Journal of Experimental Child Psychology **79,** 56–77 (2001)
doi:10.1006/jecp.2000.2584, available online at http://www.idealibrary.com on IDEAL®

Learning a Novel Grapheme: Effects of Positional and Phonemic Context on Children's Spelling

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Two experiments explored how children who encounter a new spelling for a phoneme generalize it to novel items. Children ages 5 1/2 to 9 ($N = 123$) were taught a CVC (consonant–vowel–consonant) nonword containing a new vowel spelling in the middle position (e.g., /gaɪk/ is spelled as *giik*). They were then asked to spell other nonwords containing the vowel or to judge spellings that had supposedly been produced by younger children. Children were sensitive to position in the spelling production task, being more likely to use the novel grapheme when the vowel appeared in the middle of a CVC target than when it appeared in word-initial or word-final position. Children were not significantly more likely to use the novel grapheme when the target shared the vowel and final consonant (rime) of the training stimulus than when it shared the initial consonant and vowel. Implications for views of spelling development are discussed. © 2001 Academic Press

Key Words: spelling; spelling development; vowel spelling; rimes.

At least two processes must be mastered in order to spell an unfamiliar word (Ball & Blachman, 1988; Bradley & Bryant, 1983; Byrne & Fielding-Barnsley, 1989; Stuart & Coltheart, 1988). The first is *segmentation,* in which the spoken word is broken into phonemes. For instance, /fet/ contains the phonemes /f/, /e/, and /t/. The second process is *selection* of graphemes to represent the phonemes. The selection process is a challenge for children who are learning to spell in English because a given phoneme typically has more than one possible spelling. This is especially true for vowels. For instance, Cummings (1988) lists a number

We thank the principals and teachers of Beacon School, St. Michael School, and St. Mary's School for their participation. Thanks also to Lia Sotak for her assistance in testing the children and to Marie Cassar, Bob Calin-Jageman, Brett Kessler, and the reviewers for their constructive comments. This study was supported in part by NSF Grants SBR 94-08456 and SBR 98-07736 to Rebecca Treiman.

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0022-0965/01 $35.00

of spellings for the vowel /e/, as exemplified in *hate, paid, hay, veil, eight, break, ballet*, and *café*. A child who is trying to spell the word /fet/ may not know whether the correct spelling is *fate, fait, fayt,* or *feit,* among other possibilities. The use of *context,* or information about the vowel's position and surrounding phonemes, can help alleviate—if not totally solve—the problem of ambiguity.

There are at least two types of contextual cues that could help children predict the spellings of vowels. One cue is *positional context,* or whether a phoneme is in the initial, medial, or final position of a word or syllable. For instance, children might learn that /e/ is often spelled with the digraph *ai* in the middle of a word, as in *paid* and *bait,* but with *ay* in word-final position, as in *hay* and *play*. A second cue is *phonemic context,* or the identity of neighboring phonemes. For instance, children might learn that /e/ is often spelled as *a* followed by "silent" final *e* in *came, same,* and *tame* but as *ea* in *break* and *steak*. Kessler and Treiman (in press) have shown that positional context and phonemic context can help to specify the spellings of vowels in the monosyllabic words of English. The development of context sensitivity in learning to spell (and read) is interesting because it is revealing of both the segmentation and selection processes.

The purpose of the present study was to examine children's use of positional and phonemic context in spelling. To do this, we developed a task that models a common occurrence in the acquisition of English—encountering a new word that contains a novel phoneme-to-grapheme correspondence. Children who are already familiar with one spelling of a phoneme, say *e* for /ɛ/, may come across a word, *bread*, that contains a new grapheme. Do children pick up the new phoneme–grapheme correspondence from this experience, and do they generalize it to untaught words? In our *grapheme learning task*, children were taught a new "word" that embodied a novel spelling for a vowel phoneme. For example, children learned that /gaɪk/ was spelled as *giik*. This *training stimulus* includes a novel spelling of /aɪ/, *ii*. The novel grapheme was in a particular position (the middle position of a CVC syllable) and a particular phonemic context (after /g/ and before /k/). Once children were familiar with the spelling of the training stimulus, they were presented with new syllables containing /aɪ/. These syllables are called the *targets*.

We can gain some insight into what children learn by examining their willingness to extend the novel spelling to various types of targets. Suppose that children learned to spell the training stimulus *giik* as an unanalyzed whole, not linking the components of the printed stimulus (the letters and letter groups) to the components of the spoken syllable (the sound units). In this case, children should be unlikely to use the novel grapheme *ii* when spelling other syllables containing /aɪ/. Some generalization would be expected if children segmented the training stimulus into smaller units. If this segmentation process resulted in a context-free phoneme–grapheme correspondence linking /aɪ/ to *ii*, then the position of /aɪ/ and the phonemes surrounding /aɪ/ in the target should not affect children's willingness to generalize. If context plays a role, however, children should be more likely to extend the *ii* spelling to targets that are more similar to the training stimulus than to targets that are less similar. Similarity may be measured in terms of positional context (initial, medial, or final position of vowel), phonemic context (whether the phonemes surrounding /aɪ/ are the same as in the training stimulus), or both.

Evidence from both naturalistic and experimental studies suggests that children are sensitive to positional context in the early phases of learning to spell. Treiman (1993) analyzed 5617 spellings that were generated by 43 first-grade children in their classwork over the course of a school year. She found that word position influenced the children's spelling of both vowel and consonant phonemes. For instance, children tended to use the vowel digraphs *ay* and *ey* at the ends of words and *ai* and *ei* in the middles. As another example, children were more likely to use consonant spellings such as *ll* and *ck* in the middles and at the ends of words than at the beginnings. These patterns emerged as early as the first half of first grade, suggesting that children learn about the effects of position on spelling from a young age.

Experimental evidence supports the idea that, at least in the case of consonant doublets, children are sensitive to within-word position from an early age. When Cassar and Treiman (1997) asked children to pick the "better" of two spellings such as *ppes* and *pess*, they found that performance significantly exceeded the level expected by chance as early as the second half of kindergarten. Apparently, the children had begun to realize that final consonants sometimes double (e.g., *mess* and *ball*) but that initial consonants rarely do.

Other research suggests that a sensitivity to phonemic context also emerges early in the course of spelling development. Goswami (1988, Experiment 1) conducted a study with British children (mean age 6 years, 10 months) to determine what kind of positional context is most important when children use information from a known word to help spell an unfamiliar word. To control for previous experience, children were pretested on their ability to spell a set of words. The children were then tested on the same target words when each was presented along with a clue word. For example, *peak* was presented together with the clue word *beak*, which the experimenter read for the child. The largest improvement over pretest scores occurred when a target shared its vowel and final consonant with the clue word, as with *peak* and *beak*. There was significant but smaller improvement for items that shared initial consonants and vowels with their clue words, as when *bean* was presented with the clue word *beak*. No significant improvement occurred when the target word was unrelated to the clue word, as when *rain* was presented with clue word *beak*. Goswami's results suggest that beginners pay attention to phonemic context when they spell vowels. The results further suggest that the letters following the vowel have a greater impact than the letters preceding the vowel.

Goswami has found the same pattern of results in similarly designed studies of reading. For instance, the young readers studied by Goswami (1986) derived more benefit from clues that shared vowels and final consonants with the target words than from clues that shared initial consonants and vowels with the targets.

However, Bowey, Vaughan, and Hansen (1998) questioned this conclusion with respect to the clue word task; see Goswami (1999) and Bowey (1999) for further discussion.

Goswami's findings are consistent with the idea that syllables have a hierarchical internal structure and that this structure influences the development of segmentation, spelling, and reading (see Bernstein & Treiman, in press; Kessler & Treiman, in press; Treiman, 1989, 1992; Treiman, Mullennix, Bijeljac-Babic, & Richmond-Welty, 1995). According to the hierarchical view, spoken syllables consist of two primary units, an *onset* and a *rime*. The onset is the initial consonant or consonant cluster and the rime is the vowel and any following consonants. The onset and the rime are themselves composed of smaller units. In this hierarchical view, children learn to segment the syllable into onset and rime before they learn to subdivide these units. Onsets and rimes play a role in phonological organization even after children have achieved a complete phonemic analysis of the syllable, with words that share rimes being perceived as particularly similar. Rimes may be involved in the selection process as well as the segmentation process. As Kessler and Treiman (in press) have shown, the spellings of English vowels tend to be more affected by the consonants that follow them than by the consonants that precede them. If young children are sensitive to this pattern, they may spell the rime of a new word similarly to the rime of a known word.

Although Goswami (1988) found a special effect of rimes in young children's spelling, Nation and Hulme (1996) did not. In their first experiment, Nation and Hulme tested British schoolchildren with a mean age of 7 years, 1 month. To control for previous experience, the children were pretested on their ability to spell the target words. On a later day, each target word was presented along with a clue word and children were asked to spell the target words again. The children made analogies to the same extent regardless of whether the target word and the clue word shared only the vowel (*team* with the clue word *beat*), the first consonant plus the vowel (*bead* with *beat*), or the final consonant plus the vowel (*meat* with *beat*). The pattern of results was the same for below-average, average, and above-average spellers. Thus, a hint about the spelling of the vowel improved performance regardless of the surrounding phonemes.

Nation and Hulme (1996) carried out a second experiment to further explore whether phoneme context influences spelling. This experiment used a priming task in order to make the clue–target pairings less obvious to the children. In this study, real-word primes and nonword targets were mixed together. The participants, who were similar in age and amount of schooling to those in Nation and Hulme's first experiment, spelled only the nonwords. In the experimental condition, each nonword appeared after a phonologically similar word (e.g., *came*–/pem/). In the control condition, the nonwords followed phonologically unrelated words (e.g., *does*–/pem/). Nation and Hulme counted the number of times that children used the spelling pattern of the prime word to spell the shared portion of the nonword. Such spellings were significantly more frequent in the experimental condition than the control condition. Importantly, the prime had similar effects regardless of whether the vowel (e.g., /neb/ following *came*), the rime (e.g., /pem/ following *came*), or the initial consonant and vowel (e.g., /keb/ following *came*) were shared. As in Nation and Hulme's first experiment, a hint about vowel spelling was enough to change performance, regardless of variations in phonemic context.

The present research was motivated, in part, by the discrepant results of Goswami (1988) and Nation and Hulme (1996). We used the novel grapheme learning task described above to reexamine the question of whether young children show a rime advantage in spelling. We also examined children's sensitivity to positional context within the same experiments.

EXPERIMENT 1

We developed a grapheme learning task in which children were taught a CVC syllable whose spelling included a novel vowel grapheme. For instance, children learned that a funny make-believe animal was called a /gaɪk/ and that its name was spelled as *giik*. The use of novel phoneme-to-grapheme correspondences (e.g., /aɪ/ = *ii*) controls for contributions of prior learning in that previous experience would not lead children to use these particular graphemes. Children were tested in two different tasks. In a production task, children were asked to spell the names of friends of the /gaɪk/, other make-believe animals whose names contained the same vowel phoneme in different contexts. In a recognition task, children chose the "better" of two spellings that were supposedly generated by a younger child.

We examined two types of contextual cues in both the production and recognition tasks. The first type of cue was the position of the vowel within the word. Do children express the new vowel spelling more often when it appears in the same position in the target as it did in the training stimulus? The second type of cue was the identity of the neighboring phonemes. We compared children's use of the new vowel spelling when (a) the vowel preceded the same consonant as it did in the training stimulus, (b) the vowel followed the same consonant as it did in the training stimulus, and (c) no neighboring consonants were shared. If shared phonemes beyond the vowel are important, then children should be more likely to use the novel grapheme when a consonant is shared (cases a and b) than when no consonant is shared (case c). If rimes play a special role in spelling, then children should be most likely to use the new grapheme when the final consonant is shared (case a). We tested children in kindergarten through second grade in order to examine the development of sensitivity to positional and phonemic context.

Method

Participants. Sixty-two children from a school located in a middle-class suburb of Detroit contributed data. All of the children were native speakers of English. Twenty kindergartners, 7 boys and 13 girls, were tested near the end of the school year. They ranged in age from 5,6 to 6,9 (*M* = 6,2). One additional kindergartner dropped out of the study due to lack of interest, another was replaced due to inability to perform the spelling production task, and 7 others were replaced because of low levels of letter knowledge, as explained below. Twenty-one first-graders, 11 boys and 10 girls, were tested near the end of the school year. They ranged in age from 6,0 to 7,6 (*M* = 6,6). Two additional first-graders dropped out of the study due to lack of interest and one was eliminated because of failure to follow directions. Twenty-one second-graders, 9 boys and 12 girls, were tested near the beginning of the school year. They ranged in age from 7,1 to 9,0 (*M* = 7,9). No second-graders were dropped from the study.

Materials. The training stimuli were two CVC nonwords, /gaɪk/ and /heb/, which were presented in separate sessions. Children were taught that /gaɪk/ is spelled as *giik* and that /heb/ is spelled as *haab*. These spellings contained phoneme–grapheme correspondences that were new to the children, in that /aɪ/ is never spelled as *ii* and /e/ is never spelled as *aa* in English (Cummings, 1988). Moreover, *ii* and *aa* are rare in children's own spellings (Treiman, 1993) and in conventional English. For each training stimulus, there were seven nonword targets that shared its vowel. These targets, which are listed in Table 1, varied in their relationship to the training stimulus.

Three of the targets had a CVC structure. For these targets, the shared vowel was in the middle of the stimulus, the same position as in the training stimulus. The CVC target shared the initial consonant as well as the vowel, the CVC target shared just the vowel, and the CVC target shared the final consonant as well as the vowel (i.e., the phonological rime). In the other four targets—the non-CVC targets—the shared vowel was in a different position than in the training stimulus. The vowel was in the initial position in the VC and VCC items. The vowel was in the final position in the CV and CCV items.

For the spelling production task, the children used a set of 4-cm high uppercase plastic letters to spell the items on a board. The set included only the letters necessary to spell all of the items, plus *e* (this could be used for a final *e* spelling such as *gite* for /gaɪt/). Thus, in the /gaɪk/ condition, children were given the letters *b*, *e*, *f*, *g*, *i*, *k*, *m*, *n*, *p*, *r*, *t*, *v*, and *z* and the special double vowel *ii* (two *i*s glued together). In the /heb/ condition, children were given the letters *a*, *b*, *d*, *e*, *f*, *h*, *k*, *l*, *n*, *r*, *s*, *t*, *v*, and *z* and the double vowel *aa*.[1]

For the spelling recognition task, each item from the production task was presented with a choice between the taught double-vowel spelling and the corresponding single vowel (e.g., *giit* vs *git*). Children selected the spelling that they thought was "better." Filler items were also included. The fillers were monosyllabic animal names whose spoken forms were intended to be familiar to children. On each filler trial, children chose between the correct spelling of the name and a grossly incorrect spelling. The filler items and the incorrect alternatives are listed in the Appendix.

[1]The letter *y* was not used because it is more likely to serve as a vowel in word-final position than in word-initial position. Had it been used, the number of plausible spellings for /aɪ/ would have differed across medial and final positions.

TABLE 1
Stimuli Used in Experiment 1

Training stimulus		Target type						
		CVC			non-CVC			
Phonological form	Spelling	CVC	CVC	CVC	VC	VCC	CV	CCV
/gaɪk/	giik	/gaɪt/	/zaɪm/	/vaɪk/	/aɪp/	/aɪnt/	/faɪ/	/braɪ/
/heb/	haab	/hev/	/nek/	/veb/	/ef/	/est/	/ze/	/ble/

Procedure. Children were tested individually in a quiet location at their school. Each child participated in two sessions, one with /gaɪk/ and one with /heb/. The order of the sessions was balanced across children. The same procedure was used in both sessions, and each lasted about 20 min.

At the beginning of each session, we assessed children's knowledge of the names and sounds of the letters that they would be given to use in spelling the items. The letters were placed in two rows, in a random order, and children were asked to say the name of each letter and then the sound the letter makes. A practice letter that did not appear in the test was used to demonstrate the task. Any child who made more than a total of five errors in letter names and/or sounds across the two test sessions was dropped from the experiment.

The experimenter then showed the child a line drawing of a make-believe animal. The experimenter said the training syllable aloud and explained that it was the name of the animal. The child and the experimenter repeated the name together nine times. The child then repeated the name alone three times. After this, the experimenter selected the appropriate plastic letters and spelled the training syllable on the board. The child pointed to the letters and said their names. The letters were then hidden from view and the child was asked to say the letters that were needed to spell the animal's name. The child was then given the two consonant letters and the double-vowel letter to place on the board in the correct order. In the final part of the training sequence, the letters needed to spell the animal's name were mixed with the other letters and the child was asked to spell the animal's name. Each of these tasks was repeated if a child made errors. No child required more than two repetitions.

The final phase of the experiment consisted of the production and recognition tasks, the order of which was balanced both between and within participants. In the production task, children were told that they would be asked to spell the names of various make-believe animals. The first item that the children were asked to spell was always the training stimulus. The children were shown the appropriate drawing and were prompted with, "Here's one that should be easy for you." This was followed by nine more trials, the order of which was randomized. In seven of these trials, a target was presented together with a line drawing of a novel animal. In the other two trials, the training stimulus and its associated picture were presented again. On each trial, the experimenter showed the child a drawing of an animal and said its name, the nonsense syllable, three times. The child repeated the name. This sequence was repeated if the child mispronounced the name. Following a correct pronunciation of the name, the child was asked to spell the animal's name using the letters that were provided. A card containing a picture of the training animal and the spelling of its name was left out as a hint during the production task. The child was reminded of the presence of the hint every five trials.

In the recognition task, participants were told that two younger children who were just learning to spell had tried to spell the names of some real and make-believe animals. On each trial, the experimenter presented a card containing a line drawing of an animal and two spellings of its name. The experimenter said the animal's name aloud three times, and the child repeated it. This sequence was repeated if the child mispronounced the name. Following a correct pronunciation of the name, the child was asked to point to the spelling that he or she thought was "better."

The recognition task began with presentation of two of the filler items. This was followed by the stimuli listed in Table 1 and the remaining filler items, which were randomly intermixed. A card containing a picture of the training animal along with the spelling of its name was left out as a hint during the recognition task. Children were reminded every five trials that they could use the hint.

Results

Responses in the production task were scored as *double vowel* (e.g., /gaɪt/ spelled as *giit*), *single vowel* (*git*), *final e* (*gite*), or *other* (e.g., *gt* and *gte*). Responses in the recognition task were scored as *double vowel* or *single vowel*. We were primarily interested in how often children used the novel double-vowel spellings that were included in the training stimuli. Because these spellings are so uncommon in children's own spelling and in conventional English, any substantial use of *ii* and *aa* must reflect the children's experience with the training stimuli.

Item analyses were performed to determine if children performed similarly on the sets with the two different training items, /gaɪk/ and /heb/. In separate analyses of the production and recognition tasks, a Pearson chi-square test for independence was used to determine whether the total incidence of double-vowel spellings across target types (CVC, CVC, CVC, CV, VC, CCV, VCC) was independent of the training item. In the production task, there was no significant difference between the two training items, $\chi^2(6) = 3.51$, $p > .05$. Three additional chi-square tests confirmed that this was true regardless of grade level. In the recognition test, also, the incidence of double-vowel spellings did not differ for the two training items, $\chi^2(6) = 0.96$, $p > .05$. Again, this held true regardless of grade level. We thus pooled the results across the two training items. Analyses of variance (ANOVAs) were then performed to examine the effects of context and grade on the use of double-vowel spellings.

Table 2 shows the percentage of double-vowel spellings for each of the seven types of targets in the production and recognition tasks. In the table and the associated analyses, the percentage of double-vowel spellings in the production task was calculated relative to the sum of double-vowel, single-vowel, and final-*e* responses. Analyses using the total number of trials as the baseline showed similar results to those reported here.

Production task. In the analysis of the production task data, grade (kindergarten, first, and second) served as a between-subjects factor and target type (CVC, CVC, CVC, CV, VC, CCV, VCC) served as a within-subjects factor. Double-vowel spellings significantly increased with grade, $F(2, 59) = 15.099$, $p < .001$, $MSE = 6348$. They were most frequent for second-graders ($M = 70\%$, $SD = 26$), less frequent for first-graders (M = 45%, SD = 35), and least frequent for kindergartners ($M = 18\%$, $SD = 23$). There were reliable differences in the percentage of double-vowel spellings across the seven types of targets, $F(6, 354) = 4.284$, $p < .001$, $MSE = 730$. These effects can be seen by examining the averages across grade that are presented in Table 2, as the interaction of target type and grade was not significant ($F < 1$). The effects of context were examined in a series of planned comparisons.

The first comparison examined the effect of varying the position of the vowel by comparing the CVC target to the average of the four non-CVC targets. The four non-CVC targets are comparable to the CVC target in that they share the vowel but none of the consonants of the training stimulus. There were significantly more double-vowel spellings for the CVC targets ($M = 54\%$, $SD = 46$) than for the four non-CVC targets combined ($M = 43\%$, $SD = 43$), $F(1, 59) = 7.452$, $p < .01$, $MSE = 956$.

TABLE 2
Percentage of Double-Vowel Spellings in Experiment 1 (Standard Deviations in Parentheses)

	Target type						
	CVC			non-CVC			
Grade level	CVC	CVC	CVC	VC	VCC	CV	CCV
	(e.g., /gaɪt/)	(e.g., /zaɪm/)	(e.g., /vaɪk/)	(e.g., /aɪp/)	(e.g., /aɪnt/)	(e.g., /faɪ/)	(e.g., /braɪ/)
Production Task							
Kindergarten	40 (45)	30 (44)	20 (38)	25 (41)	8 (24)	20 (41)	15 (37)
First grade	57 (46)	48 (43)	57 (46)	36 (39)	43 (40)	43 (43)	45 (44)
Second grade	83 (33)	83 (33)	71 (37)	67 (37)	69 (37)	74 (34)	71 (34)
Average	60 (44)	54 (46)	50 (45)	43 (42)	40 (42)	46 (45)	44 (44)
Recognition task							
Kindergarten	53 (44)	55 (39)	70 (41)	68 (37)	43 (37)	63 (39)	55 (43)
First grade	76 (30)	62 (35)	79 (30)	62 (27)	48 (37)	76 (30)	52 (37)
Second grade	83 (33)	74 (41)	79 (30)	79 (34)	64 (39)	83 (29)	76 (37)
Average	71 (38)	64 (39)	76 (34)	69 (33)	52 (38)	74 (34)	61 (40)

The second set of comparisons focused on differences within stimuli with a CVC structure. Syllables that shared their initial consonant and vowel with the training stimulus, the CVC stimuli ($M = 60\%$, $SD = 44$), elicited significantly more double-vowel spellings than stimuli that shared their rimes with the training stimulus, the CVC items ($M = 50\%$, $SD = 45$), $F(1, 59) = 4.284$, $p < .05$, $MSE = 1636$. However, syllables that shared two phonemes with the training stimulus, the average of the CVC and CVC items ($M = 55\%$, $SD = 45$), did not elicit significantly more double-vowel spellings than syllables that shared just their vowel with the training stimulus, the CVC stimuli ($M = 54\%$, $SD = 46$), $F < 1$.

The third set of comparisons focused on differences among targets with non-CVC structures. Double-vowel spellings were not reliably affected by whether a syllable had a single consonant or a cluster. Nor were they significantly affected by whether the vowel appeared in the initial position or the final position.

Two additional analyses were performed. In the first, we asked whether grade and/or target type affected the incidence of final-*e* spellings. There was a significant main effect of grade, $F(2, 59) = 4.456$, $p < .05$, $MSE = 507$. There were significantly more final-*e* spellings for second-grade students ($M = 7\%$, $SD = 14$) than for first-graders ($M = 1\%$, $SD = 2$) or kindergartners ($M = 0\%$, $SD = 0$). The other significant effect was that of target type, $F(6, 354) = 2.281$, $p < .05$, $MSE = 78$. The same comparisons used for the preceding analyses were carried out to explore the effect of target type. The only significant effect was that children tended to use final-*e* spellings more often for non-CVC items without consonant clusters ($M = 5\%$, $SD = 15$) than for non-CVC items with consonant clusters ($M = 1\%$, $SD = 8$), $F(1, 59) = 5.154$, $p < .05$, $MSE = 153$.

Another subsidiary analysis focused on “other” spellings. The percentage of “other” spellings relative to all spellings was analyzed using the factors of grade and target type. The only significant effect was that of grade, $F(2, 59) = 19.572$, $p < .001$, $MSE = 2252$. “Other” spellings were most frequent for kindergarten students ($M = 37\%$, $SD = 27$), less frequent for first-grade students ($M = 9\%$, $SD = 15$), and least frequent for second-grade students ($M = 4\%$, $SD = 7$).

Recognition task. The recognition task data were analyzed using the same factors as the production task data. Double-vowel spellings significantly increased with grade, $F(2, 59) = 3.342$, $p < .05$, $MSE = 3980$. They were most frequent for second-graders ($M = 77\%$, $SD = 27$), less frequent for first-graders ($M = 65\%$, SD = 18), and least frequent for kindergartners ($M = 58\%$, $SD = 25$). The effects of context are averaged across the three grade levels in the bottom row of Table 2 because the interaction of target type and grade was not significant ($F < 1$). There were reliable differences in the percentage of double-vowel spellings across the seven types of targets, $F(6, 354) = 5.241$, $p < .001$, $MSE = 26607$. The effects were examined in the same series of planned comparisons that was used for the production data.

First, we examined the effect of varying the position of the vowel by comparing the CVC target to the average of the four non-CVC targets. Double-vowel spellings were equally common in stimuli with a CVC structure ($M = 64\%$, $SD =$

39) and stimuli with a non-CVC structure (*M* = 64%, *SD* = 28), $F < 1$. The second set of comparisons focused on differences within the CVC stimuli. Those that shared two phonemes with the training stimulus, the CVC and CVC items (*M* = 73%, *SD* = 36), yielded marginally more double-vowel spellings than those that shared one phoneme with the training stimulus, the CVC item (*M* = 64%, *SD* = 39), $F(1, 59) = 3.451$, $p = .068$, *MSE* = 1663. Items that shared their rime with the training stimulus, the CVC items (*M* = 76%, *SD* = 34), elicited slightly more double-vowel spellings than items that shared their initial phoneme and vowel with the training stimulus, the CVC items (*M* = 71%, *SD* = 38). However, the difference was not significant, $F < 1$. The third set of comparisons focused on differences among targets with non-CVC structures. Double-vowel spellings were significantly more common for syllables that had a single consonant, the average of the CV and VC items (*M* = 72%, *SD* = 33), than for syllables that had a consonant cluster, the average of the CCV and VCC items (*M* = 56%, *SD* = 39), $F(1, 59) = 14.408$, $p < .001$, *MSE* = 1012. Also, double-vowel spellings were significantly more common when the vowel appeared in the final position, the average of the CV and CCV items (*M* = 68%, *SD* = 37), than when the vowel appeared in the initial position, the average of the VC and VCC items (*M* = 60%, *SD* = 36), $F(1, 59) = 3.882$, $p < .05$, *MSE* = 828. Finally, the children were very accurate at choosing the correct spellings of the filler items in the recognition task. Only two errors were made, both by kindergartners.

Discussion

The grapheme learning task allows us to ask what children learn when they encounter a single “word” that contains a novel grapheme, such as *gaik* for /gaɪk/. Children appeared to learn not only the spelling of the item as a whole but also something about the novel grapheme within it. As a result, children sometimes used the *ii* grapheme for other words that contained /aɪ/. In both the production and recognition tasks, older children were more likely than younger children to generalize the novel double-vowel spelling to new items. This effect may reflect the fact that older children are more analytic than younger children and less likely to memorize the training stimulus as a whole. Moreover, the single-vowel spellings *i* for /aɪ/ and *a* for /e/ may have been especially attractive to the younger children because the name of the letter matches the phoneme being spelled and because the grapheme contains a single letter. Older children may be more willing to entertain a new spelling such as *ii* for /aɪ because they have learned that the spellings of vowels cannot always be predicted on the basis of letter names. Also, they know that vowels are sometimes represented with digraphs and that most English phonemes have more than one possible spelling.

The pattern of performance on the various types of stimuli differed somewhat in the production and recognition tasks. The results of the production task suggest that children begin to draw conclusions about the position in which the novel grapheme may be used from their experience with the training stimulus. Thus, children were more likely to spell /aɪ/ as *ii* when /aɪ/ occurred in a CVC syllable that shared no consonants with the training stimulus than when /aɪ/ occurred in a non-CVC syllable that shared no consonants with the training stimulus. This finding suggests that the children preferred to use the *ii* grapheme in a particular position—the middle of a CVC syllable. Sensitivity to positional context in production was seen across the entire age range tested here, kindergarten through second grade. The results are consistent with other evidence that children learn about the positions in which graphemes may occur from an early age (Cassar & Treiman, 1997; Treiman, 1993; see also Thompson, Cottrell, & Fletcher-Flinn, 1996).

Although the results of the production task revealed a sensitivity to positional context, we did not find the pattern of sensitivity to phonemic context that would be predicted based on Goswami's (1988) results. Specifically, sharing a vowel plus a final consonant (e.g., /vaɪk/ with /gaɪk/) did not lead to greater use of the novel grapheme than sharing an initial consonant plus a vowel (e.g., /gaɪt/ with /gaɪk/). Indeed, there was a significant difference in the opposite direction. There was thus no evidence for a rime superiority effect in production.

In the recognition task, like the production task, there was no significant rime superiority. The results showed a small numerical superiority for shared vowel + final consonant units over shared initial consonant + vowel units, but this superiority was not significant. Thus, neither the production task nor the recognition task yielded a significant rime advantage.

In the recognition task, unlike the production task, we did not find evidence that children were sensitive to the within-word position of the novel grapheme. Specifically, children were no more likely to use the novel double-vowel spelling in CVC syllables that shared no consonants with the training stimulus than in non-CVC syllables that shared no consonants with the training stimulus. This result, together with the other results of the recognition task, may reflect children's preference for spellings that differed by fewer letters from the training stimulus over spellings that differed by more letters from the training stimulus. Thus, the CVC, CVC, CV, and VC items with double-letter vowels all contained just one letter that the training stimulus did not, and these items were picked relatively often. The CVC, VCC, and CCV items with double- letter vowels all contained two letters that the training stimulus did not, and these items were picked less often.

The differences between the production and recognition tasks suggest that judgments in the latter task may not be a good measure of spelling. The training stimulus was visible during the entire task, allowing children to compare the choices that they were offered to the training stimulus. Indeed, we sometimes observed the children making such a comparison overtly. Thus, the results of the recognition task may tell us more about children's judgments of orthographic similarity than about their knowledge of links between phonology and orthography. In Experiment 2, therefore, we used only the production task.

The absence of a rime superiority effect in Experiment 1 is surprising in light of Goswami's (1988) findings, although it is consistent with the findings of Nation and Hulme (1996). In Experiment 2, we tripled the number of stimuli per condition in order to increase the sensitivity of the paradigm. The design of the experiment was otherwise similar to that of Experiment 1. However, Experiment 2 employed only the production task for the reasons mentioned above.

EXPERIMENT 2

Method

Participants. Sixty-one children from two schools in middle-class neighborhoods in the Detroit area contributed data. All of the children were native speakers of English and were tested near the end of the school year. Eighteen kindergartners, 9 boys and 9 girls, ranged in age from 5,8 to 7,10 (M = 6,3). Nine additional kindergartners were dropped from the study because they were unable to do the spelling production task, and 11 others were replaced due to low levels of letter knowledge. Twenty-one first-graders, 12 boys and 9 girls, ranged in age from 5,6 to 7,10 (M = 7,2). One first-grade student was replaced due to illness and one due to poor performance on the test of letter knowledge. Twenty-two second-graders, 11 boys and 11 girls, ranged in age from 7,5 to 9,3 (M = 8,0). No second-grade children were dropped from the study.

Materials. The training stimuli were the same two CVC nonwords used in Experiment 1. These were presented in separate test sessions. Children were taught that /gaɪk/ is spelled as *giik* and that /heb/ is spelled as *haab*. They were then tested on their willingness to generalize the novel vowel spelling to seven types of nonword targets. Three targets of each type were generated and are listed in Table 3. Each of the targets was read aloud by the experimenter, and children used plastic letters and a spelling board as in Experiment 1. The children were given only the letters necessary to spell all the items plus *e*. Thus, in the /gaɪk/ condition, children were given the letters *b, d, e, f, g, i, k, l, m, n, p, r, s, t, v*, and *z* and the special double vowel *ii*, formed by gluing two letters together. In the /heb/ condition, children could use *a, b, d, e, f, g, h, k, l, m, n, r, s, t, v, z,* and the double vowel *aa*.

Procedure. All children were tested individually in a quiet location. As in Experiment 1, there were 2 days of testing for each child, one with each of the nonsense animals /gaɪk/ and /heb/. The order of these conditions was balanced across subjects. The procedures used in the training phase of the experiment and the production test were the same as those in Experiment 1, with the exceptions indicated below.

The stimuli were presented in a random order along with line drawings of the funny animals. Trials were presented in 3 blocks of 8 items each. Each block began with the training stimulus and included one trial for each type of target. The targets were presented in a different random order for each child. The drawings were also shuffled so that, with the exception of the training items, none of the nonsense words was consistently paired with a particular picture across children.

As in Experiment 1, we first assessed children's knowledge of the names and sounds of the letters that they would be given to use in spelling the items. Any

TABLE 3
Stimuli Used in Experiment 2

Training stimulus		Target type						
		CVC			non-CVC			
Phonological form	Spelling	CVC	CVC	CVC	VC	VCC	CV	CCV
/gɑɪk/	giik	/gaɪt/	/zaɪm/	/vaɪk/	/aɪp/	/aɪnt/	/faɪ/	/braɪ/
		/gaɪp/	/saɪp/	/faɪk/	/aɪt/	/aɪpt/	/kaɪ/	/glaɪ/
		/gaɪb/	/raɪb/	/zaɪk/	/aɪg/	/aɪnd/	/zaɪ/	/graɪ/
/heb/	haab	/hev/	/nek/	/veb/	/ef/	/est/	/ze/	/ble/
		/hef/	/ged/	/zeb/	/en/	/end/	/ve/	/dre/
		/heg/	/zem/	/leb/	/eg/	/eft/	/te/	/gle/

child who made more than a total of four errors in letter names and/or sounds across the two test sessions was dropped from the experiment.

Results

Responses were scored as in experiment 1 into the categories of double vowel, single vowel, final *e*, or other. Table 4 shows the percentage of double-vowel spellings for each type of target. As in Experiment 1, the percentage of double-vowel spellings was calculated relative to a baseline of single, double, and final-*e* responses. The pattern and magnitude of effects were not changed in an analysis in which all responses served as the baseline. The results presented in Table 4 are averaged across blocks of trials and days of testing. Preliminary analyses confirmed that block and day did not reliably influence the use of double-vowel spellings. Also, there were also no significant differences between the sets based on the two nonwords. None of these factors—block, day, or nonword—significantly interacted with the factors of grade and target type, and so they are not discussed further.

The percentage of double-vowel spellings was subjected to an ANOVA using the between-subjects factor of grade (kindergarten, first, and second) and the within-subject factor of target type (CVC, CVC, CVC, CV, VC, CCV, and *V*CC). Double-vowel spellings tended to be more frequent among second-graders (M = 52%, SD = 37) than among first-graders (M = 45%, SD = 36) or kindergartners (M = 41%, SD = 34). However, the main effect of grade level was not significant ($F < 1$). Crucially, there were significant differences in the percentage of double-vowel spellings across the seven types of targets, $F(6, 348) = 13.285$, $p < .001$, $MSE = 355$. The effect of target type was identical across grades in that the interaction of target type and grade was not significant ($F < 1$). The main effect of target type, averaged across grade levels, was explored with the same planned comparisons that were used in Experiment 1.

The first comparison examined the effect of varying the position of the vowel by comparing the CVC target to the four non-CVC targets. There were significantly more double-vowel spellings in the CVC items (M = 48%, SD = 39) than

TABLE 4
Percentage of Double-Vowel Spellings in Experiment 2 (Standard Deviations in Parentheses)

	Target type						
	CVC			non-CVC			
Grade level	CVC (e.g., /gaɪt/)	CVC (e.g., /zaɪm/)	CVC (e.g., /vaɪk/)	VC (e.g., /aɪp/)	VCC (e.g., /aɪnt/)	CV (e.g., /faɪ/)	CCV (e.g., /braɪ/)
Kindergarten	51 (29)	44 (39)	54 (42)	30 (36)	32 (36)	39 (40)	37 (42)
First grade	53 (35)	48 (41)	55 (36)	33 (40)	33 (40)	45 (45)	46 (42)
Second grade	60 (39)	50 (40)	66 (37)	42 (44)	42 (44)	54 (44)	49 (41)
Average	55 (35)	48 (39)	59 (38)	35 (40)	36 (39)	46 (43)	45 (41)

in the non-CVC items ($M = 40\%$, $SD = 41$), $F(1, 58) = 9.708$, $p < .01$, $MSE = 329$. The second set of comparisons focused on differences among the CVC stimuli. Syllables that shared just their vowel with the target, the CVC stimuli ($M = 48\%$, $SD = 39$) elicited significantly fewer double-vowel spellings than syllables that shared both a vowel and a consonant, the average of the CVC and CVC items ($M = 57\%$, $SD = 36$), $F(1, 58) = 15.817$, $p < .001$, $MSE = 322$. Syllables that shared their rime with the training stimulus, the CVC items ($M = 59\%$, $SD = 38$), elicited slightly but not significantly more double-vowel spellings than syllables that shared their initial consonant and vowel with the training stimulus, the CVC items ($M = 55\%$, $SD = 35$), $F(1, 58) = 1.274$, $p = .264$, $MSE = 634$. The third set of comparisons focused on differences among targets with non-CVC structures. Children generated significantly fewer double-vowel spellings for items that began with vowels, the VC and VCC targets ($M = 36\%$, $SD = 40$) than for items that ended with vowels, the CV and CCV targets ($M = 45\%$, $SD = 42$), $F(1, 58) = 10.485$, $p < .01$, $MSE = 552$. Double-vowel spellings were not significantly affected by whether a syllable had a single consonant or a cluster consonant.

A subsidiary analysis was carried out to determine whether there were effects of grade and/or target type on the incidence of final *e* spellings. A main effect of grade was found, $F(2, 58) = 5.082$, $p < .01$, $MSE = 3758$. There were significantly more final-*e* spellings for second-grade students ($M = 28\%$, $SD = 31$) than for first-graders ($M = 10\%$, $SD = 18$) and kindergartners ($M = 6\%$, $SD = 16$). Also, there was a significant effect of target type, $F(6, 348) = 3.912$, $p < .001$, $MSE = 198$. The planned comparisons showed that final-*e* spellings were significantly more frequent for the VC and CV items ($M = 20\%$, $SD = 32$) than for the VCC and CCV items ($M = 14\%$, $SD = 26$), $F(1, 58) = 9.802$, $p < .05$, $MSE = 196$.

Analyses of “other” spellings showed a main effect of target type, $F(6, 348) = 2.384$, $p < .05$, $MSE = 102$, and an interaction of grade and target type, $F(12, 348) = 2.467$, $p < .01$, $MSE = 102$. The simple effect of target type was not significant for either first-grade or second-grade students, but was significant for kindergartners. These children tended to generate fewer “other” spellings for the shorter items, the CV and VC items (*M* = 4%, *SD* = 12), than for the longer items, the CVC, CVC, CVC, CCV, and VCC items (*M* = 12%, *SD* = 21).

A final analysis examined the possibility that real-word outcomes would influence children's spelling choices for the nonwords. For instance, a child who might otherwise tend to spell /aɪ/ with *i* in initial position might not do so in /aɪt/ because this would yield *it*, a real word with a different pronunciation. This would mean that /aɪt/ has one fewer possible spelling than the other two VC neighbors of /gaɪk/, /aɪp/ and /aɪg/, for which none of the spellings of interest results in a word. A total of 12 nonwords could be spelled to form either real or slang words. To determine whether children tended to avoid real-word spellings, we compared the percentage of times each of the 12 items was spelled as a real word (e.g., /aɪt/ = *it*) with the percentage of times other items with the same structure were spelled the same way (e.g., /aɪp/ = *ip* and /aɪg/ = *ig*). Averaged across the three grade levels, the frequency of a spelling pattern when it resulted in a real word (*M* = 30%, *SD* = 13) was not significantly lower than the frequency of the same spelling pattern in items when it resulted in a nonword (*M* = 37%, *SD* = 11), $z = -1.461$ by a sign test, $p > .05$. When each grade level was examined separately, only the second-graders showed a tendency to avoid real-word spellings (14% vs 21%), $z = -2.53$ by a sign test, $p < .05$.

Discussion

In Experiment 2, we used the production task of Experiment 1 with a larger set of stimuli to examine the effects of positional and phonemic context on spelling. The effect of positional context found in Experiment 1 was replicated here. Children who were taught a cvc nonword that included a novel grapheme in the middle position (e.g., *giik* for /gaɪk/) produced this novel grapheme more often when the vowel appeared in the middle position of a CVC syllable than when it appeared at the beginning of a VC(C) syllable or the end of a (C)CV syllable. Thus, the phonological structure of the training stimulus and the position of the novel grapheme in that structure affected children's willingness to extend the newly learned grapheme to other items. The kindergartners in this study showed a sensitivity to positional context that was comparable to that of second-graders, pointing to the early emergence of positional sensitivity. We should note, however, that kindergartners with lower levels of letter knowledge and spelling skill were not included in the present sample.

If the target syllable shared the phonological structure of the training stimulus, did the number and position of shared phonemes beyond the vowel affect the children's willingness to use the novel vowel grapheme? The children in Experiment 2 used the novel vowel grapheme significantly more often when a new CVC shared both a consonant and vowel with the training stimulus than when it shared only the vowel. However, there was no reliable advantage for shared VCs (rimes) over shared CVs, even by second grade. The tendency for children to generate more double-vowel spellings for targets that shared their rimes with the training stimuli than for targets that shared their initial CVs did not approach significance.

The results are thus consistent with those of Nation and Hulme (1996), who did not find a rime advantage, but inconsistent with the findings of Goswami (1986), who did find a rime advantage.

The increased use of the novel double-vowel spellings with grade level, which was significant in Experiment 1, was not reliable in this experiment. This difference probably reflects the greater use of final-*e* spellings by second-graders of Experiment 2 (*M* = 29%) than those of Experiment 1 (*M* = 7%). The tendency of second-graders to spell /gaɪt/ as *gite* may have partially overridden their tendency to spell it as *giit*.

Additional analyses suggested that children used particular spelling patterns even when their use resulted in real words with other pronunciations. Only for the second-graders was there a tendency to avoid such spellings. The results for kindergarten and first-grade children agree with those found by Treiman (1993) when analyzing spellings generated by first-graders in their classwork. For instance, these children sometimes spelled /sɛd/ as *sad*, even though *sad* is pronounced otherwise. Beginning spellers seem to perform similarly in the present spelling task as in more natural situations, not always checking their spellings by reading them.

GENERAL DISCUSSION

An important part of learning to write in English is learning that most phonemes have a variety of possible spellings. This is especially true for vowels. For example, children must learn to spell /e/ one way in words like *hate* and another way in words like *break*. In the present study, we developed a task to model the processes that are involved in learning and generalizing a new spelling for a phoneme. Specifically, we taught children a new "word" that contained a novel grapheme and asked whether and when children used this grapheme in spelling other items. Our grapheme learning task models the common situation in which children encounter a new word that contains a previously unknown grapheme and in which the presence of the new grapheme is not explicitly pointed out to them. For example, a child who is familiar with the *a*-plus-final-*e* spelling and *ea* spellings of /e/ may come across the word *veil*, which contains a phoneme–grapheme correspondence that is new to the child. Often, as when the child encounters the new word in a story, the novel grapheme is not specifically pointed out to the child.

Our grapheme learning task was used to study two cues that could potentially help children predict the spellings of vowels, positional context and phonemic context. We examined the effect of positional context by asking whether children were more likely to use the new grapheme when the phoneme was in the same position as in the training stimulus than when the phoneme was in a different position. We examined the effect of phonemic context by asking whether children were more likely to generalize the vowel spelling when the consonants that preceded or followed the vowel were the same as in the training stimulus. The present discussion focuses on the results of the production task, the task that seems best suited for examining children's knowledge of the relationships between phonology and orthography. The recognition task of Experiment 1, as discussed above, appeared to pick up primarily on children's judgments of orthographic similarity.

Our results suggest that positional context has an influence on children's spelling production from an early age. Children who learned the novel spelling *ii* in the middle of *giik* used *ii* reliably more often in the middle position of a non-word target than in the initial or final position. For example, children tended to spell /zaɪm/ as *ziim* more often then they spelled /aɪp/ as *iip* or /faɪ/ as *fii*. This pattern occurred in the production tasks of both Experiments 1 and 2 and was statistically significant in both experiments. Even the kindergartners who qualified for this study were sensitive to positional context, pointing to the early emergence of this phenomenon. The size of the effect did not vary reliably across the three grade levels examined here.

Our findings on positional context support and extend those of Treiman (1993) and Cassar and Treiman (1997). In the former study, first-graders' spelling productions showed a sensitivity to the positions in which certain consonant and vowel graphemes may occur. For example, children were more likely to use *ck* in the middle or at the end of a word than at the beginning of a word. This pattern is consistent with the distribution of *ck* in English. In the latter study, young children chose nonwords with final consonant doublets (e.g., *pess*) as "better" than those with initial consonant doublets (e.g., *ppes*). The present results provide additional evidence—this time from vowels—that young children are sensitive to the positions in which graphemes occur. The results go beyond those of the earlier studies by showing that children begin to make generalizations based on position even after being exposed to a novel grapheme in just a *single* item.

There is a question about exactly what it is that children learn about position when they are exposed to a double-vowel spelling in the middle position of a CVC training stimulus. We have attributed children's greater tendency to produce the novel grapheme in CVC targets than in C(C)V or V(C)C targets to the fact that it is in the middle position of the CVC targets, the same position as it was in the training stimulus. Alternatively, children may be more likely to generalize to syllables that exactly match the phonological skeleton of the training stimulus than to syllables that do not. To differentiate between the two hypotheses, future studies could assess children's generalization from CVC training stimuli to CCVC and CVCC targets (e.g., /blaɪm/ and /raɪst/ for the training stimulus /gaɪk/). We suspect that children would show more generalization to targets such as these, where the critical segment is near the middle of the target item, than to targets where the critical segment is in the initial or final position. However, this remains to be investigated.

The second cue that we investigated was phonemic context. We found that children were not significantly more likely to use the novel vowel spelling for items that shared their rime with the training stimulus (CVC targets) than for items that shared their initial consonant and vowel with the training stimulus (CVC targets).

In neither experiment was there a reliable advantage for CVC targets over CVC targets. Our findings do not fit with those of Goswami (1988), who reported a reliable superiority for shared rimes over shared CVs in beginning spellers. The absence of a significant rime advantage in the present study is similar to the findings of Nation and Hulme (1996).

Although our findings are similar to those of Nation and Hulme (1996), they are surprising given other evidence that rimes play a role in the development of speech segmentation and in reading. As mentioned above, research suggests that children learn to segment spoken syllables into onsets and rimes before they are able to perform a full phonemic segmentation of the syllable (see Bernstein & Treiman, in press; Treiman, 1989, 1992). If rimes play a role in the segmentation process, then we might have expected more generalization between syllables that share a rime (e.g., /gaɪk/ and /vaɪk/) than between syllables that share an initial CV (/gaɪk/ and /gaɪt/). In addition, research indicates that children (and adults) use orthographic units corresponding to rimes in reading (Bowey & Hansen, 1994; Bowey & Underwood, 1996; Coltheart & Leahy, 1996; Leslie & Calhoun, 1995; Treiman, Goswami, & Bruck, 1990; Treiman et al., 1995). If the units involved in spelling are similar to those involved in reading, then we might have expected more generalization for shared VCs than for shared CVs in the present studies.

Interestingly, there is some evidence that adults use rime units when they spell novel words. This evidence comes from a study by Treiman and Zukowski (1988) in which college students were asked to spell nonwords such as /tʃɛnd/ and /frɛθ/ and to rate spellings that were supposedly generated by other students. The nonwords /tʃɛnd/ and /frɛθ/ share their VC and CV, respectively, with *friend*, which has the unique spelling of *ie* for /ɛ/. Spellings that used this unique correspondence were rated as more plausible when the VC was shared than when the CV was shared. Thus, *chiend* was rated as a "better" spelling of /tʃɛnd/ than *frieth* was of /frɛθ/. In the spelling production task, students tended to produce more *ie* spellings of /ɛ/ in nonwords like /tʃɛnd/ than in nonwords like /frɛθ/. The effects were relatively small, however, and Nation (1999) did not find a priority for rimes in a spelling study with adults.

If adults show some preference for rimes in spelling, as the results of Treiman and Zukowski (1988) suggest, one might argue based on the present results that this preference does not emerge until after the second grade. According to this *late rime hypothesis*, the use of rimes may reflect extensive experience with the orthographic patterns of English rather than an early bias to use rime-sized chunks in the segmentation and selection processes. As mentioned above, Kessler and Treiman (in press) showed that the sound-to-print correspondences in monosyllabic English words are structured in such a way that the following consonant(s) usually has more effect on the spelling of the vowel than the preceding consonant(s) does. According to the late rime hypothesis, the initial phases of spelling development may differ from those of reading, where a rime advantage has been found as early as first or second grade in many of the studies cited above. In this view, young children may rely primarily on phoneme-sized units to spell, whereas larger units may be important in reading from an early stage. Such an interpretation would be consistent with Frith's (1985) view that strategies involving units larger than single phonemes and single graphemes (strategies reflecting the orthographic phase of development, in her terms) are used in reading before they are used in spelling.

Alternatively, the lack of a significant rime advantage in the present study may reflect the fact that the children were trained on just one word that embodied the /aɪ/–*ii* correspondence. In this view, a rime advantage in spelling might be restricted to frequently encountered patterns. According to this *multiple exposures hypothesis*, children who were taught several words in which /aɪ/ was spelled as *ii* before /k/ might begin to produce *ii* spellings before /k/ more often than before other phonemes. If so, and if multiple exposures to a novel grapheme in a consistent CV context did not have an analogous effect, then the results would suggest that rimes play a role in children's spelling if their spellings are frequently encountered. Children may initially learn sound–spelling correspondences at the level of phonemes, as Frith (1985) suggested. However, they may begin to postulate correspondences at the level of rimes once they have seen a rime spelling in a number of different words.

A third hypothesis about why no significant rime advantage was observed in the present study may be called the *rime type hypothesis*. In this view, the use of rimes in spelling depends on the frequency and salience of the phonological rime units. In Goswami's (1988) study, the majority of the training items and spelling targets used relatively common rimes. Also, rime neighbors tended to be the dominant kinds of phonological neighbors for these words. The rimes used in the present study, /eb/ and /aik/, may have been less common phonological units than the rimes used by Goswami. Further studies are needed to determine whether children's use of rime-based spelling patterns depends on the frequency and phonological salience of the rime units.

The production version of the grapheme learning task is well suited for examining questions about how children segment spoken words into smaller units and how they select spellings for these units. The advantage of this task is that it allows us to examine the course of learning rather than just the end result. Specifically, we can ask what children learn after being exposed to a single word that includes a novel phoneme–grapheme correspondence. Our results suggest that young children spontaneously acquire and store relationships between the phonological and orthographic components of the novel word. These relationships are coded for position such that children begin to generalize about the position in which the novel grapheme may appear even after being exposed to the novel grapheme in a single item. With this amount of exposure, children do not appear to make generalizations about the rime context in which a novel grapheme appears. Future studies using the grapheme learning task may shed additional light on how children learn new spellings for phonemes and how they choose among alternative spellings.

APPENDIX

Filler Items for Experiment 1 Recognition Task with Incorrect Version of Each Item in Parentheses

ant (ke), bear (mnfv), bee (f), bird (oea), cat (eoi), cow (e), dog (rxx), duck (zmnv), fly (rq), fox (n), frog (ybzk), goat (rz), hen (b), horse (iafvg), mouse (rfktz), owl (v), pig (o), rat (etb), sheep (vnk), snake (oife)

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Received August 4, 1999; revised June 1, 2000