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Are Young Children Logographic Readers and Spellers?

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Abstract

According to many views of literacy development, prereaders use a logographic approach when they attempt to link print and speech. If so, these children should find pairs in which the spelling–pronunciation links are consistent with their writing system no easier to learn than arbitrary pairs. We tested this idea by comparing the ability of U.S. prereaders (mean age 4 years 9 months) to learn phonetically motivated pairs like *AP–ape* and *MA–may* and arbitrary pairs like *OM–ape* and *PO–may*. In both spelling and reading tasks, children learned the pairs with vowel letter name cues more easily than the arbitrary pairs. Phonetically motivated pairs were especially advantaged when the vowel letter names were at the beginning (e.g., *AP–ape*) rather than the end (*MA–may*). Prereaders who have some knowledge about letters, as U.S. preschoolers typically do, are not limited to a logographic approach in learning about print.

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The phonological forms of spoken words bear an arbitrary relationship to their meanings. For example, there is no reason why a chair should be called /tʃer/ as opposed to something else. Indeed, a chair is called a /'sija/ in Spanish. (For an explanation of the phonetic symbols used here, see International Phonetic Association, 1999.) Learners of spoken languages must memorize the arbitrary phonological forms that are associated with the concepts of chair, dog, and so on. There are no meaningful or systematic links that they can use to motivate the associations between the phonological and semantic forms. The situation is different for learners of most written languages. In alphabetic and syllabic writing systems, written words are linked in systematic ways to their pronunciations. For example, the spelling *chair* is related to the phonological form /tʃer/ by virtue of spelling–sound correspondences that hold across many English words. The spelling is motivated rather than arbitrary for those who know that *ch* corresponds to /tʃ/ in words such as *chip* and that *air* corresponds to /er/ in words such as *pair*. Becoming a good reader involves learning about the spelling–sound mappings of the language. Skilled readers reveal their knowledge of these links when they pronounce a previously unseen word like *glair* on first exposure or when they hesitate on a word like *choir*, which deviates from the typical spelling-to-sound mappings of the language.

We know that skilled readers benefit from the systematic links between letters and pronunciations that exist in alphabetic writing systems, but we know less about how and when children begin to do this. According to several influential views of literacy development (e.g., Byrne, 1992; Ehri, 1998; Frith, 1985), children typically learn their

first words in a *logographic* or *prealphabetic* way. Rather than using systematic links between letters and sounds, children identify each printed word based on salient visual characteristics. For example, a child may recognize *dog* by virtue of the “tail” at one end of the printed word. This approach to word identification is quite limited. Logographic learners often confuse printed words with one another, and they tend to forget them quickly. According to these influential theories of literacy development, literacy learning begins to surge only when children start to take advantage of alphabetic links between printed and spoken words.

Ehri and Wilce (1985) found evidence for a prealphabetic approach among children who they classified as prereaders when they taught U.S. 5 year olds to read two sets of printed items. The items in one set contained letters that corresponded to the sounds in the words’ pronunciations. In this condition, for example, MSK was presented as a spelling for *mask*. The items in the other set violated conventional letter–sound correspondences but were more visually distinctive. In this condition, for example, UHE was taught as *giraffe*. Children had up to 10 trials to learn the pronunciations of the items in each set. Children who could read no more than one word from a list of simple words such as *look*, *it*, and *stop* performed better on the arbitrary but visually distinctive spellings than on the phonetically motivated spellings. According to the researchers, these children were relying on a logographic approach to link print and speech. Abreu and Cardoso-Martins (1998) found similar results among Portuguese-speaking prereaders who had little knowledge about letters, although children with more letter knowledge performed differently (see also Cardoso-Martins, Resende, & Rodrigues, 2002). In the study by Ehri and Wilce, as in studies by Rack, Hulme, Snowling, and Wightman (1994),

and Laing and Hulme (1999), children who could read at least a few words aloud learned phonetically motivated items more easily than arbitrary or less well motivated items.

The results of Ehri and Wilce (1985) suggest that young children start out by using a logographic approach to learn about print. A potential problem with this conclusion, however, stems from the fact that the nature of the spelling–sound links was confounded with the visual characteristics of the print in Ehri and Wilce’s study. The phonetically motivated spellings looked less distinctive than the arbitrary ones. Thus, it is not clear whether prereaders’ failure to perform better on the phonetically motivated spellings than the arbitrary ones reflects a failure to use alphabetic mappings or a preference for spellings that are visually distinctive. If prereaders approach print logographically, they should perform no better on alphabetically motivated spellings than on arbitrary spellings when the two types of spellings are similar in appearance. We tested this prediction in the current study.

A further limitation of the studies described so far is that they examined learning in the spelling-to-sound direction, or reading, but not learning in the sound-to-spelling direction, or spelling. A complete understanding of literacy development, of course, requires consideration of both reading and spelling. Frith (1985) proposed that children move from a logographic approach to an alphabetic approach for spelling before they do so for reading. If so, we would expect to find differences in children’s pattern of performance in spelling and reading tasks. A few studies (Bowman & Treiman, 2002, Experiment 2; Treiman, Sotak & Bowman, 2001, Experiment 3) have examined learning in the sound-to-spelling direction using procedures similar to those described above. However, direct comparisons between spelling and reading have been hindered by the

fact that the letters used in these previous spelling experiments differed in their visual characteristics from the letters used in the reading experiments. For example, the earlier experiments studied learning in the sound-to-spelling direction for visually distinctive but alphabetically arbitrary spellings by using items in which the letters differed from one another in color as well as other attributes. In the experiments studying learning in the spelling-to-sound direction, however, the letters in these items differed in size and positioning but not in color. The present study examined children's learning of phonetically motivated and arbitrary print-sound associations in both spelling and reading, using stimuli that were well matched across the two tasks.

The present study was based on that of Bowman and Treiman (2002, Experiment 3), which as far as we know is the only study to have examined how children who cannot read simple words learn alphabetically motivated and arbitrary print-sound pairs when the two types of stimuli are equated for their visual characteristics. That study examined learning in the spelling-to-sound direction only. In the phonetically motivated conditions, children learned that a letter string such as *LK* was pronounced as *elk*, a word with a VCC (V = vowel, C = consonant) structure. Children also learned that a letter string such as *FL* was pronounced as *fell*, a word with a CVC structure. In the VCC and CVC phonetically motivated conditions, both consonants of the spoken words were spelled with plausible letters. The entire name of the first printed letter was heard in the spoken VCC words and the entire name of the last printed letter was heard in the CVC words. When *elk* is spelled as *LK*, for example, *L* can be interpreted as representing both phonemes in its name—/ɛ/ and /l/. Letter names were included in the stimuli because U.S. children learn the names of the letters from an early age (e.g., Worden & Boettcher, 1990) and because they

appear to use this knowledge in linking print and speech (e.g., Foulin, 2005; Treiman & Rodriguez, 1999). The arbitrary conditions of the Bowman and Treiman study included pairs such as *LT-ark* and *ML-far*. No letter name clues that could aid performance appeared in these items; the letters in the printed items were not plausible representations of the sounds in the spoken items.

Bowman and Treiman (2002, Experiment 3) tested children who had a mean age of 4 years 7 months and who could not read any simple words on a screening test. Overall, the children performed better in the phonetically motivated conditions than the arbitrary conditions. For the VCC motivated condition, where the name of the first printed consonant letter was heard in the corresponding spoken word (e.g., *LK-*elk**), the superiority for the motivated condition over the arbitrary condition was statistically significant. This superiority was smaller and not statistically reliable for the CVC items, where the name of the second consonant letter was heard (e.g., *FL-*fell**). The children in the Bowman and Treiman study, like most U.S. children of this age, knew the names of a number of letters. They used this knowledge, apparently, to rationalize spelling-pronunciation pairs such as *LK-*elk**, in which the letter name occurred in the initial position of the word. Letter names at the ends of words were less helpful, reflecting children's greater attention to the beginnings of words than to the ends. The results suggest that young children who cannot recognize simple words can go beyond a logographic approach to reading when learning words that contain consonant letter name cues in salient positions.

Bowman and Treiman's (2002) finding that even children classified as prereaders can sometimes go beyond a logographic method of linking print and speech is surprising

in light of the widespread view that such children initially approach print in a nonalphabetic manner (e.g., Byrne, 1992; Ehri, 1998; Frith, 1985). The goal of the present study was to extend the findings of Bowman and Treiman and to provide a further test of the idea that prereaders are not limited to a logographic approach to reading and spelling. This study went beyond the work of Bowman and Treiman in several ways. First, we investigated letter name clues consisting of vowels rather than consonants. Specifically, we used two-letter spellings that corresponded to words with VC or CV pronunciations and that, in the phonetically motivated condition, had a vowel letter name at the beginning (e.g., *AP*–ape) or at the end (e.g., *PA*–pay). In the arbitrary condition, the letters in the spellings did not correspond in a plausible way to the sounds in the spoken words. If children can use their knowledge of letter names in linking print and speech, at least with letter names at the beginnings of words, then this ability should appear with vowel letter names as well as consonant letter names. A second way in which the present experiment went beyond previous work is that it included a spelling task and a reading task that had very similar stimuli and procedures. This allowed for better comparisons between the two tasks than in previous research, which has relied on cross-experiment comparisons. Finally, the present study examined children’s ability to remember the taught responses after a brief delay. This issue has been investigated in some previous studies (e.g., Ehri & Wilce, 1985) but not others (e.g., Bowman & Treiman, 2002).

The participants in our study were preschoolers who could not read any of 22 simple and highly frequent words such as *look*, *stop*, and *in*. Our reading screening test used the same words as that of Bowman and Treiman (2002), which were the words that

Ehri and Wilce (1985) had found to be easiest for beginners. Although we refer to our participants as prereaders, following the lead of other researchers, the children may have been familiar with the spellings of their own first names or the names of family members. However, these children were unable to decode printed words on the basis of spelling-to-sound correspondences—the hallmark of alphabetic reading.

Method

Participants

Forty-two prereaders with a mean age of 4 years 9 months completed the experiment. Half of these children were randomly chosen to participate in the reading task and half in the spelling task. Another 16 children began the experiment but did not complete it. Six of these children were dropped from the study because they could read at least one common word on the screening task; nine (three in the reading task and six in the spelling task) found the task too demanding and at some point declined to continue; and one was absent so often that he could not complete the sessions in a timely manner. Participants attended preschools in the Detroit, Michigan metropolitan area that did not offer formal instruction in reading or writing. All of the children were native speakers of English.

Materials

There were four conditions: VC motivated, VC arbitrary, CV motivated, and CV arbitrary. The Appendix lists the printed stimuli and the pronunciations for each condition. In the phonetically motivated conditions, both phonemes in the spoken words were represented with plausible letters. The first vowel phoneme in the VC condition and the final vowel phoneme in the CV condition were spelled with a letter that had the same

spoken letter name. In the VC condition, for example, the spelling *AP* was paired with the word /ep/ (*ape*). The letters were reversed (*PA*) and paired with *pay* in the CV condition. To ensure that no child experienced duplicate spellings or pronunciations across conditions, we designed two sets of stimuli for each condition. A given child was exposed to the VC stimuli from one set and the CV stimuli from the other. The vowels of the phonetically motivated stimuli were *A*, *E*, *I*, and *O*. It was not possible to develop two sets of words with *U* that met the requirements of the study. For comparability with the Bowman and Treiman (2002) study, in which children learned five items per condition, each set also included a filler stimulus that had the letter *Y* in the target position. The fillers differed in some respects from the other stimuli, so performance on the filler stimuli was not analyzed.

The arbitrary condition paired the letters from one set of phonetically motivated items with the pronunciations from the other set to produce two-letter stimuli with a vowel letter (or *Y*) in either the initial or final position. Within each set, the letters were scrambled so that neither phoneme in the spoken word was spelled in a plausible manner. For example, *ape* was spelled *OM* in the arbitrary VC condition, and *pay* was spelled *MO* in the arbitrary CV condition. Children learned the arbitrary VCs from one set and the arbitrary CVs from the other set.

Most of the printed stimuli were nonwords, but the many constraints on the stimuli meant that it was necessary to include several words. The conventional pronunciation of these words was never taught as the targeted pronunciation for the experimental stimuli. For example, *IS* appeared in the VC motivated condition, but it was pronounced as *ice*. If children knew the conventional pronunciations of these words, this

may have made it harder for them to learn the pronunciations that were taught in the experiment. Several steps were taken to guard against this possibility. Two of the most common real words in the set of stimuli (*IT* and *IS*) were included on the reading screening test. As discussed earlier, we selected children who could not read any words on the screening list. We also pretested the children to determine how they responded to the written and spoken stimuli before training began. The children never produced either the correct pronunciation or the target pronunciation for the real words included as stimuli, as mentioned below. Finally, the items in the motivated condition were on average more frequent in texts designed for kindergartners and first graders than the items in the arbitrary condition (Zeno, Ivens, Millard, & Duvvuri, 1995). Thus, any knowledge of the real words that may not have surfaced during either the reading screening or the pretesting of the experimental stimuli should have made the motivated condition harder than the arbitrary condition, the opposite of the predicted results.

The reading and spelling tasks used visually similar materials, facilitating comparisons between the tasks. For spelling, children used 5 cm high, yellow, foam rubber, uppercase letters. The ten letters needed to spell the words in each set were displayed on a 38 cm wide by 32 cm high green and blue felt board. The board was placed horizontally in front of the child with the letters randomly laid out on the upper green portion and a 17 × 13 cm spelling board centered on the lower blue portion. The spelling board was made of plastic canvas covered in green felt and surrounded by a red felt frame, leaving an opening in the center portion. A yellow vertical line divided the center portion into two side-by-side areas into which letters could be placed to spell the words. A small yellow arrow in the upper left corner of the spelling board reminded the

child where to place the first letter. The cards for the reading task measured 17 × 13 cm and consisted of a green background surrounded by a red frame with two 5 cm high, yellow block letters centered in the open area.

To assess the children's knowledge of letter names and sounds, we used twenty-six 10 × 15 cm cards, each with a single 5 cm high upper-case letter in Arial font. We also designed a letter name recognition task using thirteen 8 × 13 cm cards to assess children's recognition of the 13 letters used in the experiment. A vertical line divided each card into two equal sections, each of which contained a different 4 cm high letter printed in Arial font. Each of the letters appeared twice, once on the left half of a card and once on the right. Correct answers occurred equally often on the two sides.

Children were screened for reading ability using the same 22 simple words used by Bowman and Treiman (2002). Two words and an easily identifiable colored picture were displayed on each of eleven 14 × 22 cm cards, and the spatial arrangement of the words and the pictures differed across cards.

Procedure

Each child participated in the VC motivated, VC arbitrary, CV motivated, and CV arbitrary conditions of either the reading or spelling task over four sessions that averaged 2 to 3 days apart. A different condition was presented during each session, and the order of conditions and word sets was balanced across children. Each session began with the child choosing one of four puppets. The children were told that they would learn to read or spell the way the puppet did, and that this was different from how people read and spell. Next, children were pretested to evaluate how they responded to the written and spoken stimuli before training began. For the reading pretest, the cards were shown one at

a time and the child was asked to read each word. No feedback was given. For the spelling pretest, the puppet first showed the child how to choose and place the letters. The puppet randomly selected the first letter, placed it in the opening by the yellow arrow, selected a second letter, and placed it in the remaining opening. After showing the children how to select and place the letters, the experimenter pronounced the first word, used it in a sentence, and then repeated it before encouraging the child to guess how to spell the puppet's word. Once the child placed two letters, the puppet showed the child the correct spelling. This ensured that, as in the reading task, the children in the spelling task saw the correct spellings during the pretest. This process was repeated for each of the five words.

After the child had been pretested on all five words for the session, the correct responses were demonstrated. For the reading task demonstration, the puppet showed each card, pointed to the word, said it, used it in a sentence, said it again, and asked the child to repeat the word. The children in the spelling task had already been exposed to the pronunciations of the words and the sentences. The spelling of each word was demonstrated, with the child repeating the words as they were demonstrated.

The demonstration phase was followed by up to eight learning trials. The reading task participants saw the cards presented one at a time in random order and had five seconds to respond to each. Correct answers were praised. If the child did not respond or gave an incorrect answer, the experimenter provided the correct answer. The children in the spelling task heard each word pronounced and were encouraged to select two letters to spell the word the way the puppet spelled it. Correct answers were praised and incorrect answers were replaced with the correct spelling. Learning trials continued until

the child had achieved the criterion of responding correctly to all five items on two consecutive trials (in which case we assumed that the child would have responded correctly on further trials) or until eight trials had been completed.

A single screening or assessment task followed the learning trials of each session. These tasks occurred after the learning trials in order to provide a time delay after which memory for the learned items was assessed once again. After the learning trials of Session 1, the reading screening task was given. Children were shown the word and picture cards and were asked to identify anything familiar on the card. If the child did not identify all three items, the experimenter pointed to each item and asked the child to identify it. Children were liberally praised for any correct responses, including identification of the pictures, so that they would experience some success and be motivated to perform the task. The letter name and sound tasks were given after the learning trials of Sessions 2 and 3, their order balanced across sessions. For the letter name task, the cards were presented one at a time in a random order. Children were asked to name the letter on each card. If the correct response was not given in this free-choice situation, two letter names were supplied and the child was asked to pick the one that corresponded to the letter printed on the card. The letter sound task was similar except that children were asked for the letters' sounds. The letter name recognition task followed the learning trials of Session 4. Children were shown each card, were told the name of a letter, and were asked to point to the specified letter on the card. After the screening or assessment task in each session, which lasted approximately 5 minutes, children completed a memory task consisting of one final trial of reading or spelling the target words in order to assess how a brief delay affected memory for the learned items. At the

end of the fourth session, children were shown the correct spellings of all the words used in the study. They were again told that the puppets spelled the words differently from how people spell them.

Results

The pretest results showed that that the children never read and very rarely spelled the words in the targeted manner before they were trained to do so. Also, the children never produced the conventional pronunciations for any of the stimuli that were words. For example, *AM* was never pronounced with its taught pronunciation, /em/ (*aim*), or its real pronunciation, /æm/ (*am*), before the learning trials began. Of interest, then, is how children learned the taught responses across trials for the phonetically motivated and arbitrary stimuli and whether they were able to remember these responses after a brief delay. Figures 1 and 2 depict the proportion of taught responses across learning trials and in the memory trial of the reading and spelling tasks, respectively. The data suggest that children showed better learning of the phonetically motivated pairs than the arbitrary pairs and that a short delay did not markedly affect performance. The graphs further show that children showed more learning across trials in the reading task than the spelling task. The difference between the phonetically motivated and arbitrary conditions was larger for the VCs, which had the vowel letter name at the beginning, than for the CVs, which had the letter name at the end.

These impressions were confirmed by a repeated measures analysis of variance carried out on the number of correct responses using the within subject factors of condition (phonetically motivated vs. arbitrary), stimulus type (VC vs. CV), and learning trial (1 to 8) and the between subject factor of task (reading vs. spelling). We used a

multivariate approach because the sphericity assumption was violated. This approach does not assume sphericity and is recommended by O'Brien and Kaiser (1985). There was a main effect of condition ($F(1, 40) = 44.54, p < .001$), with children performing better in the phonetically motivated conditions than the arbitrary conditions. A main effect of trial was also observed ($F(7, 34) = 15.64, p < .001$), such that performance improved across the learning trials. These main effects were qualified by two-way interactions between condition and stimulus type ($F(1, 40) = 10.73, p = .002$) and condition and trial ($F(7, 34) = 2.92, p = .017$), as well as a three-way interaction involving condition, stimulus type, and trial ($F(7, 34) = 3.70, p = .004$). The difference between the phonetically motivated and arbitrary conditions increased across the learning trials. The three-way interaction reflected the fact that the difference between the phonetically motivated and the arbitrary conditions became larger for VCs, with the letter name at the beginning, than for CVs, with the letter name at the end.

Task participated in only one significant effect—an interaction of trial and task ($F(7, 34) = 2.36, p = .045$). Children showed more improvement across the learning trials in the reading task than the spelling task. Although the difference between the phonetically motivated and arbitrary conditions appeared to be larger for spelling than reading, the interaction between condition and task was not significant.

Figures 3 and 4 show the total number of correct responses in each condition of the reading and spelling tasks, respectively, along with the 95% confidence interval for the means. We adjusted for between-subjects differences in computing the confidence intervals as recommended by Bakeman and McArthur (1996). The figures show that phonetically motivated items were easier for children to learn than arbitrary items,

particularly for VCs. Further evidence of this comes from examining the number of children who achieved the criterion of correctly responding to all five items on two consecutive learning trials. Six children did so in the VC motivated reading condition and four in the CV motivated condition. The figures for the spelling condition were four and three, respectively. No child reached the criterion in the arbitrary condition of either the reading or spelling task. These data support the idea that the phonetically motivated items were easier for children to learn than the arbitrary items and that initial letter names in the initial position were more helpful than final letter names.

Children showed the same pattern of performance on the final memory trials as on the learning trials, with better performance on phonetically motivated than arbitrary items ($F(1, 20) = 10.15, p = .005$ for reading; $F(1, 20) = 23.22, p < .001$ for spelling). Paired t tests comparing performance on the memory trial and the final learning trial revealed that, in each condition, performance after a 5-minute delay was statistically equivalent to performance on the final learning trial. Thus, children showed some memory for the responses they had learned over a short period of time.

We scored children's performance on the letter name task by both a strict and a lenient system. According to the strict scoring system, children had to answer correctly in the free-choice situation in order to receive credit. According to the lenient system, children received credit for a letter if they answered either the free-choice or the two-choice question correctly. The mean proportion of correct responses on the letter name task was .72 by the strict scoring system and .91 by the lenient system. Performance was poorer in the letter sound task than the letter name task. Children averaged .36 correct on the letter sound test by the strict scoring system and .73 by the lenient system. The mean

proportion correct on the forced choice letter name recognition task was quite high, .95. These results show that the preschoolers tested here were rather knowledgeable about letter names and less knowledgeable about letter sounds, the same pattern of results that has been found in other studies with U.S. children (e.g., Worden & Boettcher, 1990).

If children use their knowledge of letter names and sounds to help learn to read and spell the phonetically motivated pairs, then measures of letter name and letter sound knowledge should correlate more highly with performance in the phonetically motivated conditions than with performance in the arbitrary conditions. The data relevant to this prediction are shown in Table 1, which presents the correlations for all 42 children who completed the experiment. Because the patterns of correlations were quite similar for the reading and spelling tasks, we pooled the data across the tasks to maximize the sample size. The results shown in Table 1 are based on a strict scoring of letter name and sound knowledge, as letter name knowledge approached ceiling when scored by the lenient system. Children who knew more letter names and sounds tended to perform better in all conditions of the word learning tasks than children who knew fewer letter names and sounds. However, as expected under the view that alphabetic knowledge is particularly important for learning motivated associations, letter name and sound knowledge tended to correlate more highly with performance in the phonetically motivated conditions than with performance in the arbitrary conditions. Specifically, letter sound knowledge correlated significantly more highly with performance in the motivated VC condition than in the arbitrary VC condition ($p < .001$, one tailed) and significantly more highly with performance in the motivated CV condition than with performance in the arbitrary CV condition ($p = .018$, one tailed). Also, letter name knowledge correlated significantly

more highly with performance in the motivated VC condition than with performance in the arbitrary VC condition ($p = .037$, one tailed). A trend in the same direction was observed for the motivated and arbitrary CV conditions, but it was not statistically reliable.

Discussion

According to many views of literacy development (e.g., Byrne, 1992; Frith, 1985; Ehri, 1998), young children initially approach the task of learning to read in a logographic way. Prereaders, according to these theories, are heedless of the links between letters and sounds that are the foundation of alphabetic writing systems. Our results, together with those of Bowman and Treiman (2002), raise questions about this view as applied to 4-year-old prereaders in the United States. These children, who typically know some letter names and sounds, use this knowledge to help learn simplified spellings such as *AP* for *ape* and *MA* for *may* and to remember these spellings across at least a brief delay. Spellings that deviate from what children know about letters, such as *OM* for *ape* and *PO* for *may*, are harder for them to learn. If children relied solely on a logographic or prealphabetic approach to link print and speech, such differences should not have been found. We did not include spellings with visually distinctive letters in the present study, and so we do not know whether the children would have shown a benefit for these. Clearly, though, the children did benefit from mappings between printed and spoken words that were consistent with the English system of letter names. It is possible that children who are younger or less knowledgeable about letters than those tested here would do no better on phonetically motivated pairs than on arbitrary pairs. However, any such logographic period must be briefer than often thought.

In the present study, like that of Bowman and Treiman (2002), children showed a larger difference between phonetically motivated and arbitrary print–sound pairs when the motivated pairs had a letter name clue at the beginning (e.g., *AP* for *ape*, *LK* for *elk*) than when the motivated pairs had a letter name clue at the end (e.g., *MA* for *may*, *FL* for *fell*). This pattern thus applies to consonants, as tested in the earlier study, and vowels, as tested here. Children’s greater attention to the beginnings than the ends of words demonstrates another type of knowledge that is present even among prereaders: knowledge of the left-to-right directionality of English writing. Prereaders pay more attention to the beginning than the end letters of their own names (Treiman, Cohen, Mulqueeny, Kessler, & Schechtman, in press), and the current results suggest that the same is true for other words.

One difference between the present results and those of Bowman and Treiman (2002) is that the superiority for the phonetically motivated condition over the arbitrary condition was not statistically significant for final letter names in the previous study with consonants but was significant with the vowels tested here. This difference may arise because the letter names used in the present study are more familiar to young children than the letter names used in the earlier study. The mean proportion of correct responses for the vowel letter names used here was .70 in a large study of U.S. preschoolers (Treiman, Kessler, & Pollo, 2006), as compared to .62 for the *L*, *N*, and *R* used by Bowman and Treiman. The more familiar children are with the name of a letter, the more readily they may use this knowledge in linking printed and spoken words. That is, the vowel letters tested here may have yielded different results than the consonant letters

tested previously because of differences in familiarity, not because of intrinsic differences between vowels and consonants per se.

The prereaders in the present study performed better on phonetically motivated pairs than arbitrary pairs in both reading and spelling tasks. We saw a trend toward more benefit from alphabetically motivated associations in spelling than in reading, consistent with Frith's (1985) view that children use motivated associations in spelling before they do in reading. However, the trend was not statistically reliable. The major difference between the reading and spelling tasks was that spelling was harder. Previous comparisons between reading and spelling tasks, although hindered by a lack of comparability of the stimuli and by the fact the tasks were administered in separate experiments, have also found poorer performance in the sound-to-spelling direction (Bowman & Treiman, 2002; Treiman et al., 2001). Indeed, spelling continues to be more difficult than reading for older children than adults. The fact that the children in our study performed better on phonetically motivated pairs than arbitrary pairs in both spelling and reading tasks supports the generality of our conclusions. Children who have very limited reading skills, but who are familiar with letters, need not be limited to a logographic approach in learning about print.

The idea that familiarity with letters helps children go beyond a logographic approach to reading and spelling is supported by our correlational results. Knowledge of letter names and sounds generally correlated more highly with ability to learn phonetically motivated spelling–sound pairs than with ability to learn arbitrary pairs. Treiman et al. (2001) and Bowman and Treiman (2002) reported similar patterns of correlations. These findings suggest that, as young children gain familiarity with the

names and sounds of letters, their ability to benefit from alphabetically motivated links between spellings and sounds improves. These improvements occur even before children gain the ability to recognize common words such as *go* and *it* or to decode previously unseen words. As Rack et al. (1994) suggested, the better learning of phonetically motivated than arbitrary pairs is consistent with connectionist models of word reading. These models, as reviewed by Plaut (2005), learn mappings between orthographic and phonological units through repeated exposure to the conventional pronunciations of printed words. In future work, it will be important to compare the course of learning in children with the course of learning in specific connectionist models, using the same stimuli.

Examination of reading and spelling performance over the course of training is valuable not only for the testing of models but also for practical reasons. Specifically, looking at a child's learning over a series of trials may provide a better indication of the child's potential than looking at performance on a single trial, as researchers and educators typically do. When presented with an isolated word and asked to read or spell it, children of the age of those in this study perform quite poorly. The children tested here rarely read or spelled even the phonetically motivated words on the pretest, and they never correctly identified printed words such as *eat* and *go* on our reading screening test, even though these words include letter names. The results of our training study suggest that children could have learned the pronunciations of such letter name words with extensive practice, and more easily than they could have learned the pronunciations of words such as *is* and *who*. But children of this age learn even phonetically motivated words quite slowly, and preschoolers do not usually get the intensive training that would

be necessary for them to learn and remember words. Examining how a child responds to such training may provide an indicator of the child's potential for success in early literacy instruction, as well as shedding light on the skills the child needs to learn in order to achieve success.

In the present study, we used a rote, paired-associate training procedure to ensure comparability across conditions. We do not claim, however, that this is the best way to teach young children to read and spell words. Had the connections between the printed letters and the spoken sounds in the phonetically motivated spellings been highlighted through teaching, the superiority for the motivated condition over the arbitrary condition might have been larger than observed here. Our results suggest that a number of preschoolers have knowledge that could help them benefit from such teaching.

Several researchers have raised questions about the importance and duration of a logographic stage of literacy development for children who are exposed to languages in which the links between spellings and sounds are easier to notice or more systematic than they are in English. For example, Cardoso-Martins et al. (2002) have raised such questions for Portuguese, and Wimmer and Hummer (1990) have done the same for German. The present results suggest that the importance and duration of a logographic stage have been overestimated, as well, for children who are exposed to English. Our findings suggest that U.S. 4 year olds who cannot read any simple words have more reading-related skills than is often acknowledged. Although a complete understanding of the alphabetic system is certainly some distance away for these young children, prereaders are not always limited to making rote, logographic associations between letter strings and pronunciations.

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Appendix

Printed Stimuli and Pronunciations for Learning Tasks, With Filler Pairs Listed in
Parentheses

VC phonetically motivated condition

Set 1: AP *ape*, EL *eel*, IS *ice*, OT *oat*, (YD *wide*)

Set 2: AM *aim*, EK *EEK*, IL *aisle*, OD *owed*, (YF *wife*)

VC arbitrary condition

Set 1: OP *aim*, YL *EEK*, AS *aisle*, IT *owed*, (ED *wife*)

Set 2: OM *ape*, YK *eel*, AL *ice*, ID *oat*, (EF *wide*)

CV phonetically motivated condition

Set 1: MA *may*, KE *key*, LI *lie*, DO *doe*, (FY *fry*)

Set 2: PA *pay*, LE *Lee*, SI *sigh*, TO *toe*, (DY *dry*)

CV arbitrary condition

Set 1: MO *pay*, KY *Lee*, LA *sigh*, DI *toe*, (FE *dry*)

Set 2: PO *may*, LY *key*, SA *lie*, TI *doe*, (DE *fry*)

Table 1

Correlations Between Letter Name and Letter Sound Knowledge (Strict Scoring) and Number of Correct Responses in Different Conditions of Word Learning Task, Pooling Over Reading and Spelling Tasks

Measure	Motivated VC	Motivated CV	Arbitrary VC	Arbitrary CV
Letter Names	.53**	.47**	.30	.31*
Letter Sounds	.73**	.69**	.39*	.48**

* $p < .05$, two tailed; ** $p < .01$, two tailed

Figure Captions

Figure 1. Proportion of correct responses on reading task as a function of condition, stimulus type, and trial

Figure 2. Proportion of correct responses on spelling task as a function of condition, stimulus type, and trial

Figure 3. Total number of correct responses (of 40 possible) in learning trials of reading task as a function of condition and stimulus type; error bars represent 95% confidence intervals

Figure 4. Total number of correct responses (of 40 possible) in learning trials of spelling task as a function of condition and stimulus type; error bars represent 95% confidence intervals







