Reading Student Essays May Be Hazardous to Your Spelling: Effects of Reading Incorrectly and Correctly Spelled Words

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ABSTRACT In two experiments, we examined effects on spelling of reading and of reproducing correctly and incorrectly spelled words. Reading correctly and incorrectly spelled words influenced later spelling accuracy for those same words. Reproducing the spelling of words did not have any effects on later spelling accuracy beyond those produced by reading the words. However, reproducing a correctly spelled word did speed the production of a later correct spelling for the word, whereas reading did not speed later production. Effects on spelling accuracy were dissociated from recognition memory for previously presented words.

RÉSUMÉ Lors de deux expériences, nous avons examiné les effets, sur l'épellation, de la lecture et de la reproduction de mots correctement et incorrectement orthographiés. La lecture de mots correctement et incorrectement orthographiés influençait l'exactitude de l'épellation tardive pour ces mêmes mots. La reproduction de l'orthographe des mots n'a en aucun effet sur l'exactitude de l'épellation tardive au-delà de ceux produits par la lecture des mots. Cependant, la reproduction d'un mot correctement épelé accélérait la production d'une épellation tardive correcte du mot alors que la lecture n'accélérait pas la production tardive. Les effets sur l'exactitude de l'épellation étaient dissociés de la mémoire de reconnaissance de mots préalablement présentés.

Educators often are called upon to read student essays that are riddled with mis-spellings. Does reading a misspelled version of a word make it more likely that one will later misspell that word? A common informal observation is that it does (e.g., Frith, 1980; Nisbet, 1939). However, little formal research has been done to investigate the effects of reading on later spelling. Any effects of reading have been neglected in favour of showing that producing an incorrect spelling or discriminating between incorrect and correct spellings of a word can increase the likelihood of the word later being misspelled (e.g., Brown, 1988). One reason for the emphasis on the effects of production and of discrimination is the relevance of those tasks to educational practices. Multiple choice tests that are commonly used to assess spelling ability require discrimination between correct and incorrect spellings of a word and, consequently, might have detrimental effects. Repeated production of a misspelling has been said to result in its differentiation and suppression (e.g., Blumberg, 1976; Simon & Simon, 1973) and, contrary to the results of some experiments, has been predicted to enhance later spelling performance.

A second reason for the relative neglect of the effects of reading on spelling may be that most researchers expect any effects of reading to be much smaller than either those of production or those of discrimination. Producing a spelling as compared with reading a word should make it much more likely that one will later remember the prior encounter with the word along with its spelling. It might be reasoned that finding an effect on the later spelling of a word requires either that one be able to recollect the earlier presentation of the word or that the incorrect spelling of the word be presented a large number of times so as to make it as well learned as is the correct spelling. However, the effects of prior experience on spelling probably are not totally reliant on recollection of how a word was spelled when it was encountered earlier. For example, any effects of reading student essays on spelling are unlikely to rely on recollection. When uncertain about the spelling of a word, most educators are sufficiently aware of the unreliability of students' spelling not to resolve their uncertainty by recollecting how the word was spelled in the last student essay that they read.

One purpose of our experiments was to show that a single reading of a word can influence its later spelling even when the word is not recognized as one that was read earlier. A finding of that sort would show a dissociation in performance between a direct test and an indirect test of memory (see Richardson-Klavehn & Bjork, 1988, for a review). For indirect tests of memory, subjects are not asked directly to report on memory for a prior event, but are required to engage in some task that might reveal effects of the prior event, such as a spelling test. The use of memory is inferred from effects on performance. In contrast, recognition and recall are direct tests of memory because subjects are instructed to report on an event in their personal history, such as the presentation of a word in a list.

One interpretation of dissociations between effects on direct and indirect tests of memory appeals to differences in the compatibility of training and test processing (e.g., Jacoby, 1983a; Roediger & Blaxton, 1987). The notion is that a dissociation arises when a given form of processing is relevant for one, but not for the other, type of test. In our experiments, we compared effects in spelling performance of earlier producing correctly and incorrectly spelled words with those of earlier reading correctly and incorrectly spelled words. Effects on spelling accuracy, the time to correctly spell a word, and recognition memory peformance were examined. We expected dissociations between effects on these various measures to reflect differences in the compatibility of training and test processing.

The effects of prior experience on spelling might be similar to those on word perception. Reading a word once in the experimental setting has a large and long-lasting effect on subjects' ability to later read that word when it is flashed briefly for a test of perceptual identification (e.g., Jacoby & Dallas, 1981). That effect on subjects' perception of the tested word can be independent of their recognition of the word as having been read earlier. The levels-of-processing manipulation that has large effects on recognition memory performance (e.g., Craik & Lockhart, 1972) has no effect on later perceptual identification performance; that is, processing beyond that necessary to read a word is irrelevant to its later perceptual identification, although the additional processing can be important for recognition memory performance. Similarly, reading a word might have as large of an effect on its later spelling as

would producing a spelling of the word, although producing a spelling is likely to result in higher recognition memory performance than does reading. One reason reading might influence spelling is that the appearance of a word can be used to check its spelling (e.g., Baron, Treiman, Wilf, & Kellman, 1980). Many people judge that a word is correctly spelled by an unanalyzed feeling that it looks right. Reading an incorrectly spelled word might later make the incorrect spelling look correct, an effect that might be independent of one's ability to recollect earlier reading of the word.

The procedure used in our experiments made it unlikely that any effects on spelling were due to subjects relying on recollection of how a word was spelled earlier. In the training phase, subjects were informed prior to the presentation of words that half of the words in the list were spelled correctly and half were misspelled. They were reminded of this fact immediately before the spelling test and, so, should not have relied on recollection of the earlier presented spelling of a word when attempting to produce its correct spelling. We sought a dissociation between effects on spelling accuracy and recognition memory performance (cf. Jacoby & Dallas, 1981). In Experiment 1, a recognition memory test was given after the spelling test. In Experiment 2, the spelling and recognition memory tests were combined such that after subjects spelled each word, they judged whether that word was among those presented earlier. We expected effects on spelling accuracy to be largely independent of recognition memory performance.

Although differential effects on spelling accuracy were not expected, reproducing a spelling might do more to speed later spelling of a word than would earlier reading of the word. Dissociations between recognition memory performance and effects of prior experience on the time to produce a sequence of letters or numbers have been reported (Fendrich, Healy, & Bourne, 1988; Glass, Krejci, & Goldman, 1989). For spelling, the time required to produce a correct spelling might be substantially reduced only by prior experience reproducing that correct spelling. To check this possibility, spelling times for words that were correctly spelled when reproduced earlier were compared with those for words that were correctly spelled when read earlier and with those for words that were new on the spelling test. Spelling times for words that were incorrectly spelled when presented earlier will also be reported. However, exposure to an incorrect spelling of a word was not expected to speed the correct spelling of the word. Any effects of presenting incorrectly spelled words on the time required to later correctly spell those words are difficult to interpret because of the possibility of item selection effects. For example, correct spelling after exposure to an incorrect spelling might be observed only for words whose spelling is very well known, and those well-known words might be spelled more rapidly than are other words.

In summary, we expected to find dissociations among effects on spelling accuracy, on time to spell a word, and on recognition memory performance. Prior presentation of a word was expected to influence its later spelling even when people did not recognize the word as being previously presented. Reproducing a spelling, as compared with reading a word, was expected to produce an advantage in recognition memory performance and in spelling time, but not in spelling accuracy. In Experiment 1, reproduction of spellings was done either by printing on a piece of paper

or by typing. Typing during training matched the output mode used for the later spelling test. Prior experience reproducing the spelling of a word was expected to have a larger effect when the output mode used during training was the same as, rather than different from, that at the time of test.

EXPERIMENT 1

Method

Subjects: The subjects were 72 volunteers from an introductory psychology course at McMaster University who served in the experiment for course credit. Twenty-four subjects were randomly assigned to each of three between-subjects training conditions (read, print, or type). Subjects were tested individually.

Materials and Design: We selected a pool of 60 words from *The University Spelling Book* (Pollock & Baker, 1955) which lists words that are commonly misspelled by university students. Twenty-four words were selected from the first 100 most frequently misspelled words, 24 from the second 100 and 12 from the combined third, fourth, and fifth groups of 100 most frequently misspelled words. Of the selected words, 33 appear with a high frequency in the language (A and AA) as indexed by Thorndike and Lorge (1944); the average frequency of occurrence of the remaining 27 words was 23.9 per million. An incorrect spelling for each of the target words was selected from *The Bad Speller's Dictionary* (Krevisky & Linfield, 1982). Six different error types were selected such that the words had one of the following errors: (a) an extra letter (e.g., abscence), (b) a letter omitted (e.g., aquire), (c) a different combination of letters (e.g., rythem), (d) a reversal of letters (e.g., foriegn), (e) a doubled consonant (e.g., ammount), or (f) a wrong letter (e.g., speach). All words, both the correctly spelled and the misspelled version of a word, ranged from four to eight letters in length.

We divided the pool of 60 words into three groups of 20 words each. A 40-word list presented during training was constructed with 20 words correctly spelled and 20 words misspelled. The remaining 20 words were used as new words in the test list. The 60-word test list included 20 words from each of the three experimental conditions (correct, incorrect, and new). Three formats were constructed by rotating words through experimental conditions such that across formats each word represented each condition equally often. Further, we used two orders of presentation of items in the training phase of the experiment. The presentation order of items for both training and test lists was random. Each of the six combinations of list formats and presentation orders was used equally often.

The 60 words presented for the spelling test were also presented for a test of recognition memory. For that test, the words were arranged in a random order that differed from the order used for their presentation for the spelling test.

An additional 40 five-letter words were selected as practice words. Thirty of those words were used for typing practice at the start of the experiment to allow the subjects to become familiar with the computer keyboard. The other 10 practice words were presented at the start of the test phase but were not scored.

Procedure: An Apple II computer interfaced with a television set having a 14-in. screen was employed to present stimuli. Character size was approximately 5.7×6.6 mm and viewing distance was 70–75 cm. The words used in the practice and training phases were presented in lower case letters, whereas words typed in by subjects appeared on the screen in capital letters. The words for the spelling test, including the practice words, were presented by means of a tape recorder. The computer, from input from a voice key, disabled the motor of the tape recorder after each test word was presented. When the return key on the computer keyboard was pressed, the computer restarted the tape recorder for presentation of the next test word.

An experimental session began with a typing task that was employed to familiarize subjects with the computer keyboard. The subjects were informed that typing times were being recorded by the computer, although, in actual fact, no times were recorded during the practice phase of the experiment. As each of the 30 practice words appeared and stayed on the screen, it was the subjects' task to copy the word exactly as presented by typing it on the computer keyboard. The subjects were instructed to be as accurate as possible and were informed they could make corrections by backspacing and replacing letters if necessary. They were also instructed to check the match between the presented word and their production of it before pressing the return key. Once the return key was pressed, no further corrections could be made. Pressing the return key resulted in the message "Press return when ready" appearing on the screen. A second press of the return key resulted in the presentation of the next practice word.

After the practice phase, a list of words was presented on the screen one word at a time at a 1-s rate. Subjects were informed that half of the words in the list were correctly spelled and half were misspelled. In the read condition, the training phase was introduced as a reading test in which the time to read correctly spelled words would be compared with that to read misspelled words. In both the type and print conditions, subjects were required to read aloud each word and were directed also to pay close attention to the exact spelling of each word as they would be required to reproduce its spelling. After each word had been on the screen for 1 s, it disappeared from the screen. The subjects were then required to reproduce the exact spelling of each word either by typing the word using the computer keyboard (type condition) or by printing the word on a piece of paper (print condition). In the type condition, as soon as the word left the screen, an arrow appeared as a prompt for subjects to start typing. Subjects were instructed to be as accurate as possible, to make corrections if necessary, and to check the final spelling before pressing the return key to end the trial. Pressing the return key resulted in the message "Press return when ready" appearing on the screen. In the print condition, once the word left the screen, the subjects were to reproduce the exact spelling of the word by printing it on a sheet of paper. A separate sheet of paper was used for each word. In the print condition, the message "Press return when ready" appeared immediately after the word had been cleared from the screen. After this message appeared, for both the print and the type conditions, pressing the return key resulted in the presentation of the next word. For all conditions, the experimenter recorded subjects' accuracy of reading correctly and incorrectly spelled words as the intended words.

The spelling test was the same for all subjects. A list of words was presented one word at a time by means of a tape recorder. Subjects were to type each word, spelling the word correctly. While the tape was playing, the screen was blank. The tape presenting the list of words stopped after each word. As soon as the tape stopped, an arrow appeared on the screen to prompt subjects to start typing. The subjects were instructed to spell each word as quickly and as accurately as possible. They were informed that corrections could be made but only before the return key had been pressed. After the return key was pressed, a message that instructed subjects to press the return key to initiate presentation of the next test word appeared on the screen. Spelling accuracy and times were recorded. Spelling times were measured starting when the arrow appeared on the screen and ending when subjects pressed the return key to indicate satisfaction with their spelling of a word. A log transformation of each subject's spelling times was used to lessen the impact of extreme scores on the mean. Those log times were then transformed back to mean spelling time for each subject for each combination of conditions.

For the final test of recognition memory, subjects were instructed to judge, for each word listed on a sheet of paper, whether that word had been presented during the training phase of the experiment. Subjects were warned that all of the words on the recognition test had been presented during the spelling test and that it was the earlier presentation of words during training (regardless of spelling) that they were to judge. The subjects were to circle the words they recognized.

The significance level for all tests was set at $p < .05$.

TABLE I

Probability of Correct Spelling and Spelling Time (ms) for Correctly Spelled Words

Training Condition	Prior Presentation		
	Incorrect	Correct	New
Read			
Probability	.83	.93	.88
Spelling Time	5244	5256	5254
Print			
Probability	.81	.91	.86
Spelling Time	5357	5145	5453
Type			
Probability	.85	.94	.87
Spelling Time	5309	5006	5396

Results and Discussion

For all analyses, spelling performance for words that were incorrectly spelled when presented earlier was conditionalized on those words having been pronounced as the intended word when read. The overall probability of misreading an incorrectly spelled word was .03.

First we analyzed the effects of prior presentation and those of training condition on spelling accuracy (see Table 1). That analysis revealed a highly significant effect of prior presentation, $F(2, 138) = 31.46$, $MS_e = 0.005$. As compared with the probability of correctly spelling a word that was new at the time of test (.87), prior presentation of a correctly spelled word increased (.93) and prior presentation of an incorrectly spelled word decreased (.83) the probability that subjects would later correctly spell the word. Neither the effect of training condition (read vs. print vs. type) nor the interaction of training condition with prior presentation approached significance. That is, earlier reproducing the spelling of a word, either by printing or by typing, did no more to influence later spelling accuracy than did earlier reading of the word. Looking at Table 1, the difference in spelling accuracy between words that were correctly spelled and those that were incorrectly spelled when presented earlier was essentially identical for the three training conditions. It seems safe to accept the null hypothesis that spelling accuracy was not influenced by training condition.

Spelling errors were examined to determine the probability of subjects' misspelling of a word agreeing with the misspelling that we chose for presentation. The probability of agreement was lower for words that were spelled correctly when presented earlier (.57) than it was for words that were spelled incorrectly when presented earlier (.76) or for words that were new (.71). Those data were not broken down by training condition and subjected to formal analyses because of problems produced by empty cells. Several subjects did not spell any words incorrectly, particularly when those words had been correctly spelled when presented earlier.

TABLE 2
Probability of Calling a Word Old

| Training | Prior Presentation | | |
Condition	Incorrect	Correct	New
Read	.44	.34	.13
Print	.52	.50	.13
Type	.60	.50	.11

Words that were correctly spelled when presented earlier were correctly spelled more rapidly than were new words (5136 vs. 5368 ms, respectively) $F(1, 69) = 13.24$, $MS_e = 146,306$. The interaction between training condition and prior presentation was also significant, $F(2, 69) = 3.52$, $MS_e = 146,306$. Earlier reproducing a correct spelling of a word speeded its later correct spelling, whereas earlier reading a correctly spelled word did not influence the speed of its later correct spelling (see Table 1). The decrease in spelling time gained by typing a word earlier was not significantly greater than that gained by printing a word earlier. The time taken to spell correctly words that were incorrectly spelled when presented earlier was approximately the same as that taken to spell new words correctly.

The probability of a false alarm, calling a new word old, on the test of recognition memory was approximately the same for the three training conditions (see Table 2). The probability of a hit, correct recognition of an old word, was higher in conditions that reproduced words during training (print and type) than in the condition that only read words during training, $F(2, 69) = 6.60$, $MS_e = 0.054$. Also, words that were incorrectly spelled were more likely to be recognized later (.52) than were words that were correctly spelled when presented earlier (.45), $F(1, 69) = 13.41$, $MS_e = 0.015$. The advantage in recognition memory performance for words that were incorrectly spelled over those that were correctly spelled when presented earlier points toward a limitation on the effect of experience with misspellings. That difference in recognition memory performance probably arose from subjects noting that some presented words were incorrectly spelled and, perhaps, implicitly correcting the spelling of those words. If so, this would weaken the effect of presenting incorrectly spelled words on the subjects' later spelling accuracy.

Reproducing the spelling of a word did not have any effect on spelling accuracy beyond that produced by reading the word. This lack of an effect was observed although the manipulation of training condition did have effects on spelling time and on recognition memory performance. Prior presentation of a correctly spelled word speeded its later correct spelling only when subjects reproduced the spelling of the word in the training phase. Reproducing words earlier as compared with only reading words enhanced later recognition memory performance. The dissociation between effects on spelling accuracy and recognition memory performance is similar to that between effects on word perception and recognition memory performance (e.g., Jacoby & Dallas, 1981).

EXPERIMENT 2

In Experiment 2, we compared the effects of copying the spelling of a word that remained visible while being copied with the effects of reproducing the spelling of a word after a delay filled with rehearsal-preventing activity. Those conditions contrast with the task of reproducing the spelling of a word briefly after its presentation, the task used in Experiment 1. Larger effects of reproducing the spelling of a word might be observed when a delay intervenes between the presentation of a word and the subjects' reproduction of its spelling. An informal observation in support of this possibility is that it is common to advise those studying for a spelling test to look away from a studied word for a brief period of time prior to reproducing the spelling of the word. In a related vein, investigations of memory have shown that a delayed test of memory does more to aid performance on a later test than does an immediate test of memory (e.g., Götz & Jacoby, 1974). However, those experiments used direct tests of memory, tests of recall or recognition memory performance.

Spelling accuracy, an indirect test of memory, might not be differentially influenced by reproducing the spelling of a word after a delay as compared with copying the spelling of a word. That is, the effects of copying versus reproducing a spelling might be similar to those of reading versus reproducing a spelling, showing no effect on spelling accuracy although effects on recognition memory performance and spelling times are observed. To examine better the relation between effects on spelling accuracy and recognition memory performance, subjects were required to make a recognition memory decision for each word immediately after it had been spelled at test. We then examined words that were not recognized as previously presented to see whether the subjects' spelling accuracy for those words was influenced by prior presentation.

Method

Subjects: The subjects were 36 introductory psychology students who served in the experiment for course credit. Eighteen subjects were randomly assigned to each of two training conditions (copy vs. count).

Materials and Procedure: The materials and procedures for this experiment were identical to those of Experiment 1 with the exceptions of a change in training conditions and a change in the test phase such that subjects made a recognition memory judgement for each test word immediately after having spelled that word.

The manipulation of training conditions was between-subjects. For the copy condition, each word was presented for a 1-s duration after which a beep sounded and an arrow appeared on the screen below the word, signalling subjects to copy the word by typing it exactly as presented. The word remained on the screen while the subjects copied it. In the count condition, each word was presented for a 3-s duration. The subjects were instructed to study each word carefully, paying particular attention to its spelling, as they would be asked to reproduce that spelling after an intervening task. The intervening task involved counting backwards for a 10-s period by threes from a random number which replaced the word on the screen. After the 10 s lapsed, the screen cleared, a beep sounded, and an arrow appeared on the screen to signal subjects to type the word, exactly reproducing its earlier presented spelling. Because of the difficulty of the task, subjects were advised to try and visualize how the letters of the word fit together and to hold an image of the word in mind while they performed the intervening task. If the subjects were unable to remember the word at the end of the 10-s period,

TABLE 3
Probability of Correct Spelling and Spelling Time (ms) of Correctly Spelled
Words

Training Condition	Prior Presentation		
	Incorrect	Correct	New
Copy			
Probability	.81	.92	.86
Spelling Time	5050	5121	5073
Count			
Probability	.78	.91	.85
Spelling Time	6217	5604	6128

they were to type the word "forgot." As in Experiment 1, subjects were advised to be as accurate as possible, to make corrections if necessary, and to check the word before pressing the return key. The accuracy of subjects' reproduction of presented words was recorded.

The spelling test was identical to that in Experiment 1 with the exception that recognition memory for each word was tested immediately after it had been spelled. After the subjects had finished spelling a test word by typing the word and pressing the return key, a beep sounded and the message "Old/New?" appeared on the screen to signal subjects to make a recognition memory decision. That message stayed on the screen for 3 s and then was replaced by the message "Press return when ready." For recognition judgements, subjects were instructed to say "old" if the test word was a word they remembered from the training phase of the experiment or to say "new" if the test word was one that they did not remember. The experimenter recorded the subjects' responses. Once the subjects had given a recognition response, they pressed the return key to initiate presentation of the next test word.

Results and Discussion

In the count training condition, the probability of accurately reproducing a correctly spelled word was .84 and that of accurately reproducing an incorrectly spelled word was .85. Only spelling performance on words that were accurately reproduced entered into the analyses that are to be reported. Analyses for which accuracy of reproducing a word was disregarded were performed also and revealed the same pattern of results as the analyses that are reported.

An analysis of spelling accuracy revealed a significant effect of prior presentation, $F(2, 68) = 30.39$, $MS_e = 0.006$. Spelling accuracy was highest for words that were correctly spelled when presented earlier (.92), lowest for words that were incorrectly spelled when presented earlier (.80), and intermediate for words that had not been presented previously (.86). Neither the main effect of training condition nor the interaction of training condition with prior presentation approached significance; that is, reproducing the spelling of a word after a delay did not have a significantly larger effect later on spelling accuracy than did earlier copying of the word (see Table 3). Spelling errors were examined to determine the probability of subjects' misspelling of a word matching the misspelling chosen for presentation. The probability of a particular misspelling was higher after that misspelling of the word was presented (.80) than it was when the word was correctly spelled when presented earlier (.63) or was new (.56). As in Experiment 1, a formal analysis of those data was not done because several subjects failed to produce any spelling errors in some combinations of conditions.

TABLE 4

Probability of Calling a Word Old

Training	Prior Presentation		
Condition	Incorrect	Correct	New
Copy	.69	.60	.16
Count	.83	.85	.12

An analysis of times to spell words correctly showed a significant interaction between prior presentation and training condition, $F(1, 34) = 3.44$, $MS_e = 295,976$. Reproducing correctly spelled words after a delay speeded the subjects' later correct spelling of those words as compared with that of new words. As observed for reading words in Experiment 1, copying correctly spelled words did not influence the subjects' time to spell those words correctly later (see Table 3). The time to spell words that were incorrectly spelled when presented earlier was similar to that taken to spell new words.

Recognition memory judgements were more accurate when words had been reproduced after a delay rather than copied during training (see Table 4). Words that were reproduced after a delay were more likely to be correctly recognized as old than were words that were copied, $F(1, 34) = 21.84$, $MS_e = 0.032$. The interaction between training condition and the spelling of a word when presented earlier was also significant, $F(1, 34) = 5.89$, $MS_e = 0.010$. Words that were incorrectly spelled when copied were more likely to be recognized later than were those that were correctly spelled. The spelling of a word for its prior presentation had little effect on later recognition performance when subjects were required to reproduce the spelling after a delay.

To examine the relation between effects on spelling and recognition memory performance, we compared spelling accuracy conditionalized on whether a word was recognized as having been presented previously. Reproducing the spelling of a word after a delay resulted in a level of recognition memory performance that was so high as to provide few opportunities to observe spelling accuracy contitionalized on recognition failure. Consequently, an analysis of conditionalized scores will be reported only for data from the copy condition. That analysis did not reveal any significant difference in spelling accuracy between words that were recognized and those that were not recognized; that is, the difference in spelling accuracy between words that were correctly spelled and those that were incorrectly spelled when presented earlier was not significantly less for words that were not recognized (.81 vs. .90) as compared with words that were recognized (.82 vs. .93). The spelling of a word when presented earlier influenced its later spelling even though the word was not recognized as one that was presented earlier.

Recognition memory performance and spelling time benefited from reproducing as compared with copying the spelling of a word. Copying, like reading, did not speed later correct spelling. However, copying did have as large of an effect on later spelling accuracy as did reproducing a spelling after a delay; that is, delaying the reproduction of a spelling influenced performance on a test of recognition memory

performance (a direct test of memory), but did not influence performance on spelling accuracy (an indirect test of memory). Copying the spelling of a word produced an effect on later spelling accuracy even for those words that were not recognized as having been presented previously.

GENERAL DISCUSSION

A single reading of a word influences the accuracy of its later spelling, and the effect does not rely on recognition of the word as one that was presented earlier. The dissociation between effects on recognition memory and spelling performance is similar to that observed for word perception (e.g., Jacoby & Dallas, 1981). The results of Experiment 1 revealed a functional dissociation between effects on spelling accuracy and recognition memory performance. The manipulation of training condition had no effect on spelling accuracy, but had a large effect on recognition memory performance. Experiment 2 provided evidence of a stochastic dissociation between spelling accuracy and recognition memory performance by failing to show significant statistical dependence between performance on the two types of tasks.

Spelling accuracy is too easily influenced by experience to be adequately described as guided by knowledge of spelling rules. As an alternative to, or in addition to, rules, some theorists (Morton, 1980; Simon & Simon, 1973) have proposed that there exists a memory representation of the orthography of each word, which is used as a basis for spelling. However, as noted by Brown (1988), the effect of experience with misspellings is inconsistent with the claim of a *singular* memory representation of the orthography of a word.

One way to account for the results of our experiments is to suggest that there exists a memory representation for each of multiple spellings of a word and that those representations can be temporarily primed by prior experience. The misspellings we chose for presentation were relatively common ones, so subjects probably had already encountered those misspellings before participating in our experiment. Presenting a particular spelling of a word might temporarily prime its corresponding memory representation and, thereby, bias later spelling of the word. A priming account of this sort has been used to explain dissociations between effects on direct and indirect tests of memory. Effects of prior experience revealed by indirect tests of memory are said to reflect the priming of a preexisting abstract representation which is context free. Memory as measured by a direct test is said to rely on episodic memory which is context specific (see Richardson-Klavehn & Bjork, 1988 for a review). As applied to our results, the claim would be that reproducing the spelling of a word enhances episodic memory for the presentation of that word (as measured by recognition memory performance), but does no more to prime the preexisting memory representation of its spelling (as measured by effects on spelling accuracy) than does reading the word.

Alternatively, dissociations between effects on direct and indirect tests of memory have been explained in terms of differences in processing required by the two types of test (e.g., Jacoby, 1983a; Roediger & Blaxton, 1987). The notion is that it is the compatibility of training and test processing that determines the effects of prior experience. A dissociation arises when a given type of prior processing is relevant for the one type of test but not for the other. By this account, effects on spelling

accuracy reflect unconscious retrieval of memory (Jacoby & Whitehouse, 1989) for the spelling of a word when presented earlier. In favour of an account of this sort, the effect of prior experience on spelling accuracy was generally symmetric: experiencing a correctly spelled word improved later spelling accuracy as much as experiencing an incorrectly spelled word hurt later spelling accuracy. This symmetry of effects could not have arisen from subjects intentionally using their recollection of the earlier presented spelling of a word as a guide for later spelling. This could not be the case because effects on spelling accuracy were observed even for words that were not recognized as having been presented previously. Consequently, retrieval must have been unconscious in that it depended neither on intention to retrieve memory for the earlier presentation of a word nor on awareness that retrieval has been accomplished and had influenced spelling performance. A priming account does not provide a basis for predicting a symmetrical effect of experiencing correctly spelled and misspelled words.

The choice between accounts of effects on spelling accuracy is the same as faced when describing the dissociation between effects of prior experience on word perception and recognition memory performance. Against a priming account, effects of a prior presentation of a word on its later perceptual identification last at least a week (Jacoby, 1983b), a duration that is too long for the effect to be described as produced by the temporary priming of a memory representation. Similarly, a finding of a long-lasting effect of experiencing a misspelling on spelling accuracy would be damaging to a priming account. The effect of prior experience with a misspelled word might be to make the misspelling later look correct. An effect of that sort has been observed for nonfamous names (names for which there are no pre-existing memory representations). A single presentation of a name that people are told is nonfamous can serve to increase the familiarity of that name and make it more likely that the name will later be mistakenly judged famous (e.g., Jacoby, Woloshyn, & Kelley, 1989). Similarly, a first encounter with a particular misspelling might be damaging even if one is told that the spelling is incorrect. It is data of this sort that are needed to choose between priming and processing accounts of effects on spelling accuracy.

The results of our experiments also showed a dissociation between effects on spelling accuracy and those on the time required to spell a word correctly. Reproducing the spelling of a word did not have any effect on later spelling accuracy beyond that produced by reading or copying the word. However, there were differences in spelling times. Only reproducing a correct spelling speeded later correct spelling. This pattern of results can be taken as evidence that selection of a spelling, reflected by effects on spelling accuracy, depends on different factors than does the production of a spelling. One way this could work is by means of a hierarchical arrangement such that selection of a code representing a spelling pattern precedes production of the spelling. Similarly, it has been argued that selection of a motor programme or schema depends on different factors than does its production (e.g., Norman & Shallice, 1986).

Although presenting correctly and incorrectly spelled words resulted in a highly significant effect on spelling accuracy, the magnitude of the effect was not large. Much more dramatic results were produced by Ann Hollingshead, a research

technician in our laboratory and the second author of this paper. In the course of collecting the data for the experiments reported here, she read the incorrectly spelled words a large number of times. As a result of this extended experience with those incorrect spellings, she reports having lost confidence in her spelling accuracy. She can no longer judge spelling accuracy on the basis of a word "looking right." The word might look right because it was one of our incorrectly spelled words. Consequently, she has had to resort to other bases for judging the accuracy of spelling such as the use of spelling rules and, more often, looking words up in the dictionary.

It seems likely that effects of reading a word on one's later spelling performance generally parallel effects of reading a word on one's later perceptual identification performance. If so, it should be possible to produce effects on spelling that are large and long lasting. Those effects also might be specific to the context in which a word was read earlier. Results of this sort would be important for issues such as the role of priming versus that of unconscious retrieval of memory for particular prior encounters with a word (see Jacoby & Brooks, 1984, for a discussion of related issues). However, we are unlikely to do further experiments to examine the effects of reading incorrectly spelled words. It seems unethical to do experiments that potentially are damaging to the spelling ability of undergraduate participants. Also, there is the potential problem of lawsuits that might be brought by a research assistant whose spelling accuracy has suffered. The results of our experiments are sufficient to give one reason to worry that reading student essays may be hazardous to one's spelling accuracy.

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