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Segmentation of spoken words into syllables by English-speaking children as compared to adults

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Abstract

Given the importance of syllables in the development of reading, spelling, and phonological awareness, information is needed about how children syllabify spoken words. To what extent is syllabification affected by knowledge of spelling, to what extent by phonology, and which phonological factors are influential? In Experiment 1, six- and seven-year-old children did not show effects of spelling on oral syllabification, performing similarly on words such as *habit* and *rabbit*. Spelling influenced the syllabification of older children and adults, with the results suggesting that knowledge of spelling must be well entrenched before it begins to affect oral syllabification. Experiment 2 revealed influences of phonological factors on syllabification that were similar across age groups. Young children, like older children and adults, showed differences between words with "short" and "long" vowels (e.g., *lemon* vs. *demon*) and words with sonorant and obstruent intervocalic consonants (e.g., *melon* vs. *wagon*).

Keywords: Syllables; Syllabification; Spelling; Phonology; Vowels; Sonority

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The syllable is a fundamental linguistic unit, and syllables play an important role in the development of phonological awareness, reading, and spelling. Consider the case of phonological awareness. From an early age, children can determine the number of syllables in a word, tapping once for *dog*, twice for *wagon*, and three times for *valentine* (e.g., Liberman, Shankweiler, Fischer, & Carter, 1974). Syllabic awareness appears to predict later reading skill, such that children who perform well in syllable counting tasks and similar tasks typically become good readers (see, Snow, Burns, & Griffin, 1998). Although previous studies show that children can determine the number of syllables in a word at an early age, the results do not show where they place the boundaries between syllables. Does a child who taps twice for *wagon* consider the /g/ to be part of the first syllable or part of the second syllable, or does the child consider it an *ambisyllabic* consonant that belongs to both syllables at once? The child's successful performance in the tapping task does not provide an answer to this question. Information about the nature and location of syllable boundaries is needed to determine the role of syllables in the processing of spoken and written language and to make good use of syllables in instruction.

In the present experiments, we used a metalinguistic task to examine children's syllabification of spoken words such as *wagon*. Adults were studied as well to determine how children's syllabifications compare with adults'. Our approach follows that of Treiman and colleagues (Treiman & Danis, 1988; Treiman, Gross, & Cwikiel-Glavin, 1992; Treiman & Zukowski, 1990), who have studied how the syllabic representations constructed by adults in metalinguistic tasks mesh with the principles of syllabification postulated by linguists. A further motivation for the use of metalinguistic tasks is that children's performance on such tasks predicts reading ability, as mentioned earlier. Moreover, the syllabification principles that are implicated in metalinguistic tasks appear to be involved in the recognition of spoken words (Smith & Pitt, 1999; Titone & Connine, 1997). We focused on two factors that influence adults' syllabification of spoken words, asking whether they also affect the performance of children. The first factor concerns the spelling of the word, and the second concerns its phonological properties. We investigated the effects of spelling in Experiment 1 before turning to phonological influences in Experiment 2. By examining only single-morpheme words, we avoided influences of morphology (Derwing, 1992).

The study of whether spelling affects oral syllabification, and when these influences emerge in the course of literacy development, speaks to the theoretically important issue of how knowledge about printed language affects people's conceptions of spoken language. Linguists have typically considered speech the primary form of language, with writing a secondary or derived form. However, knowledge about the written form of a language may shape literate people's ideas about its spoken form. Supporting this view, Ehri and Wilce (1986) found that second graders from the United States who had practiced reading a word like *meteor* usually said that its first part rhymed with *feet*. Children who had not practiced reading *meteor* were more likely to judge that its first part rhymed with *seed*. These results suggest that children's classifications of the intervocalic flap sound were influenced by knowledge of its spelling. In Experiment 1, we asked whether children's and adults' conceptions of syllable boundaries are also shaped by spelling knowledge.

To determine whether a word's spelling affects its syllabification, one can compare words with similar phonological structures and different spelling patterns. English provides opportunities to do this because of inconsistencies in its spelling system. For instance, *canoe* and *annoy* are phonologically similar in that both have an unstressed, reduced first syllable, a stressed second syllable, and an intervocalic /n/. However, *canoe* is spelled with single *n* and *annoy* is spelled with *nn*. Treiman and Danis (1988) took advantage of this variation to examine how spelling affects the syllabification of US college students. They used a syllable reversal task in which participants were asked to produce the second (and any following) "parts" of a word and then the first "part." The task was introduced with items such as *kidnap*, which becomes /næpkɪd/ when reversed. The term "syllable" was not used in the instructions. Participants produced many responses like /nɔiən/ for *annoy* in which the critical consonant was placed in both syllables. In Experiment 2 of Treiman and Danis, for example, 57% of the responses to words like *annoy* with second-syllable stress and a double-consonant spelling fell into the ambisyllabic category. In contrast, only 6% of responses to words like *canoe* placed the medial consonant in both syllables. Derwing (1992) found similar results when Canadian college students judged which way of breaking a word sounded most natural. With words like *annoy*, participants who chose among the divisions /ən. . .ɔi/, /ə. . .nɔi/, and /ən. . .nɔi/ (where . . . indicates the location of a pause approximately 500 ms long) tended to prefer /ən. . .nɔi/. Together, the results show that spelling strongly influences the oral syllabification of English-speaking adults.

Other data on spelling effects come from French, which has enough variability in spelling to let researchers tease apart phonological and orthographic influences in some cases. For example, the French words *baron* and *marron* are phonologically similar but have different spelling patterns. When Content, Kearns, and Frauenfelder (2001) presented such words to college students in a syllable reversal task like that of Treiman and Danis (1988), they found 16% ambisyllabic responses to words like *marron* and 11% ambisyllabic responses to words like *baron*. The effect of spelling was statistically significant, but much smaller than in English.

Although spelling affects English-speaking and French-speaking adults' conceptions of syllable boundaries, little research has examined children. The most comprehensive study was carried out by Content, Dumay, and Frauenfelder (1999) in French. In one task, children were asked to say bisyllabic words with a pause between the parts. In another task, children were asked to say just the first part or just the second part of each word. Content et al. compared children's performance on words with single-grapheme and doublet spellings of an intervocalic consonant. Five-year-old children, who were not able to read, were not influenced by the words' spellings. Significant effects of spelling were found among 9 year olds, and the effects appeared to be stronger among 12 year olds.

Fallows (1981) did not consider the possible effects of spelling in her study of syllabification in English-speaking children. She tested a group of 4–5 year olds and a group of 9–10 year olds. Each child performed two tasks with each word—repeating the word while doubling the first part (e.g., /tʃɪptʃɪpmʌŋk/ for *chipmunk*) and repeating the word while doubling the last part (e.g., /tʃɪpmʌŋkmʌŋk/ for *chipmunk*). Some of the younger children performed an easier task that involved pausing between the syllables of the word. Some of the words in the study, such as *silly* and *summer*, had Double-consonant spellings. Other words, such as *salad* and *lemon*, were similar in phonological structure but were spelled with singletons. However, Fallows did not tabulate the results separately for the two types of words. Fallows reported that ambisyllabic responses were more common among older children than younger children, but she did not provide quantitative evidence on this point. Fallows attributed the age-related increase in ambisyllabicity to phonological factors, suggesting that older children use ambisyllabicity to maintain the preferred shapes of unstressed syllables as well as stressed syllables. By producing an ambisyllabic response for *silly*, for example, the child provides an *onset* (initial consonant) for the unstressed second syllable as well as a *coda* (final consonant) for the stressed first syllable. Another potential explanation for the age-related increase in ambisyllabic responses, however, is that the older children were influenced by spelling. They produced ambisyllabic responses for words such as *silly* because they knew that the middle consonant is spelled with two letters.

To our knowledge, Zamuner and Ohala (1999) are the only researchers to have asked whether spelling affects the syllabification of English-speaking children. These researchers tested children who averaged 34 months in age. The children were taught to pronounce bisyllabic words with a pause between the syllables, the task that Fallows (1981) had found to be manageable for younger children. The game was introduced using compound words with clear boundaries, such as *dumptruck*. The bisyllabic words that were chosen to assess the role of spelling all had a short stressed vowel in the first syllable. Some had a single-letter spelling of the middle consonant, as in *camel* and *cabin*, and others had doublet spellings, as in *mammal* and *cabbage*. Although the children did not know how to read, their responses appeared to be affected by the words' spellings. The number of ambisyllabic responses was significantly higher ($p < .05$ in a by-subjects analysis) for the *mammal*-type words than the *camel*-type words. Subsequent acoustic measurements

(D.K. Ohala, personal communication, July 11, 2001) did not find the first vowel–consonant sequence to be longer in the experimenters' pronunciations of words such as *mammal* than words such as *camel*. This suggests that the pronunciations of the two types of words do not differ in a way that could explain the surprising effect of spelling. Before accepting that spelling or some property associated with it affects the syllabification of young children, it is important to replicate Zamuner and Ohala's findings.

In Experiment 1, we looked again at whether young children differentiate between words such as *mammal* and *camel* in oral syllabification tasks. Rather than asking children to pronounce a two-syllable word with a pause between the parts, as Zamuner and Ohala (1999) did, we had children say just the first part of each word on some trials and just the second part of each word on other trials. We chose this task because people may avoid repeating a phoneme when they produce both parts of a word close in time, lowering the number of ambisyllabic responses (Content et al., 2001). We tested three groups of children that differed in age and literacy level—first graders, second graders, and sixth graders—as well as adults. We originally planned to include younger children who had not been exposed to reading instruction, as Zamuner and Ohala did. However, testing of 24 kindergartners revealed that the task was too hard for them. (In the school system where the study was conducted, kindergartners are not taught to read or write, even informally.) Experiment 1 compared words with single-consonant (e.g., *habit*) and double-consonant spellings (e.g., *rabbit*). We included 10 words in each category, as opposed to six per category in the Zamuner and Ohala study. We matched the words on other factors that might affect children's performance, such as whether the potential responses were real words. Going beyond Zamuner and Ohala, we carried out statistical tests by items as well as by subjects. We tested over 40 participants per grade level, as compared to 16 in Zamuner and Ohala. To determine whether children could spell the words they were asked to syllabify, participants were asked, for example, whether *rabbit* or *rabit* was the correct spelling of *rabbit*. By freeing participants from the need to produce the spellings, this spelling recognition test should reveal any knowledge that children possess about single-consonant versus double-consonant spellings.

Experiment 1

Method

Participants

Children. A total of 134 children contributed data. The 44 first graders (15 boys, 29 girls) whose data were included had a mean age of 6 years, 5 months (*SD* 3.7 months). The second-grade group included 24 boys and

19 girls with a mean age of 7 years, 5 months (*SD* 3.5 months). The sixth-grade group comprised 14 boys and 33 girls with a mean age of 11 years, 7 months (*SD* 4.7 months). The children attended an elementary school located in a predominantly middle-class area of Brisbane, Australia, and all were native speakers of English. Testing was carried out toward the end of the school year. Three additional first graders and one second grader did not complete the experiment because they did not meet criterion on the practice items (see below).

Adults. Forty-one undergraduates, 18 male and 23 female, were recruited from the introductory psychology participant pool at the University of Queensland in Brisbane, Australia. All were native speakers of English.

Stimuli

The test words were monomorphemic two-syllable words with (C)CVCV(C) structure. All had a short vowel with primary stress in the first syllable. The second syllable was unstressed and in most cases contained a reduced vowel. The words differed in whether the medial consonant was spelled with a single consonant (e.g., *habit*) or a doublet (e.g., *rabbit*). For words with single-consonant spellings, the consonant was one that is allowed to double in English. Ten words were selected in each of the two spelling conditions, as Table 1 shows. The words had a variety of intervocalic consonants, including liquids, nasals, and obstruents. There were too few items with each type of consonant to permit separate analyses. According to Zeno, Ivenz, Millard, and Duvvuri (1995), the *U* value (frequency adjusted for differences in distribution of words among content areas) was 74.5 per million for words with singleton spellings and 65.7 for words with doublets. The small difference in frequency was not significant ($p = .83$). The first (C)CVC segment of the test word was a real word in four words with each type of spelling. The first (C)CV segment of the test word was never a real word.

Table 1
Test words for Experiment 1

Single-consonant spelling	Double-consonant spelling
carol	parrot
habit	rabbit
metal	bottom
model	sudden
money	hammer
panel	tunnel
planet	common
salad	valley
visit	lesson
wagon	cotton

Eighteen bisyllabic practice items were constructed. The first 10 practice items were the compound words *playground*, *catfood*, *fireman*, *birdbath*, *sunshine*, *raincoat*, *bookshelf*, *football*, *bedroom*, and *treehouse*. The remaining eight practice items—*timber*, *tumble*, *picnic*, *number*, *partner*, *object*, *picture*, and *athlete*—had clear syllable boundaries. In these words, the two consonants that follow the first vowel cannot legally begin or end an English syllable. The syllable boundary thus falls between these two consonants according to linguistic theories and behavioral evidence (see, Treiman & Zukowski, 1990). (The *r* of *partner* is not pronounced in Australian English, so /tn/ immediately follows the first vowel.)

Procedure

Children. The children were tested individually in a quiet area of the school. The experimenter sat opposite the child with a tape recorder between them. The oral syllabification task was given before the spelling choice task to all participants to ensure that exposure to the words' spellings would not influence participants' responses in the oral task.

Syllabification task. All children received two versions of the syllabification task. One version required them to say just the first part of two-syllable words and the other version required them to say just the second part. The order of the two versions was balanced across children at each grade level.

Each version of the syllabification task began with the practice items. Children heard the following instructions for the first part version of the task:

> Today, we're going to play a word game. I'll tape our game as we play. It's a pretty easy game. This is how it goes. First, I will say a long word, then you say it back to me, exactly the same as I said it. So if I say *playground*, you say *playground*. You say *playground* now. [The experimenter waits for the child to repeat the word.] Then you have to tell me just the first part of *playground*. So for *playground*, the first part is *play*, so you say *play*. Say *play*. [The experimenter waits for the child to say *play*.] Very good! It's your turn now. First say *catfood*. [The experimenter waits for the child to say *catfood*.] Good! Now say the first part of *catfood*. [The experimenter waits for the child to say *cat*.] Yes, that's right. *Cat* is the first part of *catfood*. Let's do some more.

If the child responded correctly, the experimenter continued through the remaining eight compound practice items, each time providing full feedback, as above. If the child did not respond correctly to *catfood*, the experimenter gave essentially the same corrective feedback ("No, cat is the first part of *catfood*"), and proceeded with the remaining practice items, each time providing full feedback. Children who responded correctly to five of any six consecutive compound word practice items were regarded as having understood the task to this point. These children proceeded to the two-syllable practice items with unambiguous syllable boundaries. The instructions and procedure for these practice items were similar to those for the compound practice items. Children who responded correctly to five of any six consecutive unambiguous two-syllable words were considered to have met the criterion.

After finishing the practice items, those children who had reached criterion on the practice items proceeded to the 20 test items with ambiguous syllable boundaries. The experimenter told the children that they were now so good at the task that she would not need to tell them whether their responses were right. For each word, the child was asked to first repeat the word and then say the first part. The experimenter provided general encouragement but no feedback about the correctness of specific responses. The test items were quasi-randomly arranged. Two test words for which the first (C)CVC was a real word never occurred consecutively.

The procedure for the second part version of the syllabification task was similar to that just described. The only difference was that children were asked to give the end part of each word, as in *ground* for *playground* and *ber* for *timber*.

Spelling task. The children were asked to select the correct spelling of each of the 20 test words. The words were printed in 16-point Palatino font in pairs. One item in each pair was spelled with a single medial consonant and the other with a doublet. Over the 20 test words, correct items occurred equally often on the left and right. Items were quasi-randomly arranged. Within each set of four consecutive words, half had the correct response on the left side. Over all items, the correct response was on the left for half the items with singleton spellings and half the items with doublets. The experimenter said the word aloud, read it in a sentence, and then said the word again. The children were asked to put a check mark beside the correctly spelled word. The experimenter reassured them that they would probably not know how to spell many of the words and that it was fine to guess. Two practice items (*cat* vs. *kat*; *tog* vs. *dog*) were given to ensure that children understood the task.

Adults. The procedure for the college students in the syllabification and spelling tasks was similar to that for the children, except that the instructions were shortened.

Results

Syllabification task

We examined each participant's combined responses across the first part and second part tasks for each word, checking the scoring against the tapes. Each response was assigned to one of the following five categories:

(1) consonant included only as part of the first syllable,
(2) consonant included only as part of the second syllable,
(3) consonant included in both syllables,
(4) consonant included in neither syllable,
(5) some other type of response.

Response types 1, 2, and 3 may be considered valid responses, as they assign the intervocalic consonant to at least one syllable. Response types 4 and 5 are invalid. Table 2 shows the proportion of responses in each category for each grade level and type of word. Two-way, grade (grade 1, grade 2, grade 6, college) $\times$ spelling (single-consonant conventional spelling, double-consonant conventional spelling) analyses of variance (ANOVAs) were carried out by subjects and by items for each type of response, expressed as a proportion of all responses. Note that the ANOVAs for the different types of responses are not independent.

Responses that included the consonant only as part of the first syllable varied in frequency with grade, $F1(3, 171) = 4.81$, $p < .01$; $F2(3, 54) = 31.85$, $p < .001$, tending to be most common among sixth graders. The main effect of spelling was significant only by subjects, where more responses that included the consonant only as part of the first syllable occurred for words with single-consonant spellings than words with double-consonant spellings, $F1(1, 171) = 34.44$, $p < .001$; $F2(1, 18) = 3.78$, $p > .05$. The most important result was the grade by spelling interaction, $F1(3, 171) = 10.23$; $F2(1, 18) = 10.19$; $p < .001$ for both. Simple effects analyses indicated that college students, $F1(1, 40) = 28.00$, $p < .001$; $F2(1, 18) = 10.43$, $p < .01$, and sixth graders, $F1(1, 46) = 17.14$, $p < .001$; $F2(1, 18) = 9.45$, $p < .01$, produced significantly more first-syllable only responses for words that were conventionally spelled with a singleton than words that were conventionally spelled with a doublet. For first and second graders, the number of responses that included the consonant only as part of the first syllable did not vary reliably with the word's conventional spelling.

Responses that assigned the intervocalic consonant to only the second syllable, leaving the first syllable open, were uncommon. Grade $\times$ spelling ANOVAs examining these responses found no effects that were significant by both subjects and items. The ANOVAs on the proportion of responses that included the consonant as part of both syllables showed a significant main effect of grade, $F1(3, 171) = 7.78$; $F2(3, 54) = 62.30$; $p < .001$ for both. Both-syllable responses tended to increase across grades. The significant main effect of spelling in the subjects analysis, $F1(1, 171) = 28.78$, $p < .001$; $F2(1, 18) = 3.67$, $p > .05$, occurred because words with double-consonant spellings gave rise to a higher proportion of responses that included the consonant as part of both syllables. Importantly, a significant grade by spelling interaction was observed, $F1(3, 171) = 8.34$; $F2(3, 54) = 8.99$; $p < .001$ for both. Simple effects analyses showed that the spelling effect was limited to college students, $F1(1, 40) = 29.62$, $p < .001$; $F2(2, 36) = 10.38$, $p < .01$, and sixth graders, $F1(1, 46) = 17.43$, $p < .001$; $F2(1, 18) = 11.30$, $p < .01$, as for first-syllable only responses. Both sixth graders and college students produced reliably more both-syllable responses to items whose conventional spelling contained a doublet than items whose conventional spelling contained a singleton. Spelling had no significant influence on the responses of first and second graders.

Of the two types of invalid responses, those in which the critical consonant was placed in neither syllable were quite uncommon and were not analyzed

Table 2
Proportion of responses of various types in Experiment 1 as a function of grade level and conventional spelling of word

	First syllable only		Second syllable only		Both syllables		Neither syllable		Other response	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
First graders										
Single consonant	.15	.19	.03	.09	.43	.32	.00	.02	.39	.30
Double consonant	.15	.19	.02	.06	.45	.29	.01	.03	.37	.26
Second graders										
Single consonant	.19	.23	.02	.06	.48	.31	.01	.03	.30	.30
Double consonant	.18	.22	.02	.08	.48	.31	.00	.00	.32	.29
Sixth graders										
Single consonant	.40	.28	.01	.04	.49	.29	.00	.00	.10	.16
Double consonant	.25	.28	.00	.00	.65	.35	.00	.00	.10	.20
College students										
Single consonant	.31	.31	.00	.02	.64	.33	.00	.00	.04	.16
Double consonant	.15	.26	.00	.00	.81	.29	.00	.00	.04	.16

statistically. The ANOVAs on the proportion of "other" responses revealed only a significant grade effect, $F1(3, 171) = 21.98$; $F2(3, 54) = 128.84$; $p <$ .001 for both. These responses tended to be more frequent among the younger children than among the older children and college students. Because the younger children made a number of "other" responses, we examined these responses in some detail. Participants produced many more "other" responses when asked to provide the second part of the word than when asked to provide the first part. By far the most common such response was to segment the word after the onset of the first syllable and say the remainder (e.g., /ænət/ for the end part of *planet*). Occasionally, the final consonant was provided (e.g., /t/ as the end part of *visit*). Occasionally, too, other segments of the word were produced (e.g., /k/ for *carol*; /kɑn/ for *cotton*; /ɑt/ for *cotton*). Errors in providing the first part of the word were much less common. Examples include /sʌn/ for *sudden* and /sæd/ for *salad*.

Spelling task. The alternatives in the spelling choice test differed in whether the critical consonant was a singleton (e.g., *habit*) or a doublet (e.g., *habbit*). The results, shown in Table 3, were analyzed using the factors of grade and spelling. Grade had a significant main effect, $F1(3, 171) = 141.82$; $F2(3, 54) = 86.64$; $p < .001$ for both. This effect reflects the improvement in performance across grade levels. Spelling was also significant, $F1(1, 171) = 20.86$, $p < .001$; $F2(1, 18) = 4.46$, $p < .05$. Words that are conventionally spelled with doublets were recognized more accurately ($M = .83$) than words that are conventionally spelled with singletons ($M = .74$). The grade by spelling interaction was not significant, $ps > .05$. At each grade level, participants scored significantly above the level of .50 that would be expected by chance. Pooling over single- and double-consonant spellings, the proportion of correct responses was .58 for first graders, $t1(43) = 3.71$, $p < .001$; $t2(19) = 2.70$, $p < .05$, .66 for second graders, $t1(42) = 7.41$; $t2(19) = 4.20$; $p < .001$ for both, .91 for sixth graders, $t1(46) = 35.20$; $t2(19) = 11.83$; $p < .001$ for both, and .98 for college students, $t1(40) = 95.45$; $t2(19) = 48.74$; $p < .001$ for both.

Overall, the younger (first and second grade) children did not show a reliable influence of spelling on oral syllabification. To determine whether any evidence for such an effect appeared among the better second grade spellers, we examined syllabification performance in those 14 second graders who

Table 3
Proportion of correct spelling choices in Experiment 1 as a function of grade level and conventional spelling of word

	Single-consonant spelling		Double-consonant spelling	
	Mean	*SD*	Mean	*SD*
First grade	.54	.20	.61	.24
Second grade	.61	.21	.72	.26
Sixth grade	.84	.14	.99	.04
College	.97	.07	1.00	.00

scored above chance on the spelling choice test (as defined by the binomial test, 15/20 correct), relative to those 29 children who scored no higher than chance (less than 15 correct). The children in the former group showed a trend toward more both-syllable responses on words with double-consonant spellings than words with single-consonant spellings (.56 vs. .52), as well as a trend toward fewer first-syllable only responses on words with double-consonant spellings than words with single-consonant spellings (.23 vs. .31). However, neither of these differences was significant.

Discussion

As expected on the basis of previous findings with English (Derwing, 1992; Treiman & Danis, 1988), college students' oral syllabification was influenced by spelling. College students were more likely to place a medial consonant in both syllables when it was spelled with two letters, as in *rabbit*, than when it was spelled with a single letter, as in *habit*. The present findings extend the results to a new set of items and a task that differs from those used earlier.

The most novel aspect of the results is that spelling begins to influence oral syllabification only when knowledge of spelling is well entrenched. For the words examined here, a rudimentary knowledge of single- vs. double-consonant spellings emerged in first and second grade. However, these younger children's oral syllabification was not affected by this knowledge. By sixth grade, spelling had a reliable impact on syllabification. Sixth graders and college students were significantly more likely to place an intervocalic consonant in both syllables if it was spelled with a doublet than if it was spelled with a singleton. Our finding that orthographic effects emerge somewhere between second grade and sixth grade in English-speaking children is consistent with the results of Content et al. (1999), who found such effects in French speakers of 9 and above. Our failure to find spelling effects in first and second graders, even second graders with better spelling skills, makes it unlikely that such effects would be found in children of the age tested by Zamuner and Ohala (1999).

As mentioned previously, Fallows (1981) proposed a phonological explanation for her finding that ambisyllabic responses tended to be more frequent in older children than younger children. Specifically, she suggested, older children are more likely than younger ones to use ambisyllabicity to maintain the preferred shape of unstressed syllables. However, we found that ambisyllabic responses were significantly more frequent for older children than younger children only for words with double-consonant spellings. Age-related increases in ambisyllabic responses, when they occur, may be due more to orthographic factors than phonological factors.

One possible interpretation of the spelling effects observed here is that older children and adults mentally spell words they are asked to syllabify and base their responses on this representation. Younger children may not use spelling spontaneously in oral tasks, even if they can spell the words when asked to do so. Another possibility is that the phonological representations of older children and adults are shaped by their experiences with print. English speakers may come to believe that the phonological form of a word like *rabbit* "really" contains two consonants, and their responses in oral syllabification tasks may reflect this belief. These two explanations are difficult to distinguish, but they share the idea that spelling knowledge must be well developed and automatic before it begins to affect performance in oral tasks such as these.

Our results further show that it takes some time to distinguish between singleton and doublet spellings for words of the kind examined here (see also Cassar & Treiman, 1997; Henderson, 1985). These difficulties likely reflect the inconsistencies of English spelling. To better understand these inconsistencies, we used a machine-readable dictionary (Wordfind, 1984) to examine words like those studied in Experiment 1. We searched for words that were spelled with an initial consonant or two-consonant cluster (including *gu* or *qu*) followed by a short stressed vowel, a single consonant or consonant doublet (except for *q* or *x*, which typically correspond to more than one phoneme), followed by any single letter or pair of letters that corresponds to a vowel, syllabic consonant, or vowel–consonant sequence. Words with intervocalic *r* or *rr* were not analyzed, since it is not clear whether certain vowels before /ɹ/ should be classified as short or long. Of the 742 one-morpheme words that fit this description, 491 (66.2%) were spelled with a double consonant, as in *rabbit*, *apple*, and *grammar*. The remaining 251 words (33.8%) had a single-consonant spelling, as in *habit*, *medal*, and *gamut*. We also examined words that contained a long stressed vowel in the first syllable but that otherwise conformed to the above description. A total of 416 such monomorphemic words were found, including *photo*, *demon*, and *lilac*. In every case, the critical intervocalic consonant was spelled with a single grapheme. Thus, words with short vowels like those studied in Experiment 1 show a good deal of variability in whether the medial consonant is spelled as a singleton or a doublet, but long vowel words do not. Participants probably performed better on the spelling task with double-consonant words such as *rabbit* than with single-consonant words such as *habit* because doublet spellings are more common than singleton spellings for words with this phonological structure. As previous studies have shown, children and adults are more accurate at spelling words with regular sound-spelling relationships than words with irregular patterns (e.g., Fischer, Shankweiler, & Liberman, 1985; Treiman, 1984a; Waters, Bruck, & Seidenberg, 1985).

The adults tested here made more both-syllable responses to words that were spelled with single consonants than did the adults in previous studies. In Experiment 3 of Treiman and Danis (1988), which used a syllable reversal task, about 21% of the responses to words like *salad* and *promise* placed the intervocalic consonant in both syllables, as when *salad* was reversed as /lədsæl/. Here, both-syllable responses for this type of word occurred 64% of the time, less often than for words with consonant doublets like *valley* but still quite frequently. Content et al. (2001), in their study of French-speaking adults, also found more both-syllable responses when participants said the first part of a bisyllabic word and the second part of a bisyllabic word on different occasions than when they reversed the syllables of a word. This difference may arise if participants try to avoid responses such as /lədsæl/ for *salad*, which contain a repeated /l/. When the first and second part of a word are produced on different trials, ambisyllabic responses appear to be more likely. The mix of stimuli within an experiment may also affect the results. In the present experiment, unlike Experiment 3 of Treiman and Danis (1988), all of the words had a short stressed vowel in the first syllable and participants may have tended to produce both-syllable responses throughout the experiment.

In Experiment 2, we turned our attention from orthographic factors to phonological factors. We examined words with first-syllable stress, as in Experiment 1, this time manipulating the nature of the first vowel—short (or lax) vs. long (or tense)—and the sonority of the intervocalic consonant—sonorant (liquid or nasal) vs. obstruent (stop or fricative). We focused on vowel type and consonant sonority in Experiment 2 because these factors have been shown to affect syllabification in English-speaking adults. Treiman and Danis (1988), using a syllable reversal task, found that adults were more likely to close the first syllable of a word like *lemon*, which has a short vowel, than a word like *demon*, which has a long vowel. Also, responses with a closed first syllable were more common when the medial consonant was a sonorant, as in *lemon* and *lilac*, than when it was an obstruent, as in *vigor* and *judo*. Derwing (1992) found similar results when participants judged which way of breaking up a word was most natural. His stimuli were largely a subset of those used by Treiman and Danis.

In Experiment 2, we asked whether differences as a function of vowel quality and consonant sonority occur with a different set of stimuli and a different task, and whether the differences occur with children. The study of children should help us determine whether the effects of vowel quality and consonant sonority have a phonological basis, as Treiman and Danis (1988) and Derwing (1992) assumed, or whether they are spelling effects in disguise. Literate adults may produce more first-syllable syllabifications for the /m/ of *lemon* than the /m/ of *demon* because they know that the middle consonants of words like *lemon* sometimes double. That is, *lemon* could alternatively be spelled as *lemmon*. Adults know that the middle consonants of long-vowel words like *demon* rarely double; *demmon* is a very unlikely spelling of *demon*. If the difference in oral syllabification between words like *lemon* and words like *demon* is based on spelling, then children who are too young to show effects of spelling on oral syllabification should not show a difference. If the effect is phonological, then it should occur with young children.

Some relevant evidence comes from studies that have investigated syllabification in English-speaking children. Fallows (1981) reported that children, like adults, differentiate between short vowels and long vowels in oral syllabification. Fallows also observed that ambisyllabic responses were more common with intervocalic sonorants than intervocalic obstruents. However, Fallows' failure to consider the spellings of the words makes it difficult to interpret her findings. The 34-month-old children studied by Zamuner and Ohala (1999) showed effects of vowel quality on syllabification that were similar to those found in adults. These children's performance was also affected by the sonority of the intervocalic consonant. For words with a short vowel in the first syllable, liquids and nasals were more likely than obstruents to be placed in the first syllable, as in adults. When the vowel in the first syllable was long, there did not appear to be an overall difference between sonorants and obstruents. Children always placed intervocalic liquids following long vowels in the second syllable, but they did not do the same for nasals. This result suggests that some phonological factors affect syllabification differently in young children than in adults. However, Zamuner and Ohala included very few stimuli in some of the critical categories.

We designed Experiment 2 to gather more information about the effects of vowel quality and consonant sonority on children's syllabification. We chose 14 words in each of the four cells of the 2 (vowel length: short vs. long) $\times$ 2 (consonant sonority: sonorant vs. obstruent) design. We did not attempt to distinguish between liquids and nasals because this would have reduced the number of words in each category. All of the words were spelled with a single intervocalic consonant. For this spelling pattern, one can contrast long vowels (e.g., *demon*) and short vowels (e.g., *lemon*). This contrast is not possible with doublets because doublets rarely follow long vowels in English, as mentioned earlier. Because Experiment 2 contained more words than Experiment 1, increasing the demands of the task, we tested second graders and sixth graders but not first graders.

Experiment 2

Method

Participants

Children. A total of 48 children contributed data. The 23 second graders (15 males, 8 females) had a mean age of 8 years, 0 months (*SD* 4.4 months). The mean age for the 25 sixth graders (11 males, 14 females) was 11 years, 10 months (*SD* 4.9 months). The children attended schools in a middle-class suburban area near Detroit, Michigan. All were native speakers of English.

The children were tested toward the end of the school year. Four additional children, three in second grade and one in sixth grade, did not meet the criterion on the practice trials, using the same criteria as in Experiment 1, and were not included in the analyses.

Adults. Twenty undergraduates (5 males, 15 females) from Wayne State University in Detroit, Michigan, all native speakers of English, comprised the final sample. One additional student did not meet the criterion on the practice trials.

Stimuli

The test words were 56 monomorphemic two-syllable words with (C)(C)VCV(C)(C) structure. All had primary stress on the first syllable and a single-letter spelling of the intervocalic consonant. The second vowel was unstressed and, in most cases, reduced. The vowel in the first syllable was short in half the test words and long in the other half. The intervocalic consonant was a sonorant (/ɹ/, /l/, /m/, or /n/) or an obstruent (/b/, /d/, /f/, /g/, /p/, /s/, /t/, or /z/). There were equal numbers ($n = 14$) of short-vowel/sonorant-consonant items (e.g., *lemon*), short-vowel/obstruent-consonant items (e.g., *topic*), long-vowel/sonorant-consonant items (e.g., *demon*), and long-vowel/obstruent-consonant items (e.g., *tiger*). The test items are shown in Table 4. The mean word frequency *U* values for these items from Zeno et al. (1995) are: short-vowel/sonorant-consonant items 33.2; short-vowel/obstruent-consonant items 30.0; long-vowel/sonorant-consonant items 16.0; and long-vowel/obstruent-consonant items 24.5. A 2 (vowel type) $\times$ 2 (consonant type) ANOVA revealed no significant differences in word frequency as a function of vowel or consonant type ($ps > .15$).

Table 4
Test words for Experiment 2

Short vowel		Long vowel	
Sonorant consonant	Obstruent consonant	Sonorant consonant	Obstruent consonant
camel	vigor	Amos	spider
balance	habit	demon	hazel
lemon	metal	Venus	basin
carol	wagon	silent	baby
melon	radish	zero	legal
limit	credit	final	depot
relish	critic	pilot	crisis
image	widow	halo	cider
clinic	proper	moral	tiger
honor	profit	bonus	bogus
mimic	topic	tulip	slogan
promise	robin	solar	total
color	hazard	lilac	stupid
solid	pity	rumor	tuba

The first (C)(C)VC segment was a real word in 6 of the short-vowel/sonorant-consonant items, 7 of the short-vowel/obstruent-consonant items, 10 of the long-vowel/sonorant-consonant items, and 10 of the long-vowel/obstruent-consonant items. Although the four types of items were reasonably well matched in this regard, there was an asymmetry in the number of real words (counting the names of letters as real words) in the first (C)(C)V segments as a function of vowel type—none for short vowel items, and 27 for long vowel items (13 in the sonorant-consonant condition, 14 in the obstruent-consonant condition). This discrepancy could not be avoided because short vowels are illegal at the ends of English syllables, whereas many real words and letter names end with long vowels.

The practice items were the same as in Experiment 1. However, *partner* was replaced with *atlas* because *partner*, in the dialect of the present participants, contains a three-consonant medial cluster instead of a two-consonant cluster.

Procedure

All participants were tested individually. The syllabification task was given first, followed by the spelling choice task.

Syllabification task. All participants received two versions of the syllabification task. One version required them to say just the first part of the two-syllable words and the other version required them to say just the second part. The order of the two versions was balanced across participants. The instructions and procedure were the same as in Experiment 1.

Spelling recognition task. The task included 112 trials. Fifty-six critical trials contained a word used in the syllabification task paired with an incorrect double-consonant spelling of the word (e.g., *lemon–lemmon*, *topic–toppic*, *demon–demmon*, *tiger–tigger*). An additional 56 filler trials consisted of items with double-consonant spellings paired with incorrect single-consonant spellings. These trials were included to ensure that the double-consonant spelling was correct half the time and the single-consonant spelling was correct half the time. Twenty of the filler trials were monosyllabic words, half with sonorant double consonants (e.g., *bell–bel*) and half with obstruent double consonants (e.g., *egg–eg*). The remaining 36 filler trials included bisyllabic words with stress on the second syllable, half with sonorant consonants (e.g., *balloon–baloon*) and half with obstruent consonants (e.g., *attack–atack*). The mean frequency U value from Zeno et al. (1995) for the filler words (27.3) did not differ significantly from that for the critical words (25.9, $F < 1$). The correct response was on the left for half the critical trials and half the foil trials.

On each trial the experimenter said the word aloud, said it in a sentence, and then said the word again. Participants were asked to put a check mark beside the correctly spelled choice. Two practice items were given for the children.

Results

Syllabification task. Each participant's responses across both versions of the task were classified, for each word, into the same five categories used in Experiment 1. Table 5 shows the mean proportion of responses in each category for the various types of stimuli for the three age groups. Separate ANOVAs were carried out for each type of response using the factors of grade (grade 2, grade 6, college), vowel type (short, long), and consonant type (sonorant, obstruent).

For first-syllable only responses, there was a main effect of vowel type, $F1(1,65) = 113.86$; $F2(1,52) = 45.17$; $p < .001$ for both. Participants were more likely to place the intervocalic consonant in the first syllable when that syllable contained a short vowel than a long vowel. In addition, a main effect of consonant type was found, $F1(1,65) = 18.55,\ p < .001$; $F2(1,52) = 5.77$, $p < .05$. Participants were more likely to close the first syllable with a consonant when that consonant was a sonorant than an obstruent. A main effect of grade also emerged, $F1(2,65) = 11.68$; $F2(2,104) = 145.19$; $p < .001$ for both. This effect occurred because second graders more often put the medial consonant in only the first syllable than sixth graders and college students. The vowel type by grade interaction was marginal, $F1(2,65) = 2.84,\ p < .07$; $F2(2,104) = 5.26,\ p < .01$. All groups showed a significant difference between short and long vowels, but the difference tended to be largest for the second graders.

Turning to second-syllable only responses, we found a main effect of vowel type, $F1(1,65) = 288.40$; $F2(1,52) = 59.58$; $p < .001$ for both. This was qualified by an interaction between vowel type and grade, $F1(2,65) = 4.86,\ p < .05$; $F2(2,104) = 12.26,\ p < .001$. All groups were more likely to place the medial consonant in the second syllable following a long vowel than a short vowel. The interaction arose because the difference between long and short vowels was larger for sixth graders and college students than for second graders. Also, consonant type and grade interacted, $F1(2,65) = 7.50,\ p < .01$; $F2(2,104) = 9.38,\ p < .001$. Simple effects tests showed no significant effect of consonant type on second-syllable only responses for the second graders. However, the sixth graders and college students were reliably more likely to place the intervocalic consonant in only the second syllable when that consonant was an obstruent than a sonorant. The main effect of grade was also reliable, $F1(2,65) = 10.22$; $F2(2,104) = 156.88$; $p < .001$ for both. Second graders produced fewer second-syllable only responses than sixth graders and college students.

For both-syllable responses, there was a main effect of vowel type, $F1(1,65) = 81.40$; $F2(1,52) = 55.33$; $p < .001$ for both. Overall, participants were more likely to place the critical consonant in both syllables when the vowel was short than when it was long. In addition, vowel type interacted with grade, $F1(2,65) = 7.45,\ p < .01$; $F2(2,104) = 14.61,\ p < .001$.

Table 5
Proportion of responses of various types in Experiment 2 as a function of grade level, vowel type, and consonant type

	First syllable only		Second syllable only		Both syllables		Neither syllable		Other response	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Second graders										
Short vowel										
Sonorant consonant	.66	.29	.02	.05	.21	.20	.01	.03	.09	.17
Obstruent consonant	.59	.26	.05	.10	.22	.17	.03	.06	.11	.20
Long vowel										
Sonorant consonant	.40	.21	.26	.18	.13	.10	.13	.13	.08	.11
Obstruent consonant	.30	.28	.23	.23	.17	.12	.19	.15	.11	.18
Sixth graders										
Short vowel										
Sonorant consonant	.37	.28	.11	.24	.47	.27	.04	.07	.01	.02
Obstruent consonant	.29	.26	.18	.22	.47	.25	.06	.07	.01	.02
Long vowel										
Sonorant consonant	.19	.16	.43	.24	.27	.21	.09	.12	.01	.03
Obstruent consonant	.09	.13	.57	.24	.21	.17	.13	.13	.01	.05
College students										
Short vowel										
Sonorant consonant	.32	.29	.19	.24	.43	.27	.05	.09	.01	.03
Obstruent consonant	.28	.26	.28	.26	.38	.21	.06	.09	.00	.02
Long vowel										
Sonorant consonant	.16	.25	.50	.29	.21	.25	.12	.14	.01	.04
Obstruent consonant	.10	.20	.65	.30	.15	.17	.10	.15	.00	.00

Although the vowel effect was significant for all groups, it was larger for sixth graders and college students than for second graders. A main effect of grade was also found, $F1(2,65) = 6.16$, $p < .01$; $F2(2,104) = 52.98$, $p < .001$. Sixth graders and college students were more likely to place the medial consonant in both syllables than were second graders.

Occasionally, the intervocalic consonant was not assigned to either syllable. Such responses were more common for long than short vowels, as shown by the main effect of vowel type, $F1(1,65) = 45.69$; $F2(1,52) = 32.98$; $p < .001$ for both. Vowel type and grade interacted, $F1(2,56) = 4.49$, $p < .05$; $F2(2,104) = 8.11$, $p < .01$. The difference between long and short vowels, although significant at all grade levels, was larger for second graders than for sixth graders and college students.

Finally, we examined responses that did not fit into any of the categories described above. The only significant effect here was the main effect of grade, $F1(1,65) = 7.27$, $p < .01$; $F2(2,104) = 83.07$, $p < .001$. Second graders made more "other" responses than sixth graders or college students. As in Experiment 1, the great majority of these "other" responses occurred when participants were asked to provide the end part of the word. Again, the most common type of invalid response was to segment the word after the onset of the first syllable and say the remainder (e.g., /ɛləʃ/ as the end part of *relish*). The rare first-part errors tended to involve reports of onsets (e.g., /z/ as the first part of *zero*).

It is of interest to determine whether participants based their syllabification responses on the presence of real words in the first (C)(C)VC segments of the items, as with /wæg/ in *wagon*. This strategy would have resulted in a tendency to place these real words in the first syllables of the items, either in first-syllable only responses or as the first syllable in both-syllable responses. Accordingly, we calculated the number of participants who provided either first-syllable only or both-syllable responses to items that had words (e.g., /wæg/ in *wagon*) or nonwords (e.g., /vɪg/ in *vigor*) as the first (C)(C)VC. Participants were no more likely to produce these responses to items with word (C)(C)VC segments than items with nonword segments (ps $> .10$). This result suggests that performance was not driven by a tendency to produce real-word answers.

Spelling task. Table 6 shows the mean proportions of correct responses on the experimental items of the spelling choice task. The mean proportions of correct responses on the fillers, not shown in the table, were .67 (*SD* .12) for second graders, .92 (*SD* .09) for sixth graders, and .99 (*SD* .02) for college students. An ANOVA on correct responses using the factors of word type (experimental, filler) and grade (grade 2, grade 6, college) revealed only a main effect of grade, $F1(2,65) = 143.25$; $F2(2,220) = 207.45$; $p < .001$ for both. Performance improved with age, but all groups scored significantly above chance ($p < .001$ by subjects and by items). When we analyzed the responses to the experimental words using the factors of vowel type, conso-

Table 6
Proportion of correct spelling choices in Experiment 2 as a function of grade level, vowel type, and consonant type

	Short vowel				Long vowel			
	Sonorant		Obstruent		Sonorant		Obstruent	
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Second grade	.70	.21	.59	.20	.59	.18	.73	.14
Sixth grade	.86	.16	.81	.17	.89	.12	.93	.10
College	.95	.05	.95	.06	.99	.02	.99	.02

nant type, and grade, we found significant main effects of grade, $F1(2,65) = 40.20$; $F2(2,104) = 136.08$; $p < .001$ for both, and vowel type, $F1(1,65) = 17.19$, $p < .001$; $F2(1,52) = 4.31$, $p < .05$, as well as a vowel type by consonant type interaction, $F1(1,65) = 39.92$, $p < .001$; $F2(1,52) = 6.35$, $p < .05$. These effects were qualified by a three-way interaction, $F1(2,65) = 16.17$, $p < .001$; $F2(2,104) = 5.15$, $p < .01$. Second and sixth graders performed better on long vowels than short vowels for obstruents only, whereas college students performed better on long vowels than short vowels for all types of items.

Discussion

The results of Experiment 2 show that vowel quality and consonant sonority influence explicit syllabification by at least second grade. The effects found for children are similar to those found for the adults in this study and previous studies (Derwing, 1992; Treiman & Danis, 1988). Consider, first, the influence of vowel quality. With words like *demon*, which have a long stressed vowel in the first syllable, participants were more likely to assign the /m/ to only the second syllable than with words like *lemon*, which have a short vowel. Conversely, words like *lemon* gave rise to more first-syllable only responses and more both-syllable responses than words like *demon*. These differences were present by second grade, the lowest grade level tested here. The sonority of an intervocalic consonant also influenced syllabification, in some cases as early as second grade. Responses that placed the consonant in the first syllable only were more common for words like *melon*, with a medial sonorant, than for words like *wagon*, with a medial obstruent. This was true for second graders and sixth graders, as well as adults. Responses that placed the intervocalic consonant in the second syllable only were more common for words like *wagon* than words like *melon* by sixth grade. Contrary to Zamuner and Ohala (1999), children showed differences between sonorants and obstruents for long-vowel words as well as short-vowel words. To summarize, influences of vowel quality and consonant sonority emerged by second grade, earlier than the influences of spelling that were studied in Experiment 1. The different developmental courses of the phonological and orthographic effects suggest that they are indeed distinct.

Both Experiment 1 and Experiment 2 included words with a short vowel in the first syllable and an intervocalic consonant that was spelled with a single letter. Such words gave rise to more both-syllable responses in Experiment 1 than Experiment 2 for all groups of participants. This difference probably reflects the mix of stimuli in each experiment. As mentioned earlier, participants' responses appear to be less varied when only words with short vowels are presented, as in Experiment 1, than when short-vowel and long-vowel stimuli are mixed, as in Experiment 2. Supporting this idea, a pilot study in which four second graders syllabified short-vowel items alone and another four children syllabified such items in an equal-length listed that included half long-vowel items showed a higher proportion of both-syllable responses in the former group (.50) than in the latter group (.30). Such effects should have little impact on the conclusions drawn here, however, as the critical comparisons were carried out within each experiment rather than across experiments.

The categories that we examined in Experiment 2 were rather broad. For example, the short vowel category included mostly vowels that cannot legally end an English syllable, such as /ɛ/, but also /ɑ/, which can occur at the ends of syllables. The long vowel category included both monophthongs and diphthongs. Further research will be necessary to examine the specific phonetic or phonological factors that contribute to the differences observed here.

General discussion

The present experiments were designed to examine how English-speaking children syllabify spoken words. We examined the influences of orthographic and phonological factors on syllabification and how these influences change with development. The results of Experiment 1 revealed that first and second graders do not show effects of spelling on oral syllabification, whereas sixth graders and adults do. These results speak to the question of how and when knowledge of printed language comes to affect people's conceptions of spoken language. As mentioned in the Introduction, learning to read and spell appears to influence people's categorization of sounds. For example, the middle sound of *meteor* may be classified as a /t/ by speakers of American English primarily because it is spelled as such (e.g., Ehri & Wilce, 1986). Learning to read and spell may also influence whether certain segments are conceptualized as single units or sequences. For example, the vowel diphthong of *buy* is typically considered a single "sound" because it is the name of a letter (*i*). The vowel of *how*, which is also a diphthong, is often considered two "sounds" (Treiman & Cassar, 1997). Our results extend previous findings by showing that spelling also influences people's views of syllable boundaries. These effects take time to emerge, but are substantial when they do.

Experiment 1 found a developmental increase in the effect of spelling on syllabification. In Experiment 2, which focused on phonology, no strong developmental differences were found. Second graders showed effects of vowel quality and consonant sonority on oral syllabification, and these effects were similar to those seen in sixth graders and adults. This similarity supports the idea that the effects of vowel quality and consonant sonority are phonological in nature. Phonological factors explain the greater tendency to place the /m/ of *lemon* in the first syllable than to place the /m/ of *demon* in the first syllable; the difference does not reflect the knowledge that *lemmon* is a possible alternative spelling of *lemon* whereas *demmon* is a very unlikely spelling of *demon*.

Our results are not fully anticipated on the basis of linguistic theories of syllabification. Pulgram's (1970) theory predicts effects of vowel quality on syllabification, but the theories of Kahn (1976) and Selkirk (1982) do not. None of these theories predicts the effect of consonant sonority that was observed in this and previous studies. The present results strengthen the evidence for effects of vowel quality and consonant sonority and suggest that they need to be accounted for in some way. A promising way of thinking about sonority effects comes from the idea, proposed by Vennemann (1988), that syllables have a preferred structure. One aspect of this ideal structure is an onset that is low in sonority and a coda (if one exists) that is high in sonority. If words are divided so that the syllables conform as closely as possible to this ideal, then the medial sonorant of *melon* will be more likely to be placed in the first syllable than the medial obstruent of *wagon*. Consistent with the idea of a strong bond between vowels and following sonorants, sonorants, especially /ɹ/ and /l/, are more likely than obstruents to align themselves with preceding vowels even in monosyllables (e.g., Derwing & Nearey, 1991; Hindson & Byrne, 1997; Treiman, 1984b).

Our results are relevant to some proposals about syllabification that Content et al. (2001) made on the basis of their results with French-speaking adults. These authors suggested that the processes involved in determining the onsets of syllables differ from those involved in determining their offsets. In their view, speakers may make decisions about the beginnings of syllables without always committing themselves to a decision about their endings. Onset determination is more dominant and more fundamental than coda determination. The results of Content et al. are consistent with this view in that spelling and consonant sonority influenced French adults' responses in the first part task, where participants judged whether the intervocalic consonant was the coda of the initial syllable. In the second part task, which required an onset decision, participants placed the consonant in the second syllable's onset a high percentage of the time regardless of its spelling or its sonority.

Previous studies that have examined English-speaking adults' syllabification of single intervocalic consonants (Derwing, 1992; Treiman & Danis, 1988) have not generally used tasks that allow decisions about onsets and codas to be assessed separately. For instance, potential dissociations between onset and coda determination may be masked in the syllable reversal task of Treiman and Danis if participants try to avoid repeating a phonemic segment. The present task, which temporally separates onset determination and coda determination in a way that has not been done with English-speaking adults, allows us to ask whether the two processes are as different in English as they appear to be in French. Our results suggest that the two processes are quite similar for English words with first-syllable stress. English speakers' judgments about such words' onsets, like their judgments about the codas, were influenced by both spelling and sonority. For example, the adults in Experiment 1 placed the medial consonant in the onset of the second syllable in 81% of their responses to words like *valley*. For words like *salad*, the figure was substantially lower, 64%. In French, where stress is not lexically contrastive and where vowels are not reduced, the /l/ of a word like *colère* is almost always placed in the second syllable. In English words like *salad*, the second syllable is unstressed and has a reduced vowel. The onsets of such syllables are not necessarily maximized, especially when the word's spelling suggests that the consonant belongs to only one syllable and when the consonant is a sonorant.

Syllables play an important role in phonological awareness, speech processing, and reading. The present results provide some guidelines for increasing children's ability to exploit syllables in these tasks. For example, phonological awareness instruction given before children learn to read can increase their chances of reading success (see, Snow et al., 1998). Such instruction typically begins with words and syllables and progresses to the level of phonemes. Our results suggest that a word like *salad* should be broken up as /sæl.əd/ rather than as /sæ.ləd/ in syllabic awareness training for young children. The former division appears to be more natural than the latter. Our results also provide some guidance about the use of syllables in reading instruction. Bhattacharya and Ehri (2001) found that reading-disabled adolescents learned words better when they practiced reading them by breaking them into syllables than when they read them as wholes (see also Olson & Wise, 1992). However, these researchers did not compare different ways of syllabifying words to determine which is most beneficial. Participants in the syllable condition could divide *salad* either before or after the /l/, for example. Our results suggest that a division after the /l/ is preferable. As these examples show, a knowledge of which syllabifications are most natural for children can ensure that syllables are used to best advantage in instruction. In addition, such research can help us better understand the syllable's role in language processing.

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