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ABSTRACT

In order to investigate relationships between spoken and written language knowledge at a phonological level, linguistic theories of syllable structure that treat initial consonant clusters as units are first discussed. Second, experimental evidence is presented suggesting that analysis of initial clusters is difficult for both children and adults in various phonemic analysis tasks. Third, an attempt is made to show that children's difficulty in analyzing initial clusters in spoken words affects their ability to learn printed words. Analysis was made of 5,618 spellings produced during daily story writing sessions by 43 first-grade students across 2 successive school years. In the analysis, pronunciation and spelling were keyed to assist identification of specific letters children used to represent specific phonemes. Consistent with the view that clusters tend to behave as units, children relatively often failed to represent one phoneme of a syllable-initial cluster. The phoneme usually deleted was the second. Results of studies suggested that difficulties in the analysis of spoken language are reflected in the learning of printed language. Nonstandard but consistent misspellings, such as the deletions of phonemes in consonant clusters, may stem from children's conceptions of spoken language. These misspellings diminish by the end of the first-grade year, and it may be that reading experience with print provides an impetus for children to further analyze their spoken language. (RH)

Phonemic analysis and the development of spelling

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This presentation deals with relationships between spoken language knowledge and written language knowledge at a phonological level. Several investigators (e.g., Elkonin, 1973; Golinkoff, 1978; Gough & Hillinger, 1980; Liberman, Liberman, Mattingly, & Shankweiler, 1980; Rozin & Gleitman, 1977; Treiman & Baron, 1981) have suggested that the ability to conceive of spoken words as sequences of phonemes plays a critical role in the acquisition of alphabetic writing systems. Indeed, there is evidence that phonemic analysis skill correlates with and predicts reading and spelling success (e.g., Fox & Routh, 1980, Note 1; Lundberg, Olofsson, & Wall, 1980; Perfetti, Beck, & Hughes, Note 2; Treiman & Baron, in press). This talk considers one particular aspect of phonemic analysis that appears to cause special difficulty -- the analysis of initial consonant clusters of spoken syllables into phonemes. First, I will discuss linguistic theories of syllable structure that treat initial consonant clusters as units. Then, I will present experimental evidence that the analysis of initial clusters causes some difficulty for both children and adults in various phonemic analysis tasks. Finally, I will attempt to show that children's difficulty in analyzing initial clusters in spoken words affects their ability to learn printed words. I hope to demonstrate that a detailed understanding of children's phonological knowledge can shed light on some phenomena involving written language.

Linguistic theories of syllable structure

According to several linguists and psycholinguists (Cairns & Feinstein, 1982; Fudge, 1969; Halle & Vergnaud, 1980; MacKay, 1972; Vergnaud & Halle, Note 3), the English syllable contains two major constituents. The onset, which is optional, is the initial consonant or consonant cluster. The rime, which is obligatory, consists of a peak (the vowel nucleus) and an optional coda (the final consonant or consonant cluster). In addition, word-final syllables may contain an appendix of inflectional suffixes. Figure 1 depicts the postulated structure of the syllable in terms of a tree diagram. Linguists have offered

primarily distributional evidence to support this model of syllable structure. For example, virtually any onset can occur with any rime (Fudge, 1969). In contrast, there are severe constraints on which peaks can occur with which codas. These facts support the view that the peak and the coda are conjoined into a higher-level unit, the rime, and that the rime and the onset are relatively independent. Studies of errors in the spontaneous production of speech (e.g., MacKay, 1972) provide further support for the view that onsets and rimes are distinct units.

In this talk I will focus on the onset. If the onset functions as a cohesive unit, as the linguistic theories suggest, certain consequences for phonemic analysis skill and possibly also for spelling and reading would be expected. I now discuss some evidence that onsets behave as units in tasks requiring subjects to analyze and manipulate spoken syllables.

Studies involving spoken syllables

I will discuss four studies involving spoken syllables, two with adults and two with children. The first study, which was carried out with college undergraduates as subjects, was a series of seven experiments (Treiman, in press). In these experiments, subjects learned novel word games that divided spoken syllables in various ways. For example, one game required subjects to combine two CCVCC (consonant-consonant-vowel-consonant-consonant) syllables such as /krɪnt/ and /glʌpθ/ into one new syllable. One combination rule (the CC/VCC rule) joined the CC of the initial syllable with the VCC of the second syllable, yielding /krʌpθ/. This rule respected the onset/rime boundary. Other rules did not respect this boundary, and proved more difficult for subjects to learn. (See Table 1.) Further, when other subjects were permitted to combine the syllables in any way they chose a large majority of their responses revealed an onset/rime division. (See Table 2.) Converging evidence from other kinds of word game tasks supports the view that adult subjects prefer to keep onsets intact in these tasks, although they can divide them into their constituent phonemes when necessary.

Given these results with adults, one might expect that children would have even more difficulty dividing onsets into their constituents. I carried out two experiments with 5-year-olds to test whether children more often fail to recognize the presence of an initial consonant when that consonant is the first element of a cluster than when it is a singleton. The subjects for the first experiment were 12 children with a mean age of 5 years, 5 months. The children were introduced to a puppet who, they were told, liked a certain sound. Children listened to tape-recorded lists of syllables and judged whether each one began with the puppet's favorite sound. The target sound was /s/ for two lists and /f/ for a third list. The syllables beginning with the target were of three types: CV (e.g., /sa/, /fo/), CVC (e.g., /san/, /fol/), and CCV (e.g., /sna/, /flo/). Error rates varied significantly as a function of syllable structure: 12% on CV syllables, 14% on CVC syllables, and 28% on CCV syllables. Planned comparisons showed that error rates on CV and CVC syllables were indistinguishable, but that significantly more errors were made on CCV syllables than on syllables beginning with singleton consonants.

Another experiment further tested the hypothesis that children have difficulty recognizing /s/ and /f/ in clusters by comparing performance on CVCC and CCVC syllables. The subjects were 16 children with a mean age of 5 years, 10 months, and the procedure was similar to that of the previous experiment. However, the target was in the initial position for two lists (one with an /s/ target and one with /f/) and in the final position for two other lists (one with each target). Sample stimuli for the /s/ initial target condition are /sɪmp/ and /smɪp/, and samples for the /f/ initial target condition are /fɛlθ/ and /flɛf/. Sample stimuli for the final target position include /θars/, /θras/, /pʌlf/, and /plʌf/. The error rates in the syllable-initial condition were 19% on CVCC syllables and 25% on CCVC syllables. This difference was significant by a planned comparison. As in the earlier experiment, children more often failed to detect a syllable-initial consonant when it was part of a cluster than when it

was a singleton. In the final target condition, the error rates were 21% on CVCC syllables and 19% on CCVC syllables. These values did not differ significantly. The results of the two experiments with children are consistent with the view that syllable-initial consonant clusters tend to behave as units (see also Barton, Miller, & Macken, 1980). At least with initial /s/ and /f/, 5-year-olds more often fail to detect an initial consnant when it is followed by another consonant than when it is followed by a vowel.

Finally, I will discuss a fourth study involving spoken syllables, this one carried out with college undergraduates as subjects (Treiman, Salasoo, Slowiaczek, & Pisoni, 1982). Here, we asked whether adults take longer and/or make more errors in recognizing initial consonants when they occur as clusters than when they occur as singletons. The experiment was run under computer control. Subjects were instructed to push a button as quickly as possible when they heard a syllable that began with a previously-specified target phoneme, and response times and errors were measured. The stimuli were CV, CVC, and CCV syllables. In the first part of the study, /s/ and /f/ targets were used. Subjects took longer to respond to initial targets in CCV syllables than to targets in CV and CVC syllables, as the top panel of Figure 2 shows. Error rates also differed as a function of syllable structure (bottom panel of Figure 2). Stop consonant targets were used in the second part of the study. Similar results were obtained in the response time measure (see Figure 3), although no error differences emerged as a function of syllable structure. These results suggest that even adults require some additional time to analyze initial consonant clusters into their constituent phonemes.

Studies involving printed words

The results reviewed above suggest that initial consonant clusters or onsets are cohesive units within the syllable. Adults are able to analyze clusters into sequences of phonemes when required to do so , but children appear to have more difficulty. This difficulty may have implications for children's ability to

represent a spoken syllable in written form. If children tend to conceive of initial consonant clusters as single units, they might be expected to use one letter rather than two to spell the cluster.

To examine this and other questions, I have begun to analyze a large corpus of spellings produced by children in a first grade class in Indianapolis. These children are taught by a language experience approach. Each morning they write and illustrate a story. The teacher or teacher's aide writes the word that the child says he or she intended over the child's own spelling but does not otherwise correct the child. Each story is also dated by the teacher. A sample production is seen in Figure 4. The children's spellings, as revealed in these spontaneous productions, reflect their conceptions of sounds and of sound-spelling relationships. This reflection is presumably more direct than would be the case for children who receive extensive drill and memorization with standard English spellings. I have collected the writings of 43 children who attended this first grade class in two successive school years. There are 5,618 spellings in all.

To analyze this large data base, we have developed a computer program that accepts, for each record, the child's name, the date in the school year, the standard spelling of the word, its pronunciation in Hoosier speech, and the child's spelling of the word. The pronunciation and spelling are keyed so that we can examine which letters were used to represent which phonemes. This data base will allow us to examine many of the same phenomena first noted by Read (1975) in his influential study of preschoolers' invented spellings. However, these children are older than those studied by Read (1975) and are learning to spell in a classroom situation instead of on their own.

Here I will discuss only the analyses concerning children's spellings of syllable-initial consonant clusters. Consistent with the view that clusters tend to behave as units, children relatively often failed to represent one phoneme of a syllable-initial cluster. The phoneme that was deleted tended to be the second

phoneme rather than the first phoneme. First phonemes of syllable-initial clusters were deleted in 1.32% of cases, while the same phonemes followed by vowels were deleted in .87% of cases. (See Table 3.) This difference is not significant by a *t* test across the nine phonemes involved ($t(8) = .90$), or by a *t* test across subjects ($t(38) = 1.57$; four subjects did not attempt to spell any consonant clusters so this analysis is based on 39 subjects). Second phonemes of syllable-initial clusters were deleted 23.40% of the time. When these same phonemes were in syllable-initial position followed by a vowel they were only deleted .89% of the time. This difference is highly significant (across stimuli $t(7) = 4.83$; $p < .001$, one tailed; across subjects $t(38) = 7.63$, $p < .0005$, one tailed). Examples of deletions of the second phonemes of syllable-initial clusters may be seen in Figure 5. Could the tendency to omit the second phonemes of syllable-initial clusters arise from a general tendency to omit the second phonemes of words? This does not seem to be likely. Children were much less prone to omit a phoneme such as /l/ when it occured in a word like "alone" (second phoneme of word and syllable-initial position; 2.70% omissons) than when it occurred in a word like "blue" (second phoneme of word and second element of a cluster; 23.31% omissions). This difference was significant by *t* tests across stimuli ($t(6) = 2.41$, $p < .05$, one tailed) and across subjects ($t(18) = 3.80$, $p < .001$, one tailed).

Thus, there is evidence that first graders learning to spell sometimes represent syllable-initial consonant clusters with a single letter. The first phoneme of the cluster appears to be more salient and more often represented than the second phoneme. Omissions of nasals in syllable-final clusters have been reported in previous studies (e.g., Beers & Henderson, 1977; Read, 1975), as in the spelling BOP for "bump". Investigators suggested that the predictability of the nasal might contribute to its omission: before /p/, for example, only the nasal /m/ can occur. However, the second elements of syllable-initial clusters are not predictable: after /b/, for example, two consonants may occur and after

/s/ even more are possible. I suggest that children's omissions of phonemes in clusters reflect syllable structure rather than predictability. Children tend to conceive of syllable-initial clusters as units, and may consequently spell these units with a single letter.

Conclusion

The results presented here suggest that difficulties in the analysis of spoken language are reflected in the learning of printed language. Nonstandard but consistent misspellings, such as the deletions of phonemes in consonant clusters, may stem from children's conceptions of spoken language. These misspellings diminish by the end of the first grade year, and it may be that experience with print, through reading, provides an impetus for children to further anlayze their spoken language (Ehri, 1983). The relation between spoken language knowledge and written language has been illustrated here for a particular phenomenon at the phonological level. The same relation is expected to hold for other phenomena at the phonological level and at other levels of language.

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Table 1

Results of experiment comparing adults' ability to learn four different syllable-combination rules

Rule	Example	Mean number of errors in learning rule (max. = 13)
C/CVCC	krint + glupth → klupth	1.84
CC/VCC	krint + glupth → krupth	.64
CCV/CC	krint + glupth → kripth	6.24
CCVC/C	krint + glupth → krinth	4.24

Table 2

Results of experiment examining adults' preferred syllable-combination rule

Rule	Example	Mean number of responses (total = 15)*
C/CVCC	krint + glupth → klupth	1.50
CC/VCC	krint + glupth → krupth	10.08
CCV/CC	krint + glupth → kripth	.83
CCVC/C	krint + glupth → krinth	1.00

*The remaining 1.58 responses fit none of these rules.

Table 3

Deletions of consonants in clusters and in non-cluster positions in first graders' spellings

Consonants that occur in the data base as the first phonemes of syllable-initial consonant clusters (b, d, g, p, t, k, f, θ , s)

	#cases	#cases in which consonant is deleted
in syllable-initial position in a cluster	453	6 (1.32%)
in syllable-initial position followed by a vowel	1960	17 (.87%)

Consonants that occur in the data base as the second phonemes of syllable-initial consonant clusters (l, r, m, n, w, p, t, k)

in second position in a cluster	453	106 (23.40%)
in syllable-initial position	2250	20 (.89%)
in syllable-initial position and second phoneme of word	37	1 (2.70%)

Figure 1

Postulated structure of the English syllable

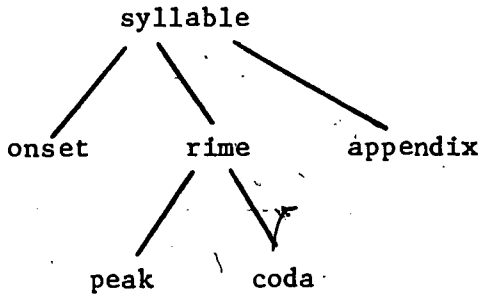


Figure 2

Latencies for correct responses (top panel) and percent errors (bottom panel) in detection of syllable-initial /f/ and /s/ targets in CV, CVC, and CCV syllables.

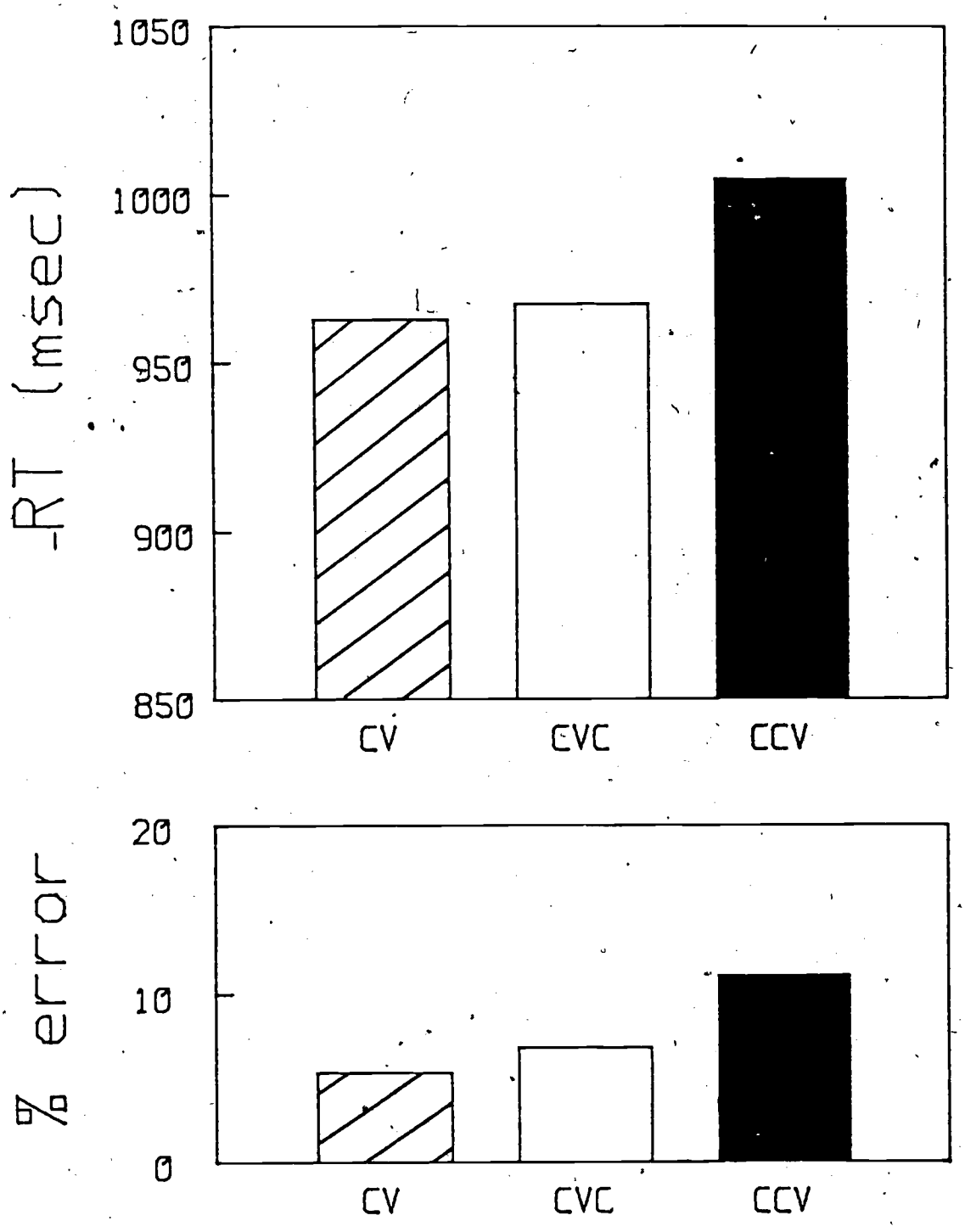
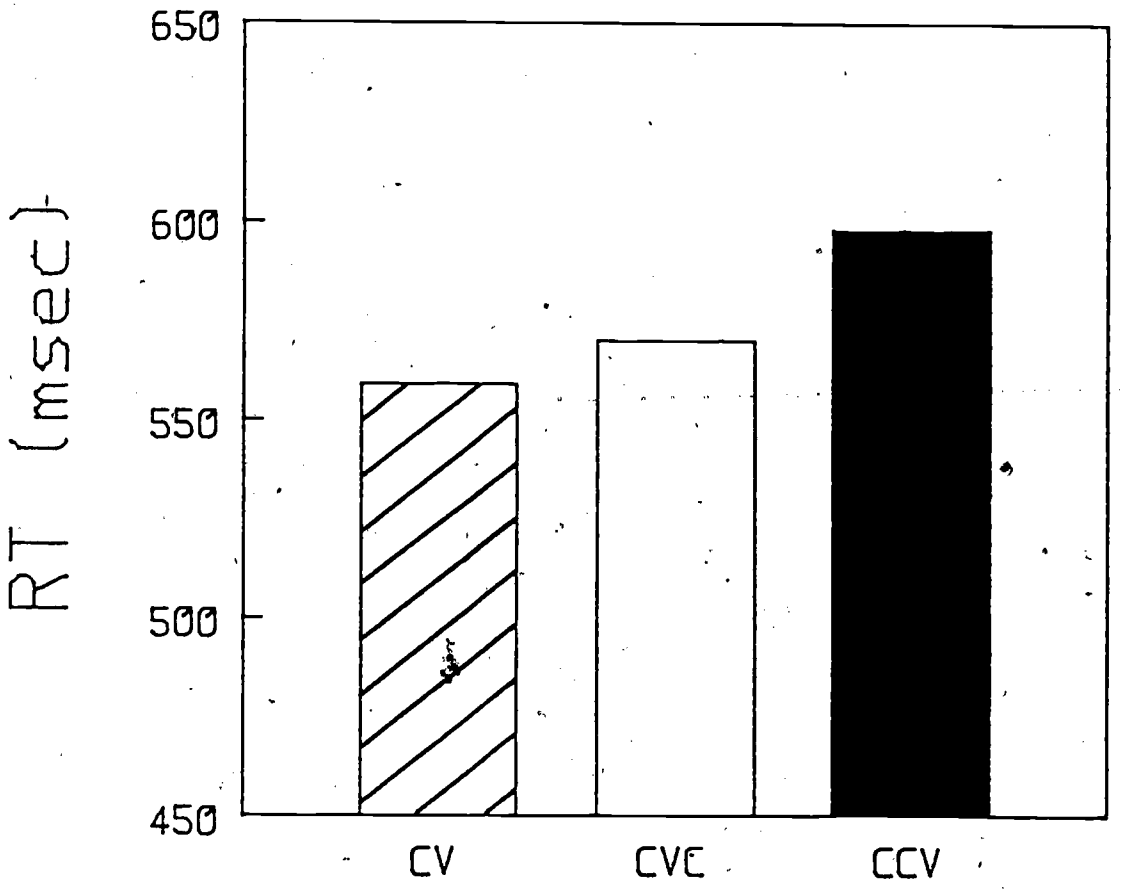


Figure 3

Latencies for correct detections of syllable-initial stop consonant targets in CV, CVC, and CCV syllables.



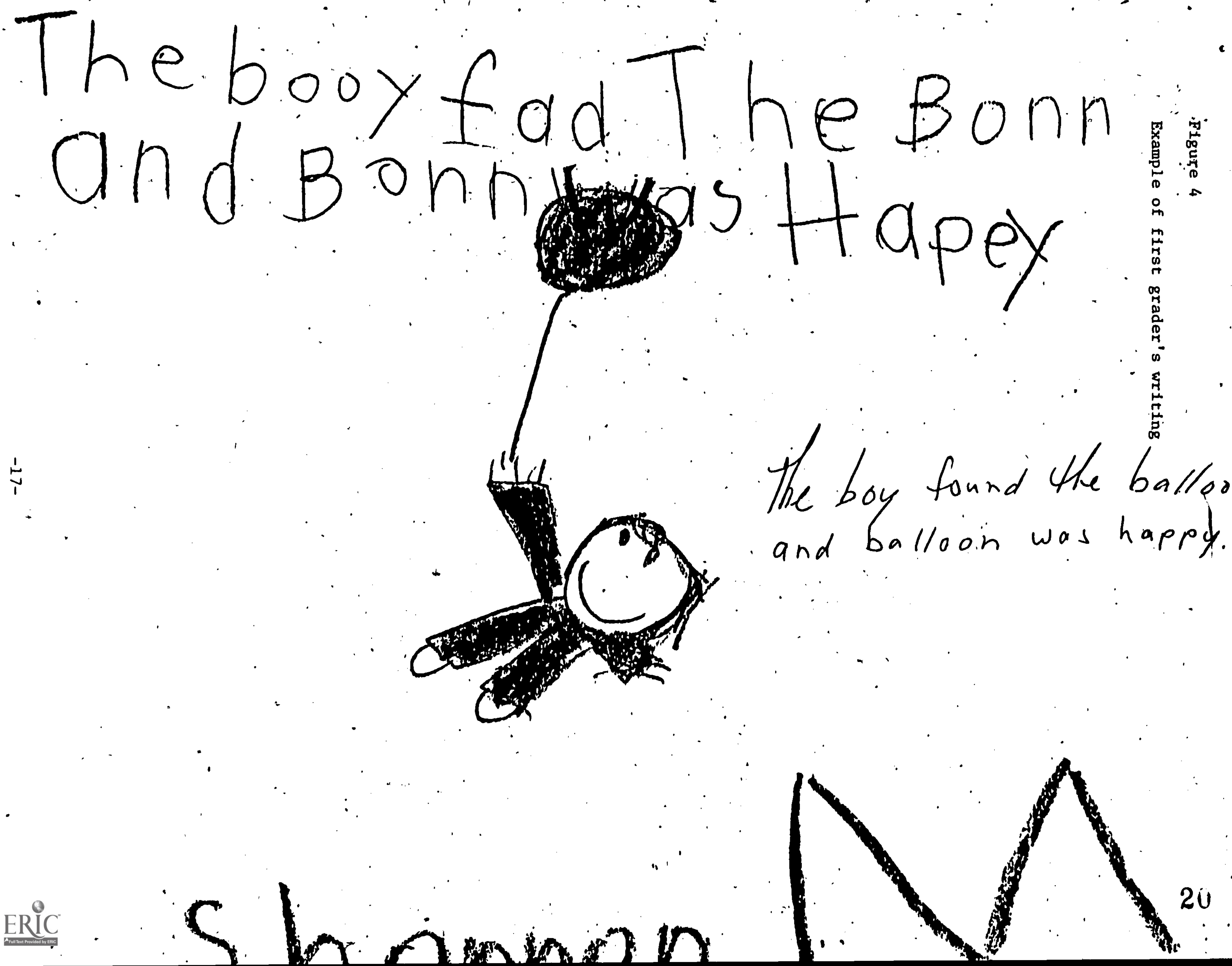


Figure 4
Example of first grader's writing

Figure 5

Examples of first graders' spellings of syllable-initial consonant clusters

Intended word	Child's spelling
blow	BO
butterfly	BUDRFI
clothes	KOS
secret	SICT
plane	PANE
tree	TEE
street	SET