 1 and 2 do not appear to link written words to their objects via the phonemes in the corresponding spoken words. How, then, do these children conceptualize writing? Recent findings show that prephonological writers are more likely to use the same spelling or a similar spelling when they write the same word twice in succession than when they write different words (Treiman, Decker, Kessler, & Pollo, 2015) and that young children have some expectation that a written word should be read the same way on different occasions (Treiman, Hompluem, Gordeon, Decker, & Markson, in press). These findings suggest that children make some sort of link between a spelling and a word or a concept. Here we test the idea that these links are based on certain physical characteristics of the object to which a word refers rather than on the linguistic form of the word itself (Ferreiro & Teberosky, 1982; Luria, 1978; Tolchinsky, 2003). According to this view, children expect writing to have some degree of iconicity, that is, some degree of similarity to its object.

Productions that reflect properties of the objects whose names are being written were first reported with Russian children who were asked to write down sentences as an aid for later recall (Luria, 1978). In some cases, 4- and 5-year-olds seemed to represent in their writing the sizes, shapes, or colors of the objects mentioned. One child scribbled very dark marks to represent black coal, for example. Levin and Bus (2003) observed that Israeli and Dutch children would sometimes do things such as write the word for *sun* in yellow, and Pontecorvo (1995) mentioned an Italian child who used two marks to write *gatto* 'cat' and three marks to write *gatti* 'cats'. Similarly, Homer and Olson (1999) reported that some English-speaking 4-year-olds used more marks when asked to write *two dogs* than when asked to write *one dog*. Such productions may be attempts to represent physical properties of the objects referred to, in these examples color or quantity, rather than attempts to represent linguistic properties of the corresponding words. Productions of these sorts are often called *referential writing*.

Several influential theories of literacy development, including Ferreiro's constructivist theory (Ferreiro & Teberosky, 1982) and Ehri's phase theory (Ehri & Roberts, 2006), include a role for referential writing. The evidence cited so far in favor of referential writing, however, has not come from well-controlled experiments. The two experiments reported here were designed as a more stringent test. We tested one specific prediction of the idea that young children use a referential approach to writing: that they take the quantity of marks to stand for the quantity of objects. If so, then children should use more visual elements to write plural nouns than to write singular nouns. We describe the few studies that have experimentally tested this prediction before introducing our research.

Several researchers have asked whether young children use a referential approach to interpret writing produced by others, taking a longer written word to stand for a plural noun and a shorter written word to stand for a singular noun when given a choice between the two options. Levin and Korat (1993) tested this prediction by showing children cards on which one word was written above another. Children were told what the two words were and were asked to guess which word was written where. The participants were Israeli children in nursery school (mean age 5;0 [years;months]) and kindergarten (mean age 6;1) who had not yet received formal reading instruction. Levin and Korat used four pairs consisting of a singular noun such as *חרוז* /xa'ruz/ 'bead' and its plural form, in this example, *חרוזים* /xaru'zim/. The plural noun contained two additional letters at the end (the left for Hebrew, which is read from right to left) that represent the Hebrew plural morpheme. Another four pairs consisted of a masculine form such as *אח* /ax/ 'brother' and the corresponding feminine form such as *אחות* /a'xot/ 'sister'. The latter is a two-morpheme word in Hebrew, *ות* being a feminine marker. Nursery school children performed significantly above the level expected by chance with the singular–plural pairs but not with the masculine–feminine control pairs. Kindergartners performed above chance on both types of pairs but better on singular–plural pairs than masculine–feminine pairs. The results are consistent with the idea that children believe that a longer written word stands for a larger number of objects before they learn that a longer written word stands for a spoken word that contains more morphemes, syllables, or phonemes.

Byrne (1996) used a reading recognition task in a series of experiments with English-speaking preschoolers of about 4 years of age. In the first phase of the critical experiments, children were taught to read pairs of one-morpheme and two-morpheme words. For example, the one-morpheme word *book* and the two-morpheme word *books* were taught by placing *book* next to a drawing of a single book and *books*, with *s* printed in red, next to a drawing of a group of three books. When children had learned these words, they were presented with, for example, *dog* and *dogs*, with the *s* again in red. Children were told that one word said *dog* and that the other said *dogs*, and they were asked to select the word that said *dogs*. Children who did not respond correctly when asked what sound the letter *s* makes performed significantly better than expected by chance with singular and plural nouns such as *dog* and *dogs*. This did not seem to reflect use of phonological cues, for children were not significantly better than chance at determining, for example, that *bus* represented bus and *bug* represented bug. Children's ability to generalize to pairs of singular and plural nouns may reflect a belief that longer written strings should correspond to larger quantities: a referential approach. Alternatively, as Byrne suggested, children may believe that two-morpheme words should have longer spellings than one-morpheme words.

Even if young children use a referential strategy when interpreting writing, they may not do so when producing it. Indeed, several investigators have suggested that young children are more likely to use an analytic, phonologically based approach when writing words than when reading them (Frith, 1985; Huxford, Terry, & Bradley, 1991). One of the few experiments to have asked whether young children produce more marks for plural nouns than for singular nouns was conducted with Israeli children in nursery school (mean age 4;1), kindergarten (mean age 5;4), and the first week of first grade (mean age 6;7) who had not yet received formal literacy instruction (Tolchinsky Landsmann & Levin, 1987). The children were asked to write four pairs of monosyllabic and disyllabic nouns. In one pair, /kad/ כד 'jar' and /ka'dim/ כדים 'jars', the disyllabic noun was the plural of the monosyllabic one. It represented a larger quantity of objects, and it also contained an additional morpheme and an additional syllable. In the other three pairs, the disyllabic noun was not a plural. It shared a syllable with the monosyllabic noun but did not have an additional morpheme, as in the pair *פה* /pe/ 'mouth' and *פרח* /'perax/ 'flower'. The experimenter dictated each word of the pair and showed a corresponding picture. The child was asked to write the word below the picture. The results suggested that a tendency to use more characters for the disyllabic noun than the monosyllabic noun emerged at a younger age for the pair /kad/ 'jar' vs. /ka'dim/ 'jars' than for the other three pairs. This result is consistent with the idea that children use a referential strategy, using more marks for larger quantities than for smaller quantities, before they begin to use a phonological strategy, using more marks for phonologically longer words than for phonologically shorter words. However, it is also possible that children use more marks to write words that contain more morphemes than words that contain fewer morphemes.

The Israeli nursery school and kindergarten children in the previously mentioned study by Levin and Korat (1993) performed a writing task as well as a reading recognition task. In the writing task, the children were asked to write words in pairs; no pictures were presented. The words were the same as in the reading recognition task: pairs of singular and plural nouns such as *חרוז* /xa'ruz/ 'bead' and *חרוזים* /xaru'zim/ 'beads' and pairs of masculine and feminine nouns such as *אח* /ax/ 'brother' and *אחות* /a'xot/ 'sister'. Children tended to use more marks for the longer word than the shorter word for both types of pairs. The tendency was stronger for singular–plural pairs than for masculine–feminine pairs, suggesting an influence of the quantity of the referent. However, the fact that children also tended to use more marks for the longer word than the shorter word for masculine–feminine pairs suggests that their choices were also influenced by phonology, morphology, or both.

The results of the writing experiments done to date do not clearly show whether young children use a referential approach or an approach based on number of phonemes, syllables, or morphemes. The findings may be unclear, in part, because

Table 1
Characteristics of prephonological spellers.

Characteristic	Experiment 1	Experiment 2
Number of prephonological spellers (number of girls)	36 (19)	42 (20)
Mean age (range)	4;3 (3;2–5;5)	4;4 (3;3–5;6)
Mean number of words read (range)	0.09 (0–2)	0.07 (0–2)

researchers did not have a good tool to identify those children who would be expected to produce most referential writing: prephonological spellers. Levin and Korat (1993) did restrict some of their analyses to children who produced few or no correct or phonologically plausible spellings. However, such children may produce phonologically plausible spellings of some phonemes in some words, showing a beginning ability to use phonology. This may help to explain why the children tested by Levin and Korat tended to produce longer spellings for feminine words such as /a'xot/ 'sister' than for masculine words such as /ax/ 'brother': the former words are phonologically longer.

In the present experiments, we identified prephonological spellers using a rigorous approach introduced by Pollo, Kessler, and Treiman (2009) and employed in several subsequent studies (Kessler, Pollo, Treiman, & Cardoso-Martins, 2013; Treiman, Pollo, Cardoso-Martins, & Kessler, 2013; Treiman et al., 2015; Zhang & Treiman, 2015). We describe this approach in Section 2.1.4. In Experiment 1, we asked children to write pairs of singular and plural nouns such as *cow* and *cows*. If prephonological spellers use more visual elements to represent larger quantities than smaller quantities, then they should use more elements for plurals such as *cows* than for singulars such as *cow*. To anticipate, we found this result in Experiment 1. Experiment 2 was a follow-up study to determine whether prephonological spellers' tendency to use more elements for plurals than for singulars indeed reflected the quantity of the referent. In this experiment, children wrote pairs such as *buy* and *buying*. If the tendency to use more elements for *cows* than for *cow* in Experiment 1 reflected the quantity of the referent rather than length in phonemes, syllables, or morphemes, then prephonological spellers in Experiment 2 should not use more elements for verbs like *buying* than for verbs like *buy*.

Previous studies of writing production are limited not only by the lack of a good tool to identify prephonological spellers but also by the small numbers of items in the studies. There was only one pair of singular and plural nouns in the study by Tolchinsky Landsmann and Levin (1987) and four in the study by Levin and Korat (1993). We used a pool of 20 pairs in each of our experiments, making it less likely that the results would reflect idiosyncratic characteristics of particular items. Each child spelled 10 of the 20 pairs, 5 pairs in each of two test sessions. Across children, all pairs were represented approximately equally often. These procedures allowed us to obtain data on a reasonably large number of pairs without overtaxing each child. In addition to the spelling test of primary interest, we included a reading task involving simple words. We expected that the prephonological spellers, like those in previous studies (Pollo et al., 2009; Treiman et al., 2015; Zhang & Treiman, 2015), would be able to read no or few words.

2. Experiment 1

2.1. Method

2.1.1. Participants

In order to identify prephonological spellers, we tested 63 children (33 girls) who ranged in age from 3;2 to 5;8. The children attended preschools and daycare centers in the area of St. Louis, Missouri. All were native speakers of English. The left column of data in Table 1 provides information about the children who were identified as prephonological spellers using the procedures described in Section 2.1.4 and whose data were included in the analyses that we report.

2.1.2. Stimuli

We selected 20 pairs of words, as shown in Appendix A. Each pair contained the singular and plural form of a common word that referred to a concrete object, as with the pair *cow* and *cows*. We constructed a simple sentence for each word. The sentences for the singular and plural word of a pair were similar in length but described different situations. For example, the sentence for *cow* was "The cow is eating some grass" and the sentence for *cows* was "Many cows live on the farm."

The reading task used a selection of short words that are commonly found in children's reading materials: *book, come, dog, eat, go, green, in, is, it, jump, look, no, play, red, see, stop, the, up, we, yellow, yes, and you*. Eleven cards were prepared, each of which contained two words written in uppercase letters. Each card also contained one easily identifiable picture that was not related to either word. The pictures were included to make the task less frustrating for children who could not read the words.

2.1.3. Procedure

Children were tested individually over two 10- to 15-min sessions. The two sessions were usually separated by about a week. During the first session, children spelled five pairs of words and then took the reading test. During the second session, children spelled five additional pairs of words. To ensure that each pair was approximately evenly represented across children, a random shuffling of the word pairs was generated for each group of two children. The first 10 pairs in

the random order were assigned to the first child and the second 10 pairs to the second child. The order of the pairs for the spelling task were randomized for each child. The order of presentation of the singular and plural items within each pair was also chosen at random, meaning that the singular was spelled first on approximately half of the trials and the plural was spelled first on the other half.

The children were given a booklet with blank pages in which to spell the words. The experimenter explained that she and the child would play a game that involved saying words and writing them in the booklet. The experimenter asked the children to use letters to write the words to the best of their ability. She stated that she was not worried about whether children spelled the words as grown-ups do. After explaining the game, the experimenter opened the booklet vertically with the first page above the second. The experimenter presented the first pair of words, saying for example, “We are going to spell *cow* and *cows*. We will spell *cow* first on the top page. Can you say *cow*?” In those rare cases in which a child did not repeat the word correctly, the experimenter said the word a second or a third time, if necessary, and asked the child to repeat it again. The experimenter then used the word in the predetermined sentence and asked the child to spell it. After the child completed his or her production, the experimenter asked the child what letters he or she had used. This information was used in scoring the responses, as described below. Next, the experimenter presented the second word of the pair, saying for example, “Now we are going to spell *cows*.” The same procedure was then followed as with the first word of the pair, and the experimenter asked the child to spell the second word on the bottom page of the two-page spread. The child’s spelling of the first word of each pair was thus visible when the child spelled the second word.

For the reading task, the experimenter presented one card at a time and asked the child to identify any items that he or she knew on the card. If a child did not identify all of the items, as was typically the case, the experimenter pointed to each item on the card in turn and asked if the child knew it. The order of presentation of the cards was scrambled for each child. The experimenter praised every response from the child.

2.1.4. Identification of prephonological spellers

To identify prephonological spellers among children who orally reported letters in the majority of their productions, our first step was to determine the extent to which each spelling represented the sounds in the target word. We based this scoring on the letters orally reported by the child because children of the ages tested here are not always good at producing well-formed letters. The specific scheme that we used for scoring the degree to which the spellings represented the sounds in the target words, from [Treiman and Kessler \(2004\)](#), credits not only orthographically correct letters but also letters that fit with conventional sound–letter correspondences that are not correct for the word in question and certain letters that are common in young children’s spelling errors, such as *g* and *j* for the initial sound of *drive*, in which the pronunciation of /d/ changes before /ɪ/. The scoring scheme does not penalize extraneous letters, nor does it require letters to be in the correct sequence. We counted one unit of distance for each letter addition that was needed to transform a child’s spelling into a phonologically plausible spelling. For each spelling response, we computed the distance between it and each of the phonologically plausible spellings of the target word and used the lowest possible score. For example, a child who spelled *door* as “dor” would receive an error score of 0 because no letters need to be added to make a phonologically plausible spelling. A child who spelled *dor door* as doooilt would receive an error score of 1 because one addition would be needed to make the spelling phonologically plausible in North American English: a representation for /ɪ/. The extraneous letters in doooilt did not detract from the score. As a final example, cmgg for *door* received an error score of 3 because three letters must be added to make the spelling phonologically plausible. As these examples show, higher error scores correspond to greater deviations from plausible spellings. We summed the error scores across all of the spellings that a child produced to obtain the aggregate error score for that child. The second step in the identification of prephonological spellers was to randomly match the child’s spellings to the target words and rescore the spellings as if they had been attempts to spell those words. For example, a child might have produced cmgg for the target *door*. When the child’s spelling were randomly matched to the target words, cmgg might be treated as an attempt to spell cmgg *doll*. We calculated the aggregate error score for the rearranged spellings. This gives one view of what the child’s score would be if the spellings were not informed by the phonology of the target word. We performed this rearranged scoring 10,000 times using the program Ponto ([Kessler, 2009](#)), and we computed the proportion of rearranged spellings for which the aggregate error score was at least as good as the original score. To identify children for whom there was no convincing evidence that the spellings reflected the phonemes in the words, we required that the *p* value of the hypothesis that spellings reflected phonemes was greater than .20. To be more confident in our identification of prephonological spellers, we repeated the analyses using the first letter of children’s spellings and the first phoneme of the words’ pronunciations. This procedure was motivated by the observation that young children find it easier to spell the first phonemes of words than the later phonemes ([Treiman, Berch, & Weatherston, 1993](#)). If the *p* value was greater than .20 according to both the whole-word analysis and first-letter analysis, we classified a child as a prephonological speller. Children who were unable to identify letters in all or most of their productions were also so classified.

2.1.5. Scoring of number of elements in spellings

On trials where children reported using letters, we scored the number of elements as the number of letters that the child reported. We followed this procedure because children’s letters were not always well formed. Thus, a child who failed to join the horizontal lines of an E to the vertical line was scored as having produced a single element if the child identified the

entire form as the letter *e*. When children could not identify letters in a production they had made, we counted the number of marks that were not connected to other marks within the production. For example, a production like that shown on the right side of Fig. 2 was counted as a single element. Very small marks, those the size of a pencil point or smaller, were not included on the grounds that they could have been produced unintentionally. To check the reliability of scoring, a second judge scored a subset of the productions for which children could not identify letters. This reliability check was conducted using 25% of the total set of productions from this experiment and Experiment 2. The second scorer agreed exactly with the primary scorer in 93% of cases, and the correlation between the two sets of scores was .97.

2.2. Results

Prephonological spellers used an average of 2.74 (SD = 1.75) elements in their productions of singular nouns as compared to 3.17 elements (SD = 2.06) in their productions of plural nouns. To test whether the difference was statistically significant, we conducted a mixed effects analysis using the R software package lme4 (Bates, Maechler, Bolker, & Walker, 2013). The package lmerTest (Kuznetsova, Brockhoff, & Christensen, 2013) was used to compute *p* values. Number of elements was log transformed prior to analysis in order to make the distribution more normal. The model included random effects for participants and word pairs and the fixed factors singular versus plural. The effect of singular versus plural was statistically reliable ($\beta = 0.103$, SE = 0.039, $p = .008$).

2.3. Discussion

Prephonological spellers produced more elements in their spellings of plural nouns, which signify more than one object, than in their spellings of singular nouns, which signify one object. This finding is consistent with the idea that children's early writing has some degree of iconicity (Ferreiro & Teberosky, 1982; Luria, 1978; Tolchinsky, 2003). Previous experimental support for this idea in the case of object quantity has come from learners of Hebrew (Levin & Korat, 1993; Tolchinsky, Landsmann & Levin, 1987), and the present findings points to similar results among learners of English.

However, there are two possible alternative explanations for why children in Experiment 1 used more elements to write plural nouns than singular nouns. The first is that children were expressing a sensitivity to phonology. We consider this very unlikely because we used rigorous procedures to select children whose spelling was not based on phonology. Indeed, previous studies in which prephonological spellers were selected in a similar manner to that used here found that these children did not use more elements to write phonologically longer words than phonologically shorter words (Pollo et al., 2009, with U.S. and Brazilian children; Zhang & Treiman, 2015 with U.S. children; Treiman et al., 2013, with Brazilian children). This was true even though the differences in phonological length were more salient in those studies than in the present study. Another possible alternative explanation of the finding that prephonological spellers used more elements to write plural nouns than singular nouns is that they were expressing a sensitivity to morphology. That is, consistent with the suggestion made by Byrne (1996), young children may believe that words that contain more morphemes should have longer spellings than words that contain fewer morphemes.

Experiment 2 was designed to test both alternative explanations of Experiment 1: that prephonological spellers are sensitive to phonological length and that they are sensitive to number of morphemes. We did this by comparing children's spellings of verbs such as *buy* and *buying*. The present progressive form, *buying*, contains one more syllable and one more morpheme than the bare verb, *buy*. The additional morpheme does not correlate with quantity, as does the additional morpheme in Experiment 1. If the results of Experiment 1 reflect a sensitivity to object quantity, then children in Experiment 2 should not use more elements to spell verbs such as *buying* than verbs such as *buy*. If the results of Experiment 1 reflect a sensitivity to phonological length or number of morphemes, then children in Experiment 2 should use more elements for verbs such as *buying* than verbs such as *buy*. We chose the present progressive verb (e.g., *buying*) rather than the third person singular verb (e.g., *buys*) for Experiment 2 because the present progressive is not easily confused with a noun plural, as the third person singular verb could be. Also, the present progressive contains one more syllable and two more phonemes than the bare verb. This gives children every chance to perceive the presence of extra phonological material. Experiment 2 used the same methods as Experiment 1, differing only in the items that children were asked to spell. The procedure for selecting prephonological spellers was also the same.

3. Experiment 2

3.1. Method

3.1.1. Participants

In order to identify prephonological spellers, we tested 64 children (32 girls) who ranged in age from 3;2 to 5;8. The children attended preschools and daycare centers in the area of St. Louis, Missouri. All were native speakers of English. The right column of data in Table 1 provides information about the children who were identified as prephonological spellers whose data were included in the analyses. As the results in Table 1 show, these children were very similar in age and reading performance to those in Experiment 1.

3.1.2. Stimuli, procedure, and scoring

We selected 20 pairs of words, which are shown in [Appendix A](#). Each pair included a bare verb, such as *buy*, and the present progressive form of the verb, such as *buying*. We constructed a simple sentence for each word. The procedure for the experiment was the same as that of Experiment 1, and the experimenter and the reading task were also the same. Prephonological spellers were identified as in Experiment 1. We scored the number of elements in the productions in the same way as well.

3.2. Results

Prephonological spellers used an average of 2.70 (SD = 1.52) elements in their productions of bare verbs as compared to 2.64 (SD = 1.48) in their productions of present progressive verbs. We conducted a mixed effects analysis as in Experiment 1, including random effects for participants and word pairs and the fixed factor bare verb versus present progressive. The slight tendency for children to use more elements for the bare verbs than for the progressive forms was not statistically reliable ($p = .81$).

To compare the results of Experiment 2 with those of Experiment 1, we conducted a combined analysis of the data from the two experiments. This analysis included the factor number of morphemes, where singular nouns and bare verbs were coded as having one morpheme and plural nouns and present progressive verbs were coded as having two. The other fixed factors were experiment and the interaction between number of morphemes and experiment. The model included random effects for participants and items. The most important finding of the combined analysis was an interaction between number of morphemes and experiment ($\beta = 0.110$, SE = 0.047, $p = .019$). That is, the effect of number of morphemes was significantly different in the two experiments. Spellings of two-morpheme words were longer than those of one-morpheme words in Experiment 1, where two-morpheme words were plurals (see [Section 2.2](#)), but spellings of two-morpheme words were not longer than those of one-morpheme words in Experiment 2, where two-morpheme words were present progressive verbs. The main effect of number of morphemes was also statistically significant ($\beta = 0.103$, SE = 0.034, $p = .003$). There was no main effect of experiment ($p = .72$). The finding that children in the two experiments used similar numbers of elements provides further evidence for the similarity between the two groups of prephonological spellers.

In additional analyses of the combined data, we asked whether other variables influenced the number of elements used: the child's gender, the child's age, and whether the child was able to identify letters on the majority of trials. We did so by adding each variable to the model as a main effect in turn. Gender did not have a significant effect ($p = .61$) but age did, such that older children used more elements than younger ones ($\beta = 0.381$, SE = 0.099, $p < .001$). Whether a child identified letters on the majority of trials had a significant effect when it was entered on its own, such that children who identified letters used more elements than children who did not ($\beta = 0.364$, SE = 0.145, $p = .014$). However, much of this effect appeared to reflect the fact that children who identified letters on the majority of trials tended to be older than children who did not, for the effect of letter identification was no longer statistically significant ($p = .08$) in a model that also included age. Given the relation between number of elements and age, we then asked whether the critical interaction between number of morphemes and experiment was influenced by the child's age. To do this, we compared a simpler model that included the main effects of age, number of morphemes, experiment, and the interaction between number of morphemes and experiment to a more complex model that also included the interaction between age and number of morphemes, the interaction between age and experiment, and the three-way interaction involving age, number of morphemes, and experiment. The more complex model did not account for significantly more variance than the simpler model ($p = .80$). This outcome suggests that, although older prephonological spellers generally used more elements than younger ones, the pattern of results was similar across the age range of the children in our experiments.

3.3. Discussion

The central result of Experiment 2 is that prephonological spellers produced similar numbers of elements to write two-morpheme verbs such as *buying* and one-morpheme verbs such as *buy*. This result is important because it helps us to interpret the finding of Experiment 1 that prephonological spellers produced more elements for two-morpheme nouns such as *cows* than one-morpheme nouns such as *cow*. The results of Experiment 2 suggest that this outcome reflects the increase in quantity that is signaled by the plural, for the prephonological spellers in Experiment 2 did not use additional marks when an extra morpheme did not indicate an increase in quantity.

The results of Experiment 2 are also noteworthy in light of the theory that children pass through a *syllabic stage* before they begin to spell alphabetically ([Ferreiro & Teberosky, 1982](#)). During the syllabic stage, children are said to approach the task of spelling by using as many visual marks as there are syllables in a word. Even when the marks are real letters, they may be phonologically implausible. For example, [Vernon \(1993\)](#) described a U.S. 4-year-old who wrote *kjge* for the four-syllable word *elevator* and *hu* for the two-syllable word *bedroom*. However, the results of other studies with learners of English and Portuguese cast doubt on the idea that young children generally use more letters to write words that contain more syllables than words that contain fewer syllables ([Cardoso-Martins, Corrêa, Lemos, & Napoleão, 2006](#); [Pollo et al., 2005](#); [Pollo et al., 2009](#); [Treiman et al., 2013](#); [Zhang & Treiman, 2015](#)). In Experiment 2, unlike these previous studies, words that contrasted in number of syllables were presented in pairs, such as *buy* and *buying*. Such presentation might have been thought to highlight the difference in phonological length between the two words and elicit some tendency to use more elements to

spell the longer word. However, it did not appear to do so. The results of Experiment 2 thus provide additional and stronger experimental evidence that prephonological spellers' choices about the number of elements to use to write a word are not influenced by the word's length in either syllables or phonemes. This outcome speaks against the idea that children go through a syllabic stage in the development of spelling, and it also helps to validate the methods that we used to select prephonological spellers.

The results of Experiment 2 speak to the theory that young children's conceptions of writing are based on morphology. [Byrne \(1996\)](#) proposed this idea based on experimental results suggesting that 4-year-olds who were taught to read pairs of one-morpheme and two-morpheme adjectives such as *fat* and *fatter* performed above the level of chance in determining that *softer* says "softe" rather than *soft* but did not perform above the level of chance in determining that *hammer* says "hammer" rather than "ham". In the production task of Experiment 2, however, prephonological spellers did not use more elements to write two-morpheme verbs than one-morpheme verbs. This result does not appear to be consistent with the idea that prephonological spellers' conceptions of writing are based on morphemes. Further research will be needed with learners of English and other languages to compare the effects of morphology in recognition tasks, like that used by Byrne, and production tasks, like that used here. However, the results of Experiment 2 do not encourage the idea that prephonological spellers expect the visual elements in words' written forms to represent morphemes.

4. General discussion

Research on the learning of alphabetic writing systems has focused on how children link sounds in spoken words to letters in printed words. For example, researchers have documented that young speakers of British English often spell the second vowel of *muffin* with *i* because the vowel is pronounced as /ɪ/ in their dialect, whereas children who speak Australian English, who pronounce the vowel as /ə/, are less likely to produce this spelling ([Kemp, 2009](#)). The question of how children gain the cognitive understanding that is needed to make links between sounds and spellings has not been studied a great deal. That is, how do children learn that writing symbolizes the sounds of speech and what, if any, knowledge do they possess about the symbolic function of writing before they are able to spell phonologically? Some investigators have proposed that young children take certain physical characteristics of written words to reflect characteristics of the words' referents, treating writing as somewhat iconic ([Ferreiro & Teberosky, 1982](#); [Luria, 1978](#); [Tolchinsky, 2003](#)). However, some of the evidence for referential writing has been anecdotal and some of the experiments on the topic have weaknesses.

Here we asked whether there is solid empirical evidence for one aspect of referential writing in learners of English: production of more visual elements for plural nouns such as *cows* than singular nouns such as *cow*. To determine whether any such difference reflects the quantity of the referent, we also asked whether children use more elements for two-morpheme verbs such as *buying* than one-morpheme verbs such as *buy*. Going beyond the few previous experiments that have addressed this aspect of referential writing, we used stringent criteria to identify children who do not yet represent phonemes in their written productions. We found that prephonological writers used significantly more elements for two-morpheme words than one-morpheme words when the additional morpheme corresponded to an increase in quantity, as it did in Experiment 1, but not when it did not, as in Experiment 2. The tendency to use more elements for *cows* than for *cows*, therefore, does not reflect a sensitivity to the number of phonemes, syllables, or morphemes in word. If it had, then children should have used more marks for *buying* than for *buy*. Prephonological writers' tendency to use more elements for plural nouns than for singular nouns must instead reflect a tendency to use more elements for words that refer to more than one object than for words that refer to a single object.

Our results support the idea that young children's writing shows some degree of iconicity ([Ferreiro & Teberosky, 1982](#); [Luria, 1978](#); [Tolchinsky, 2003](#)). We documented that here for U.S. prephonological spellers in the case of object quantity, with children using on average more elements to write plurals than to write singulars. Another recent study of U.S. children found evidence for referential writing in the case of object size, such that prephonological writers' productions of words corresponding to larger objects tended to be larger in area than their productions of words corresponding to smaller objects ([Zhang & Treiman, 2015](#)). The present findings in support of referential writing are stronger than those of previous studies with learners of other languages ([Levin & Korat, 1993](#); [Tolchinsky Landsmann & Levin, 1987](#)) in that we used a rigorous procedure to identify prephonological spellers and in that we addressed other methodological weaknesses of the previous studies.

We suspect that a tendency to use more elements to write plural nouns than singular nouns, reflecting children's sensitivity to the objects that words represent rather than to the words' linguistic forms, would be found across languages and writing systems. To test this idea, research is needed with children whose languages convey the notion of quantity differently than English does. Of particular interest are languages in which the number of phonological and morphological units is regularly the same in singular and plural nouns (e.g., Italian *gatto* 'cat' with masculine singular *-o*, *gatti* 'cats' with plural *-i*; and Chinese, where singular and plural nouns are identical, with no inflectional endings at all). In these cases, a tendency to use more elements for plural meanings than for singular ones could not be explained by differences in the number of linguistic units.

Although our results support the idea that young children's writing shows some degree of iconicity, the effects are not large. Children learn about the outer form of writing from an early age, learning for example about some of the differences in appearance between writing and pictures ([Brenneman et al., 1996](#); [Levin & Bus, 2003](#); [Rowe, 2008](#); [Treiman & Yin, 2011](#)). Children learn that writing does not look much like its object, whereas pictures generally do. The iconicity that is found in

the productions of prephonological writers may reflect these children's difficulty in grasping the inner structure of writing: how written words convey their objects. Speech is ephemeral, and it is not easy for children to understand that its sounds can be represented with visual marks. Children sometimes fall back on the idea that a printed word should bear some physical similarity to its referent, just as a picture does to its referent.

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Appendix A.

Pairs for Experiment 1: *block blocks, boot boots, boy boys, chair chairs, clown clowns, cow cows, crib cribs, cup cups, doll dolls, door doors, egg eggs, hand hands, lamp lamps, leg legs, owl owls, plant plants, sock socks, spoon spoons, stamp stamps, truck trucks.*

Pairs for Experiment 2: *bring bringing, buy buying, carry carrying, climb climbing, cook cooking, dance dancing, drive driving, eat eating, finish finishing, follow following, go going, hurry hurrying, pretend pretending, show showing, sit sitting, splash splashing, stand standing, throw throwing, touch touching, water watering.*

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