

EFFECTS ON SPELLING OF TRAINING CHILDREN TO READ

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Experiment 1 investigated whether training subjects to read words aloud would induce correct written spelling of the words even though spelling had no experimental consequences. Training in reading was followed by a weak increment in correct spelling. Experiment 2 investigated whether overtraining in reading would improve spelling more. Spelling improved as overtraining continued until the subjects spelled all the words correctly. Experiments 3 and 4 investigated the components of overtraining responsible for this improvement in spelling. Initial training in reading followed by repeated opportunities to look at (but not say aloud) the printed words resulted in the same gradual improvement in spelling as seen in Experiment 2. The results were related to Skinner's theory of verbal behavior and to studies of the relationship between speaking and instruction-following in children.

Key words: verbal behavior, reading, spelling, children

A contingency of reinforcement can strengthen responses outside the class of reinforced responses. For example, Martin (1971) found that reinforcing *either* imitation or instruction-following strengthened both repertoires, and Wahler and Nordquist (1973) found that reinforcing compliance strengthened both compliant and imitative responses. Other studies have had similar results (e.g., Lee, 1981; Nordquist, 1971; Wahler, Sperling, Thomas, Teeter, & Luper, 1970; Whitehurst, 1977).

The indirect induction of behavior by a contingency of reinforcement is important theoretically, because it is one aspect of the problem of how behavior is organized (e.g., Herrnstein, 1977). Verbal behavior is a case in point. Dismissing the global notion of "use of language," Skinner (1957, pp. 187-198) hypothesized that "the same word" may participate in two or more independent functional units of behavior. He meant by this that the various kinds of behavior described traditionally as "use of language" need not necessarily have any connection functionally. Recent studies (Guess, 1969; Guess & Baer, 1973; Lee, 1981; Whitehurst, 1977) investigated this possibility for the relation between grammatical speaking

and instruction-following. They found that these two kinds of behavior, though involving "use of the same word," were not always connected functionally, a result consistent with Skinner's hypothesis.

The present study extended investigation of Skinner's hypothesis to the relation between oral reading (texting) and written spelling (transcribing). Some educators (e.g., Bennett, 1967; Greene & Petty, 1971) have suggested that children learn to spell many words through reading them. This possibility implies a functional connection between reading and spelling. Thus, on the average, children who read well also spell well (Horn, 1969). Apparently, however, there have been no attempts to analyze experimentally whether training children to read words aloud can induce correct written spelling of the words. Whether any functional connection exists between these two kinds of behavior remains to be determined.

EXPERIMENT 1

This experiment investigated whether training subjects to read words orally would be followed by correct spelling of the same words on request.

METHOD

Subjects

Rua and Ed (both 11 years old) were fifth graders who could not read. Before this experi-

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ment, their teacher (Anne M. Pegler) had spent 10 minutes daily for several weeks teaching them to read words from Holdaway's (1972) basic sight vocabulary. Teaching had been unsystematic and progress slow. This and the following experiments were designed to make progress more rapid.

Setting and Sessions

Daily 15-min sessions were held by the teacher-experimenter with each subject individually, while other students engaged in seatwork. Subject and teacher-experimenter sat alongside each other at the subject's desk.

Materials

Materials were 406 cards. Each card was 12 by 3 cm and showed one word printed in black. The teacher had prepared these cards prior to the experiment for teaching basic sight vocabulary to Rua and Ed. The words shown were the 406 words in Holdaway's (1972) basic sight vocabulary.

Reinforcers

Praise and tokens (poker chips) followed correct responses during reading training. Ten tokens were exchangeable for one minute of free time taken in multiples of ten minutes during any teaching period except math and sport. The subjects engaged in free time at their desks—coloring, playing with toys brought from home, playing with math equipment, looking at books, and so on.

Initial Pretest

The experiment began with a pretest, to select 50 words the subject could not read and to test spelling of these words.

On the first trial, the teacher selected one word randomly and without replacement from the pool of 406 words. The card showing this word was placed on the desk in front of the subject, and the teacher said "Read it." The subject was given five seconds to respond, after which the card was removed. A reading response, if any, had no experimental consequence.

On the next trial, the teacher selected a second word from the remaining 405 words, again randomly and without replacement, and asked the subject to read the word. The same procedure of selecting a word and asking the subject to read it was used across successive trials,

with a new word presented on each trial, until 60 words not read correctly had accumulated.

These 60 words were then presented again, following the same procedure, until 50 words not read correctly had accumulated.

Next, spelling of these 50 words was tested. The subject was given paper and a pencil. On the first trial, the teacher selected one word randomly and without replacement from the pool of 50 words and said "Spell (word)." The subject was given 10 seconds to write his response, after which the teacher selected a second word and asked the subject to spell it. This procedure of selecting a word and asking the subject to spell it was repeated across successive trials, with a new word presented on each trial, until spelling of all 50 words had been tested (i.e., 50 trials). Spelling responses had no experimental consequences.

Scoring

Responses during the initial pretest, and during subsequent procedures, were scored as follows. The teacher listened to each reading response and noted on her scoring sheet whether the response was correct or incorrect according to the conventions of English usage. The written products of spelling were examined after each spelling test (not after each word), and each word was scored correct or incorrect, again according to the conventions of English usage.

Overall Design

The 50 words in the initial pretest gave five sets of ten words each. Reading training and spelling testing were carried out for each set in succession. The subject was trained to read the words in the first set, later the words in the second set, and so on. Spelling was neither modeled nor consequated experimentally. It was merely tested. The first spelling test was during the initial pretest described above. Spelling of the words in each set was also tested immediately before (pretest) and after (posttest) reading training for that set.

First Set of Words

Pretest. Ten words were selected randomly and without replacement from the 50 words. A pretest was conducted using only these 10 words. Reading was tested first (10 trials) and then spelling (10 trials), using the same testing procedure as in the initial pretest.

Reading training. After the pretest, the subject was trained to read (text) the 10 words. Spelling was neither tested nor trained while reading was taught.

On the first trial during reading training, the teacher selected one word card randomly from the 10 word cards. She placed the card in front of the subject and said "Read it."

The teacher praised the subject and gave him one token following a correct response. Following an incorrect response, she said "No," removed one token (if tokens had been accumulated), and modeled the correct response. The teacher simply said the correct response (e.g., "bridge"). She did not model phonic self-prompting (e.g., "br-idge, bridge"). No experimental consequence followed if the subject imitated the teacher's model. If the subject did not respond within 10 seconds or indicated he could not respond correctly (for example, by saying "I don't know"), the teacher removed one token (if possible) and modeled the correct response. Again, imitating the model had no experimental consequence.

The same word card was presented across successive massed trials, with reading responses consequated as above, until the subject responded correctly on two consecutive trials.

After this criterion was met, the teacher selected a second word card randomly and without replacement. The subject was trained to read both the word initially trained and this second word. The words were presented in random order, with responses consequated as above, until correct reading responses were given on four consecutive trials, two for each word. To control the teacher's randomizing of word cards and scoring of responses, each word was written at the top of a numbered column on a ten-column scoring sheet. Only two columns were used in this part of reading training since only two words were trained. Each box at the intersection of a column and a row on the scoring sheet represented one trial and was checked for a correct response and crossed for an incorrect response. Randomizing was controlled by working down a list showing 20 randomly determined sequences of the numbers 1 and 2 that corresponded to the two words being trained.

After criterion was met when two words were trained, a third word card was selected, and the subject was trained to read this word and the two previously trained words, until he

gave correct responses on six consecutive trials, again two for each word. Randomizing and scoring were controlled as before, except that now three columns and a list showing 20 randomly determined sequences of the numbers 1, 2, and 3 were used. After criterion was met, a fourth word was selected, and so on, through successive words, until all 10 words were taught concurrently and a final criterion was met of correct reading responses on 20 consecutive trials, two for each word.

After this criterion performance, a posttest for both reading and spelling was conducted. Procedure was as in the pretest conducted before reading training on this word set. Reading was tested (10 trials) and then spelling (10 trials). Neither reading nor spelling had experimental consequences.

Subsequent Sets of Words

After the posttest for the first set of words, another pretest was conducted, with a second set of word cards. These words were selected randomly and without replacement from the remaining 40 words. The pretest was conducted exactly as for the first set of words, with reading tested first and spelling later.

Following this pretest, the subject was trained to read the 10 new words, in the same way and to the same criterion as before. A posttest for both reading and spelling was then conducted, again exactly as with the first set of words.

Next, a third set of 10 words was selected randomly and without replacement from the remaining 30 words. Reading and spelling of these words were pretested; the subject was trained to read them; and reading and spelling were posttested. The same three procedures (pretesting, reading training, and posttesting) were repeated with the fourth and fifth sets of words.

Interobserver Agreement

Reading responses in pretests and posttests were tape-recorded. Later Vicki L. Lee listened to the recording and noted on a scoring sheet whether each response was correct or incorrect according to the conventions of English usage. The scoring sheet listed the words shown to the subject in each pretest and posttest. Lee's data were compared trial-by-trial with Pegler's. Agreement was 100% in every pretest and posttest.

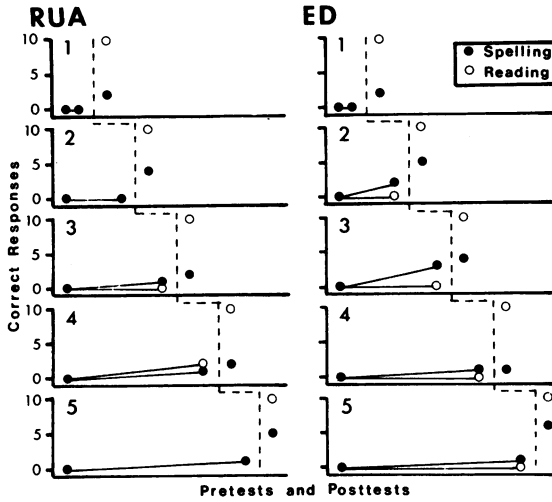


Fig. 1. Correct spelling and reading responses by Rua and Ed in pretests and posttests for the five sets of words in Experiment 1. Dashed line indicates reading training. The pretests precede the line; posttests follow it.

Lee also scored the subject's spelling paper for every pretest and posttest. Her data were compared trial-by-trial with Pegler's and, again, agreement was 100% in every pretest and posttest.

RESULTS AND DISCUSSION

Figure 1 shows correct spelling and reading responses on each set of 10 words for each subject in the initial pretest, in the pretest that immediately preceded reading training on each word set and in the posttest that followed reading training on each word set. Figure 2

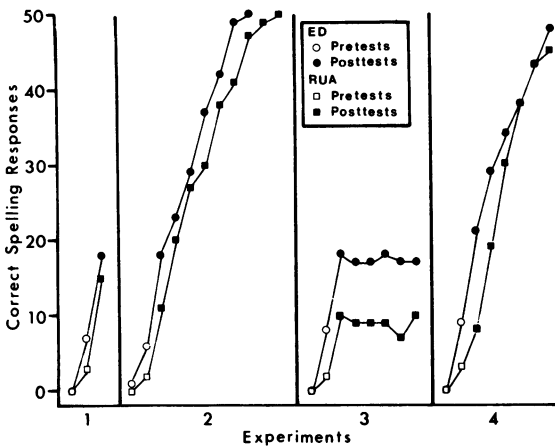


Fig. 2. Correct spelling responses by Rua and Ed in pretests and posttests. Data are summed across the 50 words in each experiment.

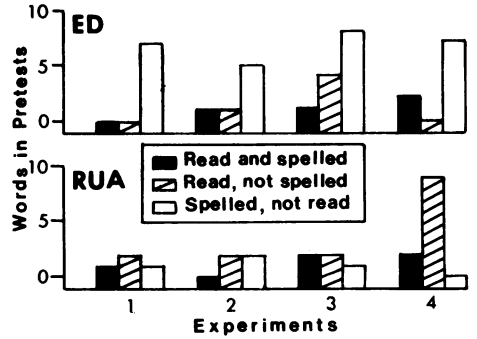


Fig. 3. Results of pretests that immediately preceded reading training. Black bars: words read and spelled correctly. Shaded bars: words read correctly but not spelled correctly. White bars: words spelled correctly but not read correctly. Data are summed across the 50 words in each experiment.

shows the same data, for spelling only, summed across all 50 words.

The subjects neither read nor spelled any words correctly in the initial pretest. Given the way the 50 words were selected, this result for reading was inevitable.

In the pretests that immediately preceded reading training, there was overall a small increment in correct reading and spelling for Rua and in correct spelling for Ed (first panel of Figure 2 and Figure 1). For Rua, this increment included words read correctly but not spelled correctly and vice versa; for Ed, it consisted entirely of words spelled correctly but not read correctly (first set of bars in Figure 3).

The first panel of Figure 4 shows trials to reading criterion. Graphs for Rua and Ed correspond closely in slope. Rua required consistently fewer trials. Overall, trials to reading

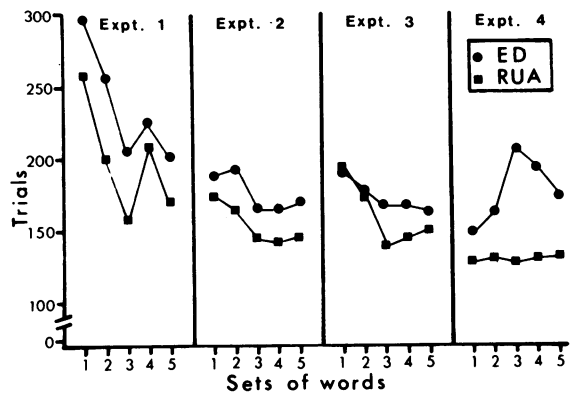


Fig. 4. Trials to criterion during reading training, across the five sets of words in each experiment. Experiment 2 shows results only for initial reading-training.

criterion decreased across successive sets of words, as expected from other studies of verbal behavior (e.g., Baer & Guess, 1971, 1973).

During reading training, correct reading responses occurred on first-trial presentations of words for Rua more often than predicted by his reading performance in the immediately preceding pretests. Across the five sets of words, Rua read six words correctly on their first presentations during reading training, though he read only one word correctly during pretests (first set of bars in Figure 5).

This appearance of new reading responses suggests that future experiments should include more pretesting to ensure stability of reading before training in reading begins. On the other hand, it is possible that reinforcing some correct reading responses strengthened other previously acquired reading responses. Given the age of these subjects, they doubtless had previously been trained, more or less adequately, to read some, if not most, of the words used in this experiment. It is known (e.g., Isaacs, Thomas, & Goldiamond, 1960) that reinforcing some members of a response class can reinstate other previously acquired members of that class. Perhaps this occurred here with reading.

Except for Ed's spelling in the posttest for the fourth set of words, posttest spelling always improved relative to pretest spelling. But the improvement was small and variable, and sometimes less or no more than the improve-

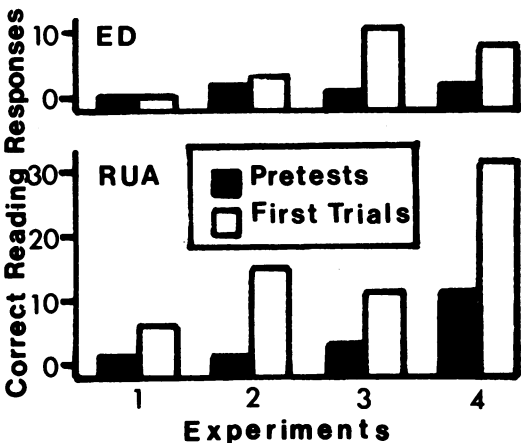


Fig. 5. Black bars: words read correctly in pretests that immediately preceded reading training. White bars: words read correctly on their first trials in reading training. Data are summed across the 50 words in each experiment.

ment in pretest spelling relative to spelling in the initial pretest (Figure 1).

It is clear that spelling sometimes improved following reading training. But whether these improvements resulted from this training is not so clear. The problem arises more from the weak variable changes in spelling following reading training than from the design of the experiment. Imagine that spelling had consistently and dramatically improved in posttests, as reading did. With pretest scores for later sets of words to estimate spelling improvement in the absence of reading training, the conclusion could have been made that reading training had the collateral effect of improving spelling. But the present results support no such clear conclusion. They suggest only that if reading training had any effect at all, this effect was small and variable.

EXPERIMENT 2

Overtraining, the continued training of behavior following criterion performance, can facilitate transfer of verbal behavior (e.g., DeHaven & Garcia, 1974). Experiment 2 investigated whether reliably correct spelling would follow overtraining in reading. The same subjects participated, and the same teacher conducted the experiment. Procedure was as in Experiment 1, except that new words were used and overtraining in reading was given for each set of words. Refer to Experiment 1 for details of the procedures.

METHOD

Initial Pretest

The experiment began with an initial pretest as in Experiment 1, both to select 50 words the subject could not read and to test his spelling of these words. The words were selected from the remaining 346 in the basic sight-reading list.

Testing and Training with each Set of Words

The 50 word cards were sorted randomly into five sets of 10 cards. With each set of 10 word cards, a pretest was conducted for reading (10 trials) and then spelling (10 trials). The subject was then taught to read the 10 words, in the same way and to the same criterion as in Experiment 1. Following this, a posttest for

both reading (10 trials) and spelling (10 trials) was conducted.

Subsequent procedures with a set of words depended on posttest spelling. If the subject had spelled all 10 words in the set correctly, the pretest for the next set of words would have begun immediately (i.e., no overtraining in reading would have been given for the current set of words; in fact, this never happened). But if the subject spelled fewer than 10 words of the current set correctly (i.e., less than 100% correct spelling), reading training was repeated with the same set of words (i.e., overtraining in reading was given). Reading overtraining was conducted in the same way and to the same criterion as before. Following the first round of reading overtraining on a set of words, another posttest was conducted, for spelling only. If the subject did not spell all 10 words correctly during this posttest, another round of overtraining in reading was given, followed by another spelling posttest, then another round of overtraining in reading (unless the subject spelled all 10 words correctly in the third posttest), and so on. This alternation of reading training and spelling posttesting continued until the subject spelled all 10 words in a set correctly in a single posttest or until 10 posttests had been given with that set of words, whichever came first.

Table 1 summarizes the procedures used with each set of words in this experiment and compares them with the procedures used with each set of words in the other three experiments.

Interobserver Agreement

Interobserver agreement was assessed for spelling and reading as in Experiment 1 and was again 100% in every pretest and posttest.

RESULTS AND DISCUSSION

Except for one correct spelling response by Ed (first set of words), the subjects neither read nor spelled any words correctly in the initial pretest (second panel of Figure 2 and Figure 6). As in Experiment 1, the result for reading was forced, since only words not correctly read in the initial pretest were selected for the experiment.

In the pretests that immediately preceded reading training, there was overall a small increment in correct reading and correct spelling (Figure 6). As in Experiment 1, some words

Table 1
Procedures Used With Each Set of Words^a

<i>Experiment 1</i>	<i>Experiment 2</i>	<i>Experiment 3</i>	<i>Experiment 4</i>
Pretest	Pretest	Pretest	Pretest
Reading training	Reading training	Reading training	Reading training
Posttest ^b	Posttest ^b	Posttest ^b	Posttest ^b
	Reading overtraining	Posttest	Word exposure
	Posttest	Posttest	Posttest
	Reading overtraining	Posttest	Word exposure
	Posttest	Posttest	Posttest
	Reading overtraining	Posttest	Word exposure
	Posttest		Posttest
	Reading overtraining		Word exposure
	Posttest		Posttest
	<i>etc.</i> ^c		Posttest

^aAn initial pretest for all 50 words used in the experiment always preceded use of these procedures with the first set of words.

^bThis posttest was for both reading and spelling; all other posttests were for spelling only.

^cReading overtraining and spelling posttesting alternated until the subject spelled all 10 words correctly in a single posttest or until a total of 10 posttests had been conducted, whichever came first.

were read correctly in pretests but not spelled correctly and vice versa. Ed's pretest increment consisted largely of words spelled correctly but not read correctly (second set of bars in Figure 3).

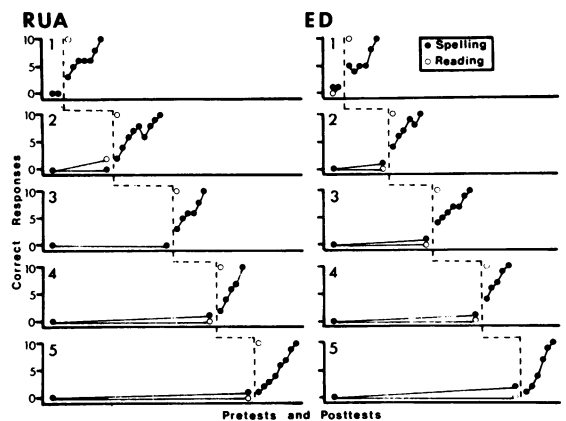


Fig. 6. Correct spelling and reading responses by Rua and Ed in the two pretests and several posttests for each set of words in Experiment 2. Dashed line indicates initial reading-training, which preceded the first posttest. The pretests precede the line; posttests follow it. Overtraining in reading preceded the second and each subsequent posttest for each set of words.

The second panel of Figure 4 shows trials to criterion during reading training. As in Experiment 1, Ed required consistently more trials than Rua; the slopes of the two graphs are similar; and the number of trials to criterion decreased overall. Correct reading responses on first-trial presentations of words during reading training sometimes occurred, again mainly for Rua (second set of bars in Figure 5).

Except with the fifth set of words for each subject, spelling always improved, even if slightly, following initial reading training (first posttests in Figure 6). But the improvement was small and variable across sets of words. The best conclusion these results support is, as in Experiment 1, that if reading training had any effect on spelling at all, this effect was small and variable.

But that conclusion applies only to initial reading training and to spelling in the first posttest. If we take reading training to include both initial training and overtraining and consider the results for all posttests given for each set of words (Figure 6), a different conclusion emerges. Spelling improved across successive posttests for each set of words with each subject, with occasional regressions and lack of improvement, until all 10 words were spelled correctly in a single posttest.

Approximations to correct spelling often preceded the occurrence of a correct spelling response. Table 2 presents some examples.

On its face, the improvement in spelling can be attributed to reading training (i.e., initial training and overtraining taken together) since improved spelling for each set of words occurred only when reading training was introduced for that set of words. Spelling in pretests given immediately before initial reading training for the second and subsequent sets of words showed little, if any, improvement in the absence of reading training. This suggested that reading training (i.e., initial training together

with overtraining) was responsible for the increment in correct spelling.

EXPERIMENT 3

The procedure in Experiment 2 of alternating reading training and spelling posttesting gave the subject repeated opportunities to look at the written words, repeated opportunities to read the words aloud, repeated opportunities to receive praise and tokens for correct reading responses, and repeated opportunities to spell the words. Experiment 3 tested whether spelling would improve over time following initial reading training. Initial reading training was given in the same way as in Experiment 2 but, after that, the subject simply had repeated opportunities to spell the words.

METHOD

Initial Pretest

Fifty words the subject could not read were selected from the remaining 286 words in the basic sight-reading list, using the same random-selection procedure as before, and spelling of these words was tested.

Testing and Training with each Set of Words

The 50 word cards were sorted randomly into five sets of 10 cards. With each set of 10 word cards, the three usual procedures were used; both reading and spelling were pretested; the subject was trained to read the words; and both reading and spelling were posttested.

After the posttest, a second posttest for spelling only was conducted using the same set of words. On the first trial, the teacher selected one word randomly and without replacement from the pool of 10 words and said "Spell (word)." The subject was given 10 seconds to write his response. The teacher then selected a second word and asked the subject to spell it. This procedure of selecting a word and asking for a spelling response continued across successive words until spelling of all 10 words had been tested (i.e., 10 trials). Spelling responses had no experimental consequences. This procedure for posttesting spelling was then repeated until there had been six spelling posttests (the first posttest for both reading and spelling, and the five later posttests for spelling only). Each posttest immediately followed

Table 2

Some Approximations to Correct Spelling

rindin*	mach	levf	blck	brihega
rading	magh	levi	bleak	birdge
readnig	magie	levic	blak	bridge
reading	magic	leva	black	
		leave		

*Each list shows spellings in successive posttests from the first attempt to spell the word to the first correct spelling.

the preceding posttest; there was never any interval between these posttests.

Interobserver Agreement

Interobserver agreement was assessed as before. Agreement between Pegler and Lee was 100% in every pretest and posttest for both reading and spelling except for Ed's spelling in the third posttest. Here, there was agreement on nine of the ten words.

RESULTS AND DISCUSSION

The subjects neither read nor spelled any words correctly in the initial pretest. In the pretests that immediately preceded reading training, there was overall a small increment in correct reading and spelling (third panel of Figure 2 and Figure 7). Again there were words read correctly but not spelled correctly and vice versa in these pretests (third set of bars in Figure 3).

Reading performance during reading training was much as in Experiment 2 (third panel in Figure 4). As before, reading training included correct reading responses on first-trial presentations of words, beyond those predicted by pretest reading performance (third panel in Figure 5).

There was a weak variable increment overall in correct spelling following reading training (first posttest for each set of words in Figure 7). But, apart from four instances of one additional correct spelling response (Rua: Sets

1 and 4; Ed: Sets 2 and 3), spelling did not further improve (second and subsequent posttests in Figure 7).

These results showed that repeated opportunities to spell the words were not sufficient to obtain the improvement in spelling seen in Experiment 2. Apparently, overtraining in reading, or one or more of its components, was necessary for the increment in correct spelling to occur.

EXPERIMENT 4

This experiment differed from Experiment 2 only in that a word-exposure procedure, instead of overtraining in reading, preceded the second and subsequent posttests for each set of words (Table 1). In the word-exposure procedure, the subject was shown the printed words, after being instructed not to read them aloud. After initial reading training for each set of words, the subject had no opportunity to read the words aloud or to receive praise and tokens for correct reading responses. The experiment investigated whether reading aloud was necessary for the improved spelling seen in Experiment 2. The same subjects participated.

METHOD

Initial Pretest

Fifty words not read correctly by the subject were selected from the remaining 226 words in the basic sight-reading list, and spelling of these words was tested.

Testing and Training With Each Set of Words

The 50 word cards were randomly sorted into five sets of 10 words. The three usual procedures were used with each set of 10 words. Both reading and spelling of the 10 words were pretested; the subject was trained to read the words; and reading and spelling were post-tested.

After the posttest with each set of 10 words, the word-exposure procedure began. It consisted of 10 trials, one for each word. Immediately before the first trial, the teacher instructed the subject: "I'm going to show you some words. Look at each word but don't read it to me." On the first trial, the teacher selected one word card randomly and without replacement from the set of 10 words and

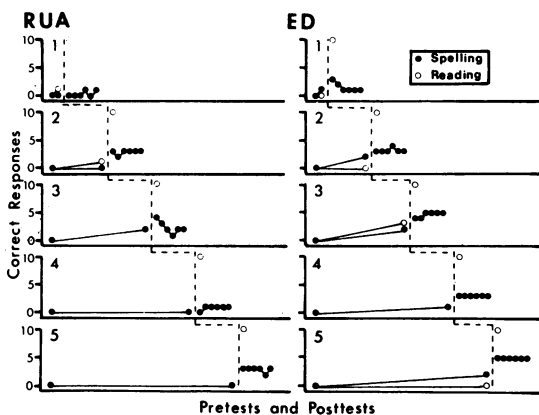


Fig. 7. Correct spelling and reading responses by Rua and Ed in the two pretests and several posttests for each set of words in Experiment 3. Dashed line indicates reading training. The pretests precede the line; posttests follow it.

placed it on the desk in front of the subject. After 10 seconds, she removed the card, presented a second word, and so on, until all 10 words had been presented (10 trials). The procedure was the same as that of Experiment 2, except the subject did not respond textually with consequence after initial reading training. If the subject began to read a word on any trial, the teacher said "No, don't read it to me." Apart from that, the word-exposure procedure included no experimental consequences.

Following one round of the word-exposure procedure, spelling was posttested. The subject was asked to spell each word once (10 trials), exactly as in the first posttest. Reading was not tested. After this second posttest, there was another round of the word-exposure procedure with the same set of words, followed by another spelling posttest, and so on, until a total of six posttests had been conducted (Table 1).

Interobserver Agreement

Interobserver agreement was assessed as before and was 100% in every pretest and posttest for both reading and spelling.

RESULTS AND DISCUSSION

The subjects neither read nor spelled any words correctly in the initial pretest. The increment in correct reading and correct spelling in the pretests that immediately preceded reading-training was weak and variable across the five sets of words (fourth panel in Figure 2 and Figure 8). Again, there were words spelled correctly but not read correctly, and vice versa, in these pretests (fourth set of bars in Figure 3). During reading training, Rua's number of trials to criterion reached a stable low, but Ed's performance was anomalous (fourth panel in Figure 4). As before, reading training included correct reading responses on first-trial presentations of words beyond those predicted by pretest reading (fourth set of bars in Figure 5).

Posttest spelling results were much as in Experiment 2 (fourth panel of Figure 2 and Figure 8). Overall there was an increment in correct spelling in the first posttest, immediately after reading training. But seen across the five sets of words for each subject, this improvement was not reliable and was generally weak

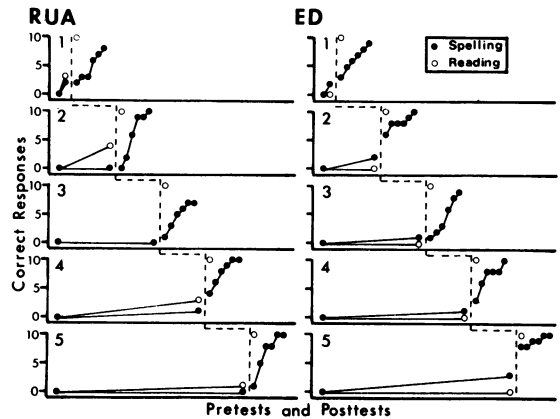


Fig. 8. Correct spelling and reading responses by Rua and Ed in the two pretests and several posttests for each set of words in Experiment 4. Dashed line indicates reading training. The pretests precede the line; posttests follow it. Word exposure preceded the second and each subsequent posttest for each set of words.

where it did occur. However, after the first posttest for each set of words, correct spelling responses did increase in number, and for some sets of words, 100% correct spelling occurred (Figure 8). As in Experiment 2, successive approximations to correct spelling were seen (Table 2).

Experimentation with each set of words terminated after six posttests instead of continuing either to a maximum of 10 posttests or until all 10 words were spelled correctly in a single posttest as in Experiment 2. However, posttest spelling performance in the present experiment was comparable to posttest spelling performance in Experiment 2. Summed across the five sets of words, Rua's correct spelling responses in the sixth posttests totalled 45 in Experiment 4 and 41 in Experiment 2; and Ed's totalled 48 in Experiment 4 and 49 in Experiment 2 (Figure 2).

The results of Experiment 2 suggested that the improvements in spelling in that experiment could be attributed tentatively to initial reading training and overtraining in reading taken together. Comparable improvements in spelling occurred in the present experiment just with exposure to the printed words after initial training in reading. Word exposure was one component of overtraining in reading. It seems that the other two components (reading words aloud, and differential consequence for correct and incorrect reading responses) were

not necessary for spelling to improve following initial reading training.

GENERAL DISCUSSION

Since spelling was never reinforced directly, its persistence suggests an insensitivity to differential reinforcement. But, more probably, it reflected the effects of other variables implicit in the experimental design and in the classroom. Instructional control is one such variable. Instructions, even when minimal (Matthews, Shimoff, Catania, & Sagvolden, 1977), can strongly affect behavior, making it seem insensitive to differential reinforcement (Steinman, 1977). It is likely that the teacher's instructing the subjects to spell the words and her continued presence (e.g., Peterson, Merwin, Moyer, & Whitehurst, 1971) accounted for the persistence of spelling.

Chained practice of spelling probably accounts for the improvement in spelling. Common experience tells us that some children learn to spell some words through chained practice. They look at the word, look away and try to spell it, check their spelling against the printed word, rehearse the spelling again, and so on, until they spell the word correctly. When this chained practice leads to improved spelling of the word practiced, then it contains, by definition, a contingency of "automatic" reinforcement, between spelling and seeing that the written product of spelling is correct or approximately correct. This means that if chained practice occurred in the present experiments, then spelling was reinforced by "automatic" reinforcers implicit in the chained practice.

If chained practice occurred in these experiments, then we should find that spelling improved, that the subjects rehearsed, and that opportunities to check rehearsed spellings against correct spellings followed rehearsals. Spelling improved in Experiments 2 and 4. And, according to teacher reports, the subjects rehearsed spellings, between trials during reading training (Experiments 2 and 4) and both during and between word-exposure trials (Experiment 4). Sometimes the subjects whispered the spellings; at other times, they simply moved their lips. The present results do not show that rehearsal emerged anew collateral to reading training and spelling posttesting. Still, even if the subjects had previously learned to

engage in chained practice of spelling, their inability to spell most words in the initial pretests of these experiments suggests they had not often used this skill successfully to expand their spelling repertoires. Finally, opportunities to check rehearsed spellings against correct spellings followed some rehearsals. During posttests, the subjects could respond covertly as readers to their own spellings. We could suggest that doing so reinforced correct spellings and their approximations if spelling subsequently improved and if the subjects discriminated correct from incorrect spellings. Spelling did improve and teacher reports suggest that the subjects made the required discriminations. In the later stages of testing and training each set of words in Experiments 2 and 4, the subjects spelled many words correctly. At these times, they often rehearsed only words spelled incorrectly during the previous posttest. Also, following these later posttests, the subjects sometimes made such comments as "I know which words I got wrong" and "I got (word) wrong." Posttest spelling may also have been reinforced, with a delay, when the word cards were presented during subsequent reading training (Experiments 2 and 4) or word exposure (Experiment 4). Also, there were limited opportunities for "automatic" reinforcement during word-exposure trials, when the subjects could check their subvocal rehearsals against the printed words.

Interpreting the present results as reflecting chained practice in spelling makes sense of the data but is admittedly speculative. The interpretation depends on common experience of children's efforts to master spellings and on teacher reports. No data were collected for subvocal rehearsals or for discriminations between correct and incorrect spellings. We need detailed studies both of the acquisition of chained practice of spelling and of the contribution of this skill to improved spelling following reading training.

The present results are limited, in part because only two subjects participated. Still, it is worth comparing them to the results of studies of the relation between grammatical speaking and instruction-following (Guess, 1969; Guess & Baer, 1973; Lee, 1981; Whitehurst, 1977). The subjects of the present study read some words yet did not spell them and, less obviously to common sense, spelled some words yet did not read them. Earlier studies, of the rela-

tion between speaking and instruction-following, found that children may speak certain words or phrases (e.g., "behind the book") yet not follow instructions that contain those words or phrases (e.g., "Put the cup behind the book") and vice versa. Taken together, previous studies of speaking and instruction-following and the present study of spelling and reading support Skinner's (1957, pp. 187-198) suggestion that behavior classes involving "the same word" need not be acquired together. The results suggest that speaking and instruction-following, or spelling and reading, can be trained separately, so that the subject's repertoire includes one but not the other.

Separate acquisition is not surprising since there is no physical basis for response induction between spelling and reading or between speaking and (nonverbal) instruction-following. What does seem surprising is that training in one repertoire sometimes instates new skills in the other, as in the present study. With speaking and instruction-following, this collateral instatement of new skills has not convincingly been shown in children learning grammatical skills in their first language (Lee, 1981). But it has been shown in adults learning second-language skills (Rocha e Silva & Ferster, 1966). The question raised by such collateral instatement of new skills is how subjects get from one repertoire to the other when there is no physical basis for response induction. This discussion suggested that chained practice of spelling let the present subjects get from reading to spelling. Perhaps chained practice in getting from listening to speaking accounted for the collateral instatement of speaking in adults (Rocha e Silva & Ferster, 1966). If so, then the possibility exists of teaching this skill of "translating" between the two repertoires to children who have yet to learn it, so that they can "self-control" their acquisition of grammatical skills in one repertoire collateral to training in the other.

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