Some Contingencies of Spelling

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This paper presents some speculation about the contingencies that might select standard spellings. The speculation is based on a new development in the teaching of spelling—the process writing approach, which lets standard spellings emerge collateral to a high frequency of reading and writing. The paper discusses this approach, contrasts it with behavior-analytic research on spelling, and suggests some new directions for this latter research based on a behavioral interpretation of the process writing approach to spelling.

A radical behaviorist interested in spelling finds a vast literature. Some of this literature is behavior-analytic in orientation (e.g., Axelrod & Paluska, 1975; Axelrod, Whitaker & Hall, 1972; Broden, Beasley & Hall, 1978; Foxx & Jones, 1978; Gettinger, 1985; Harris, Sherman, Henderson & Harris, 1972; Kauffman, Hallahan, Haas, Brame & Boren, 1978; Lovitt, Guppy & Blattner, 1969; Neef, Iwata & Page, 1980; Ollendick, Matson, Esveldt-Dawson & Shapiro, 1980; Rapport & Bostow, 1976; Rayek & Nesselroade, 1972; Reith, Axelrod, Anderson, Hathaway, Wood & Fitzgerald, 1974). But most of it is not (e.g., Anderson, 1985; Beers & Beers, 1981; Beers, Beers & Grant, 1977; Bolton & Snowball, 1985; Campbell, 1977; Chomsky, 1970, 1971; Cramer, 1976; Cripps, 1979, 1983, 1985; DiStefano & Hagerty, 1985; Gentry, 1982; Hauser, 1982; Henderson, 1980; Peters & Cripps, 1983; Rivalland, 1985). That is, most literature on spelling presents research and theory contributed by people working outside the framework of radical behaviorism.

This large literature raises a question for radical behaviorists interested in extending the operant account of verbal behavior (Skinner, 1957). Spelling, as a dimension of writing, is an aspect of verbal behavior that an operant account must include. The question of interest is whether we have to start afresh in studying spelling or whether we can find useful information in the pre-exist-

ing literature. At first sight, finding useful information in this literature seems unlikely, because of the metatheoretical and methodological gap between radical behaviorism and the rest of psychology. This gap can present us with a formidable task when we try to cull something useful from the literature of nonoperant psychology.

With spelling, we have the advantage that much of the nonoperant literature is written by or for practitioners; in this case, teachers. That such a literature might interest us will seem surprising. After all, academic psychologists ordinarily show little interest in the practitioners' literature. But perhaps this lack of interest is mistaken, given the convergence historically of craft and speculation in science. This convergence has been discussed elsewhere (e.g., Kranzberg, 1968; Van Melsen, 1961; Ziman, 1976). Craft consists of techniques that arise through trial-and-error experience of what works in solving practical problems ahead of or independently of science. The practitioners who develop and use these techniques transmit them to other practitioners and to students through demonstration and apprenticeship. Eventually, practitioners publish written descriptions of their techniques as rules of thumb for achieving practical results (Ziman, 1976, p. 140). Much of the literature on spelling is of this kind. A literature written by or for practitioners might interest radical behaviorists because it is more likely than the literature of traditional psychology to deal both with the behavior of individuals and with the conditions under which behavior seems to

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change. Goldiamond (e.g., Goldiamond, Dyrud & Miller, 1965) has pointed out that practice shares its interest in such things with operant research. To the extent that a literature outside behavior analysis deals with actual events, as opposed to obscure abstractions, we might cull something useful from it. That something useful will consist of guesses about the contingencies that might operate in the domain of interest and the effects of which we might subsequently investigate with an experimental analysis. The present paper offers some speculation about some contingencies of spelling and in doing so, raises several problems that might guide an experimental analysis of spelling.

STANDARD SPELLING AS A COLLATERAL EFFECT OF WRITING

One preoccupation of educators has been the place of the spelling test in teaching children to spell. Whether to teach children to spell by using an assign-and-test strategy has been debated since the turn of the century (Peters, 1970). Doubt about this strategy has arisen in part because of the lack of carry-over to writing from performance on spelling tests (Freyberg, 1964). Indeed, this doubt was expressed by some behavior analysts (Brodén et al., 1978) who described their retention data following parent tutoring of spelling as unimpressive. Doubt about spelling tests has also arisen on the ground that spelling tests divorce spelling from writing and obscure the function of spelling in writing. Critics who present this objection ask us to see spelling as the means to an end rather than as an end in itself (e.g., Beers & Beers, 1981; Bolton & Snowball, 1985; Cramer, 1976; Gaskins, 1982; Rivalland, 1985). In this view, the end is writing; specifically, writing for a reader.

Associated with criticisms of the spelling test is an alternative to the assign-and-test strategy. This alternative recommends that teachers arrange for children to write frequently and abundantly, without penalty for nonstandard forms (i.e., for spelling errors). That is, the alternative approach rejects the traditional notion that standard spelling is a prerequisite for writing and accepts nonstandard spellings as *approximations to standard forms*. With this acceptance of approximations, the critical consequences of writing become, not grades or corrections of

spelling errors, but instead various effects on the reader that advocates of this alternative call "the sharing of meaning." Children present and read their writing to classmates and teachers, and these readers and listeners react. That is, the emphasis is on the writer affecting the reader—providing the reader with new information, eliciting emotion, and with having the reader ask for more detail ("What will happen next?" "I'd like to know more about this," and so on). The emphasis is also on ensuring success so that the children will write again the next day without requiring coercive contingencies to do so. This alternative, known as "the process writing approach" or "the conference approach," asks teachers to maintain a high frequency of writing while they gradually increase the demands of the reader upon the writer for clarity, completeness, and precision (e.g., Anderson, 1985; Gaskins, 1982; Graves, 1981; Walshe, 1981, 1982). This alternative is associated with a developmental interpretation of spelling as a class of behavior that emerges through a series of approximations over time (e.g., Beers & Beers, 1981; Gentry, 1982).

The process writing approach to spelling contrasts with behavior analytic research on spelling. Behavior analytic research has emphasized children's performances on daily or weekly spelling tests in educational settings. These studies have investigated the effects of contingent free time (Rapport & Bostow, 1976), the Good Behavior Game (Axelrod & Paluska, 1975), parent tutoring (Brodén et al., 1978), peer tutoring (Harris et al., 1972), interspersal training (Neef et al., 1980), teacher modelling (Gettinger, 1985; Kauffman et al., 1978; Nulman & Gerber, 1984), and delayed matching (Gettinger, 1985) on performance in spelling tests. As important as these studies are, they cannot provide all we would want from an operant account of spelling. Concern exclusively with the number of words spelled correctly on spelling tests provides little information about the details of how spelling performance changes through time (Kerr & Lambert, 1982; Nulman & Gerber, 1984). Further, concern only with contingencies that improve test performance gives no place to an analysis of the contingencies under which standard spellings emerge through a series of approximations. To study these contingen-

cies, we might consider spelling performances of the kind seen in the process writing classroom. Doing so might lead us to interpretative work aimed at identifying possible contingencies and from there to experimental work intended to explore the effects of those contingencies on spelling performance. Such work would be in the spirit of Skinner's (1957) *Verbal Behavior* and would extend that account in a way that would connect it to new developments in the teaching of spelling.

READ-WRITE CYCLE

The contingencies of a process writing classroom involve the individual as a reader of other people's writing, as a writer (whose writing has effects on other readers), and as a reader of his or her own writing. Stated differently, the contingencies involve what we might call "a read-write cycle," in which the individual writes with effects on him or herself and on other people, and reads, again with various effects, writes again, and so on. A behavior analysis of spelling should include laboratory analogues of the contingencies of such a read-write cycle.

Exploring the Read-Write Cycle

Lee and Pegler (1982, Experiment 2) used a read-write cycle *with words in isolation*. The subjects *read* each of ten words in succession and were then asked to *write* each of those ten words in succession. This read-write cycle was repeated with the same ten words until the subjects spelled each word correctly in one cycle or until ten cycles had been run, whichever came first. No experimental consequences followed spelling, but the subject still eventually wrote all the words in standard form. A read-write cycle in which the subjects did not read the words aloud after initial training in reading, but instead only looked at each word for five seconds, had the same effect (Experiment 4). These results, which were replicated across four sets of words for each child, suggested that standard spelling can emerge collateral to training in reading words followed by repeated exposure to the words and repeated writing of them or, rather, of their approximations.

Spelling had no experimental consequences in Lee and Pegler's (1982) study, but other contingencies of the experimental setting probably accounted for the eventual

appearance of standard forms. The children saw their own spelling contingent on writing each word, and they were given the opportunity to look at the ten words following each cycle of spelling them. Stated differently, the gradual appearance of standard spellings seemed to depend on the children's discrimination of standard from nonstandard forms in their own writing, the delayed matching implicit in the read-write cycle, or both.

An interesting result in Lee and Pegler's (1982) study was the appearance of nonstandard forms for each word before the standard form occurred. For example, one child wrote the series of nonstandard forms LEVF, LEVI, LEVIC, and LEVA before writing LEAVE. A similar series of nonstandard forms was noted by Cramer (1976) in the writing of a first-grade child who had no history of spelling instruction. Cramer reported the series LNT (in October), ELFNT (in December), ELPHNT (in February), and, finally, ELEPHANT (in June; also see Graves, 1981). Authors who describe process writing often provide examples of children's writing that include nonstandard forms (e.g., "Wan I gow to schl frs tam I waz skard wan my sadrz coz to dr I m skard"; Beers & Beers, 1981). These nonstandard variants have been called "spontaneous spellings," "invented spellings," and "spelling approximations" (e.g., Bolton & Snowball, 1985; Snow, 1983). The occurrence of nonstandard spellings in Lee and Pegler's (1982) study indicated that we can bring these approximations to standard spellings into the laboratory by arranging a read-write cycle. That is, we can do an experimental analysis of these developmental phenomena.

Extensions

In pursuing an experimental analysis of the read-write cycle, we need to explore some variations on Lee and Pegler's (1982) procedure. In particular, we might consider the number of words presented in any single block of words, the possibility of presenting prose rather than words in isolation, the delay between reading the words and having the occasion to write them, the ratio of reading to writing, and the possibility of having another task intervene between reading and writing. These possibilities might make an experimental read-write cycle functionally similar to aspects of the process writing

classroom. That setting involves a large number of written words, temporal delays between reading and writing, some ratio of reading to writing, and other activities that intervene between reading and writing (e.g., talking, listening).

Extending the experimental read-write cycle from isolated words to prose raises the issue of how to select the prose and control its presentation. A study by Trice, Parker and Furrow (1981) provides an example of the kind of procedure we might use. In this study, the subject read a question written by the experimenter (e.g., "What kind of job do you have for the summer?", "How are things going in science?", "What are you doing now in physical education?") and then wrote his reply. In the first condition, free time followed writing if the number of words written exceeded the number written the previous day. Number of words written increased in this condition, but the percentage of words spelled correctly did not. In the second condition, free time followed writing if the subject earned more points than he had earned the previous day. The subject earned two points for each word spelled correctly and one point for every other word. In this condition, words spelled correctly increased in number. In counting words spelled correctly, Trice et al. excluded words that had appeared in the written questions, an exclusion we would not make in using the technique to investigate the read-write cycle. In sum, the basic technique of written conversation between experimenter and subject might be used in developing a read-write cycle for prose.

The look-cover-write-check method of learning to spell a word is a read-write cycle. In this method, the child looks at the word, covers it, writes it, and checks his or her spelling against the original (Cripps, 1983). The child repeats the read-write cycle until he or she spells the word correctly. Rayek and Nesselroade (1972) used the procedure in their spelling program and called it "delayed matching." In exploring this procedure, we asked an 11 year old girl, with a spelling repertoire of predominantly non-standard forms, to use the look-cover-write-check procedure. She produced the standard spelling after one or two read-write cycles for most words, and so we did not see any series of approximations. This result suggested that

the look-cover-write-check method can produce standard spelling too rapidly to be of use as a procedure for studying spelling approximations. However, it is worth noting that this commonplace procedure amounts to a read-write cycle.

In using the read-write cycle, we might also want to identify the variables that alter the *spelling repertoire*. This issue has to do with the traditional problem of retention. Variables relevant to this issue include overtraining (i.e., increasing the number of trials of standard performance before training ceases) and frequent reviews of words previously trained (Brodén et al., 1978). A study by Neef et al. (1980) suggests that overtraining with regular reviews can increase retention. In two other studies, distributed practice with a few words practiced each day produced better retention than did massed practice with many words practiced at one time (Fishman, Keller & Atkinson, 1968; Rieth et al., 1974). The issue of retention concerns both the scheduling of words in a read-write cycle and the purpose of such a cycle—whether to alter a repertoire or to change momentary performance.

The Lee and Pegler (1982) study used number of words correct as its dependent measure. In this respect, it was consistent with other behavior-analytic studies, which have typically used number or percentage of words correct. Another measure we might use in the read-write cycle is the bigram. This measure was used by Nulman and Gerber (1984), who borrowed it from Deno, Mirkin, Lowry and Kuehnle (1980). These latter authors found that the number of bigrams present when children spelled randomly selected words predicted performance on standardized spelling tests. As a unit of letter order, the bigram indicates the presence of two adjacent items in a word, including the space before the first letter together with the first letter (one bigram) and the last letter together with the space after the last letter (one bigram). For example, the word STARS has six bigrams, starting from the space before the word through to the space after, and these nonstandard forms of STARS—STHRE, SRES, and SRAS—each has two bigrams in connection with the word STARS (Nulman & Gerber, 1984). We could use a bigram count to quantify nonstandard variants in the read-write cycle. Higher bigram

counts seem to suggest closer approximations to the standard spelling. An example from our exploratory work is the word UNIVERSE (nine bigrams), spelled UNIAVE (five bigrams), and later of letter order for research on spelling approximations. The possibility is worth exploring but will probably require computer assistance as counting bigrams by hand is arduous, time-consuming, and open to error.

SEPARABLE CONTINGENCIES OF THE RAED-WRITE CYCLE

The discussion so far has considered the read-write cycle as an integrated set of contingencies. In addition, we might abstract out a number of contingencies from the read-write cycle and study their separate effects. The following discussion considers some possibilities that these separable contingencies suggest for research.

Reaction of Readers

Advocates of process writing have argued that readers should react to the *content* of writing and should treat nonstandard forms with indulgence. They have argued that instead of expecting standard forms from the outset, teachers should give children frequent opportunities to write without penalties for nonstandard forms (Beers & Beers, 1981; Cramer, 1976; Giacobbe, 1981; Rivaland, 1985). Advocates of process writing have defended their approach by noting the indulgence of parents while children are becoming talkers. They have noted, for example, that a child approximates the standard DAD with DA and that parents accept and respond to this approximation. The parents do not tell the child he has mispronounced DAD (Cramer, 1976). Advocates of process writing have argued that children learn to talk by hearing other talkers, and by talking themselves with effects on indulgent listeners (Beers, Beers & Grant, 1977), and that children can learn to write in the same way; that is, by reading the writing of other writers and by writing themselves with effects on indulgent readers.

The arguments of theorists who espouse this developmental approach to spelling *seem* congenial to a radical behaviorist. Indeed, Skinner (1974, p. 100) implied that children learn to speak by hearing other speakers and

by speaking themselves with effects on their listeners. An account that emphasizes approximations and that implies contingencies at every turn is an account radical behaviorists should not ignore. We need to relate this account that has grown out of practice and extended observation to our own arguments about the development of verbal repertoires.

For one thing, the emphasis upon writing-for-a-reader is compatible with an operant account. Just as the listener accounts for the behavior of the speaker (e.g., Skinner, 1957, pp. 33-34), so does the reader account for the behavior of the writer (Skinner, 1957, p. 169). Given that, we can talk about the effect of writing on the reader in the same way that we talk about the effect of speaking on the listener. So, writing can get the reader to do something for the writer, it can extend the reader's effective environment, it can elicit emotion, it can build an intraverbal repertoire (Skinner, 1957, p. 34, p. 257, p. 418, pp. 432-433), and, further, the effect can be immediate or delayed (Skinner, 1957, p. 357). Moreover, just as a *speaker* can be his or her own *listener* (Skinner, 1957, pp. 438-446), so a *writer* can be his or her own *reader*. A teacher that arranges for children to write frequently and with effects upon a reader implicitly recognizes the total verbal episode (behavior of writer and reader) of which writing is a part.

Second, the notion of indulgence toward approximations is consistent with the operant emphasis on shaping. In shaping, the available behavior is maintained and its properties are gradually changed through exposure to a series of gradually changing contingencies (e.g., Goldiamond & Dyrud, 1966, 1968; Skinner, 1968). Process writing assumes that the contingency of writing-for-a-reader can keep writing at a high frequency while it gradually selects standard spelling, effective style, extensive vocabulary, and other properties of writing. The process writing classroom has the reader react as if she or he has read the content ("Tell me more about . . .," "When you said that, I expected some information about this to follow," and so on). Consequences of this kind presumably contribute to maintaining a high frequency of writing while at the same time they prompt changes that might produce a more complete written product in the long

term. Directing questions to the writer about content is reminiscent of Skinner's (e.g., Skinner in Evans, 1968, pp. 7-8) account of how a self-descriptive repertoire might develop—through members of the verbal community manding the individual for self-descriptive behavior ("Why are you doing that?", "What will you do next?", "Are you sure you want to do it?", and so on). Similarly, the demands of the reader upon the writer might gradually prompt and select various properties of writing that enhance the effect of writing upon the reader.

Writer as Own Reader

Several contingencies arise because a writer can read his or her own writing as a reader. We will discuss two such contingencies.

Reading your own writing later. Graves (1981) noted that children cannot read their earliest writing if asked to do so when a delay follows writing. Skinner (1957, p. 69) called the required performance "self-textual behavior." Invented spellings such as LC for LIKE decrease the chance of accurate self-textual behavior when a delay intervenes between reading and writing. But, as spellings approximate standard English more closely, children apparently start to text their own (past) writing, sometimes expressing surprise when this possibility becomes available (Graves, 1981). This observation relates to Skinner's (1974, p. 67) comment that new contingencies operate as the behavioral repertoire becomes more complex. In the present case, the new contingency is between writing and delayed self-texting. The observation raises the question of when this contingency begins to operate and what effect it might have on the frequency and form of writing. We need to work out ways to study the contingency and its effects.

Discriminating standard from nonstandard spellings. The letter sequences that constitute written words might depend in part on the automatic reinforcement provided when words are written in standard form. The concept of automatic reinforcement has been discussed before (e.g., Skinner, 1968, p. 20, p. 160; Vaughan & Michael, 1982). It refers to the facilitating effects of contingencies in which behavior and consequence are intertwined. Such contingencies include completing a word in a crossword puzzle with the consequence that other parts can be com-

pleted, riding a bicycle with the consequence of moving through space, and striking the keys of a piano in a particular way with the consequence of hearing a melodic sequence. In these contingencies, behavior and its consequences are so intertwined that the contingency is hard to see (Goldiamond, Dyrud & Miller, 1965). The contingency between the motor behavior of writing and the visual product of that motor behavior (textual stimuli) is similarly easy to overlook.

Some speculation offered in another context (Risley, 1977) suggests how automatic reinforcement might work in the acquisition of standard spelling. This speculation was about how automatic reinforcement might differentiate piano playing. Contingencies in which parental consequences depend on a child actually playing the piano might maintain a high rate of striking the keys, but they do not provide differential reinforcement for melodic sequences. Even so, recognizable tunes often emerge. Presumably, if a high rate of playing is maintained by other contingencies, then the automatic reinforcers of producing melodic sequences might differentiate the behavior that produces them (Risley, 1977). The process depends, presumably, on children discriminating melodic from nonmelodic sequences. Contingencies of the same kind might operate in spelling. If children write frequently, then the weak, automatic reinforcers of producing standard spellings might differentiate standard spellings. The possibility assumes that children can discriminate standard from nonstandard spellings in their own writing.

Some preliminary work has suggested to us that the requisite discrimination does not necessarily occur. Subjects in this preliminary study read a set of four words, then wrote the words by dictation, read the words again, and so on, until they spelled all four words correctly. The procedure was repeated across several sets of words with each subject, and correct spellings resulted in the child receiving a dime. The experimenter asked the child to check each correct word and to cross each incorrect word immediately after writing it. The subjects typically checked all *correct* words (i.e., judged them correct). But they also checked (i.e., judged correct) on average half their *incorrect* words. When a dime was removed contingent on every misjudgment, the percentage of mis-

judgments decreased slightly. We plan to repeat these experiments over a longer period of time and in more detail once computer assistance becomes available to us. But, for the moment, we think that sometimes children do not see their errors as errors. This result occurred during a read-write cycle that *did* end with the children spelling all the words correctly, a result that might place more burden on delayed matching than on automatic reinforcement in accounting for progress toward standard forms.

Related to this issue of discriminating standard from nonstandard spellings is the suggestion that practitioners should prompt children to vary their spellings; that is, to test and experiment with various alternatives until a word looks correct (Cotterell, 1971; Rivalland, 1985). The recommendation seems based on the observation that adults uncertain about how to spell a word write it to see if it looks correct and sometimes try several versions until the spelling does look correct (Peters, 1985, p. 41). Cotterell (1971) said that practical experience indicates that children might require as many as eight attempts before spelling the word correctly.

In some exploratory work, we found that prompted variation of spelling was rarely successful. We arranged for each subject to spell the same six-letter (seven-bigram) word on ten successive trials. Each *nonstandard* spelling was followed by an instruction to try again and to try it in a different way this time. Each *standard* spelling was followed by praise and a twenty cent piece. We used ten words with an initial bigram count of one or two and ten words with a bigram count of five or six. Reading the words was *not* interspersed with writing. Each of the three subjects spelled only one word in standard form, and that word initially had five or six bigrams present. This result needs checking, but it suggests that simply prompting a child to try a different spelling is unlikely to produce the correct spelling. Even so, common experience indicates that the procedure can sometimes work with adults, so we need to explore the conditions under which it is successful. For the procedure to work, the writer would presumably have to discriminate the standard from nonstandard forms, otherwise repeated writing of the word would cease before the standard form appears. As

indicated before, the requisite discrimination might not be available.

Writer as Reader

In the process writing classroom, the writer is also a reader of material written by other people. This occurrence of reading raises the question of whether reading can affect spelling directly. We could interpret this question in the strict sense of whether a child trained to read a word can then spell that word without any direct training of spelling. Lee and Pegler (1982, Experiment 1) investigated this question, using words in isolation. After a pretest for reading and spelling, two nine-year boys were trained to read ten words, and then their spelling of these words was tested. The increment in correct spelling was small and unreliable. The result was replicated across four sets of words for each child. This finding was consistent with comments in the literature about the incidence of spelling deficits (Frith, 1980; Peters, 1970): Children who *read* well do not necessarily *spell* well. That is, a reader can read (or, better, text) the same word he or she cannot spell (i.e., write in standard form) on another occasion.

Further supporting the possibility of the functional independence of spelling and reading, children sometimes *spell* words they cannot *read*. Lee and Pegler (1982) observed several instances of spelling without reading. Bradley and Bryant (1979) made the same observation when they asked children to *read* eighteen words in one session and to *write* the same words in a second session. Some children spelled more words correctly than they read correctly. Bradley and Bryant (1979) found that the gap between the two repertoires narrowed as each repertoire broadened. They commented that spelling in the absence of reading was a surprising result.

From the point of view of behavior analysis, though, such results do not seem unexpected. With texting and spelling, we have two different kinds of acts, much as we do in speaking and responding nonverbally to speech (e.g., Guess & Baer, 1973; Lee, 1981a, 1981b). It is probably only the unspoken expectation of an underlying knowledge of language that leads to surprise when we find that sometimes the two repertoires are dissociated or functionally independent. Behavior analysts do not share this expecta-

tion with other psychologists.

If children sometimes spell without reading, then we might teach writing (and, with it, spelling) ahead of reading. Chomsky (1971) suggested this possibility of reversing the expected order of writing and reading. She suggested having a child who can sound letters experiment with sets of plastic letters to make words that might, then occasion reading. Chomsky observed the unprompted occurrence of this writing-before-reading by a three-year-old child who combined plastic letters to make letters and who then read (better, texted) them. The possibility suggests another direction for behavior-analytic research on spelling; namely, studies that establish writing (spelling) ahead of reading and explore the collateral effect of writing on reading. Moxley and Barry (1985) have developed a word-picture program for teaching nursery children to spell words. Their method might be used to study the present issue.

POSSIBLE UNITS AND CLASSES IN THE SPELLING REPERTOIRE

The preceding discussion about the read-write cycle and its contingencies omits what is known about the structure of English spelling. Specifically, it ignores the spelling units known as "morphographs" and the spelling classes known as "word families." Ignoring this knowledge conceals some other directions that behavior-analytic research on spelling might take. The discussion now turns to morphographs, word families, and some of these other directions for an experimental analysis of spelling.

Morphographs and Word Families

Morphographs are the smallest units of meaning in written English; for example, RE (again), ISH (sort of), CON (with), and ED (in the past) (Dixon, 1976). These units either keep the same spelling or change in predictable ways when used in different words. For example, SIGN sounds different in CON-SIGN, RESIGN, and SIGNAL but is spelled the same. As another example, LIKE appears as LIKE in LIKELY and as LIK in LIKABLE, but the change in LIKABLE is predictable from the regularity of English spelling that is stated by the rule "drop the E from a

morphograph when the next morphograph begins with a vowel."

A collection of words built around a common morphograph has been called a "word family" (Chomsky, 1970). An example is the word family comprising PORT, PORTHOLE, PORTABLE, EXPORT, PORTER, and so forth. Another example consists of PART, PARTING, DEPARTURE, and so on. Word families are the classes we would consider if conducted experiments using morphographs as the units of interest.

Direct and Collateral Acquisition

The spelling program associated with Englemann's work (Dixon, 1976) recommends direct, educational reinforcement of morphographs. The argument is that children taught a small number of *morphographs* can write a large number of *words* without direct training in writing those words. For example, a child who can spell the morphographs ABLE, RE, ARM, CLAIM, ER, ING, COVER, ED, DIS, ORDER, UN, and NESS can spell over seventy-five words by combining the twelve morphographs in various ways (Dixon, 1976).

This possibility of combining morphographs is consistent with the concept of composition discussed in *Verbal Behavior* (1957, p. 123, pp. 344-352) and elsewhere (Lee, 1983; Skinner, 1974, pp. 100-101). Composition is the combining of previously acquired fragments in a novel response form on a novel occasion. A fragment is a unit of behavior under the discriminative control of a separable variable; for example, the spoken form 's' under the control of plurality. Empirical work demonstrating the process of composition can be found in studies of generalized grammatical behavior (e.g., Guess, 1969; Whitehurst, 1971, 1972; Frisch & Schumaker, 1974), in studies of creative performances (e.g., Goetz & Baer, 1973; Goetz & Salmonson, 1972; Parsonson & Baer, 1978), and in Epstein's work on the spontaneous merging of separate repertoires (e.g., Epstein, 1981). Behavioral analyses of composition in spelling would extend these previous analyses of composed performances.

An alternative to direct, educational reinforcement might be the acquisition of behavioral units corresponding to morphographs indirectly as a by-product of the

acquisition of longer units having the morphograph in common. The longer units would be the members of a word family. This possibility relates to the hypothesis that functional units corresponding in form to a common element can be added to a repertoire either through direct educational reinforcement or through the separate acquisition of longer units with an element in common (Skinner, 1957, p. 63, p. 67, pp. 119-121). Training successive instances of a word family might result in a child combining the common element with other fragments already part of his or her repertoire. An example might be when spelling the training series PORTABLE, IMPORT, and PORT-HOLE is followed by spelling the untrained form REPORTED. The appearance of REPORTED under these circumstances would suggest the combining of the previously acquired fragments RE and ED with the newly-acquired fragment PORT. Other interpretations are possible, of course; for example, the combining of the previously-acquired fragments REPORT and ED. But careful sampling of the available repertoire ahead of experimentation would reduce the plausibility of such alternative interpretations. The appearance in case histories of invented spellings such as YOUNITED for UNITED and EGUL for EAGLE (Gentry, 1982) gives some support to the idea that fragmentary units of writing (YOU, GUL, etc.) can acquire functional unity. Experimental analyses of this problem would be worth doing.

Awareness of Word Families

We might also explore what spellers say about spellings. This possibility is suggested by Gentry's (1982) report of some if-then statements about spelling made by a five-year-old boy while writing. For example, the boy said "You spell 'book,' B-O-O-K. To write 'look,' you change one letter—you take away the B and add an L." He also said, "If you take away the T and R off 'trike,' and put a B in front of it, you have 'bike'" (Gentry, 1982). These statements are about visual patterns in writing rather than about word families. But, similar statements about word families were mentioned by Tenney (1980), who presented adult subjects with pairs of words, with one word spelled correctly and the other incorrectly (e.g., COMMITMENT, COMMITMENT). Subjects had to choose

the correctly spelled word and justify their choice. Tenney noted that one subject said she chose COMMITMENT over COMMITMENT because the word consists of the base COMMIT and the suffix -MENT. She chose CONSENSUS over CONCENSUS because the related word "consent" is spelled CONSENT. This result suggested awareness of the relevant morphographs and word families.

Some writers have suggested that children can talk about word families and reason from known spellings to unknown spellings within a word family. For example, DiStefano & Hagerty (1985) suggested that a child uncertain about spelling the word "really" might say that if "real" and "reality" are spelled REAL and REALITY, then "really" must be spelled REALLY and not REELY. Similarly, Bolton and Snowball (1985) suggested that a child might say that if "design" and "designate" have related meanings (belong to the same word family), then "design" must contain the letter "g." These comments seem to assume stimulus equivalence within word families, a matter to which Sidman's work (e.g., MacKay & Sidman, 1984) might be relevant.

Skinner (1968, pp. 39-41) suggested a training procedure that might establish standard spelling and might develop awareness of morphographs and word families. Skinner recommended that in teaching children to spell the word "manufacture," we might prompt them to identify the part that "manufacture" shares with "factory" and the part it shares with "manual." That is, in training children to spell one word, we might prompt them to identify the morphographs common to two or more words. Similar procedures for training children to identify word families and their common elements have been suggested by several contributors to the spelling literature (Beers & Beers, 1981; Chomsky, 1970; Rivalland, 1985).

Stimulus Control of Invented Spellings

The spelling literature contains speculation about a developmental transition in invented spellings (e.g., Anderson, 1985; Gentry, 1982; Marsh, Friedman, Desberg & Welch, 1980; Nolan & McCartin, 1984). The transition is typically discussed in terms of strategies that children use, concepts they develop, discoveries they make, hypotheses they form, and knowledge they internalize.

For example, Anderson (1985) described the transition as "a qualitative shift from the use of phonemic strategies to the use of a variety of highly effective strategies which draw on lexical memory and deep levels of linguistic analysis" (p. 146). As another example, Gentry (1982) said that "as spelling develops, children draw increasingly from alternative strategies—phonological, visual, and morphological" (p. 198). Statements of this kind present us with difficulties of translation. We need to identify the behavioral phenomena that occasion such statements and to develop an operant account of those phenomena.

Some spellings (e.g., MUSEM [for MUSEUM], KICHN [for KITCHEN], and SPRIS [for SURPRISE]) have led contributors to the spelling literature to speak of children using a sound-based or phonemic strategy (Nolan & McCartin, 1984). This strategy amounts to the matching of successive letters to successive sounds (as the particular child hears those sounds; Beers & Beers, 1981). Stated otherwise, the child's writing (spelling) has a point-to-point correspondence with the spoken utterance.

Letter-sound matching will not reliably produce standard spelling. In English, the same letters can represent different sounds (e.g., SAID, DAISY; DEAD, BEAD), and many letters can represent one sound (e.g., the sound /ar/ can be written as in HEART, FATHER, CAR, LAUGH, and CALF). Stated differently, nothing in how we speak can indicate that WHAT is standard but WHOT is not, that THEY is standard but THAY is not, and so on. English spelling has some letter-sound matching, but it also has many units said to preserve meaning despite phonological variation (e.g., Chomsky, 1970; Venezky, 1980). So, for example, orthography stays the same despite changes in pronunciation of the first vowel in the word pairs NATION-NATIONAL, SANE-SANITY, EXTREME-EXTREMITY, and so on. As another example, the past tense morpheme is written ED though it is pronounced in three different ways, as in "started," "stopped," and "happened." Letter-sound matching in these examples would probably not produce standard spellings.

Standard spellings often depend on the matching of writing to print (rather than to sound). The success of the read-write cycle and the prevalence of the look-cover-write-

check procedure as a technique for learning to spell (e.g., Cripps, 1983) underscore this dependence. That is, the read-write cycle arranges for the matching of writing to print rather than to the spoken utterance.

Nonstandard spellings not interpreted as sound-based in the nonoperant literature consist of inappropriate extensions of morphographs (e.g., OCCUPIE for OCCUPY, PURECHASE for PURCHASE), inappropriate extensions of patterns other than morphographs (e.g., MAIK for MAKE, EXPLAINE for EXPLAIN) and errors that suggest weak control by printed words previously observed (e.g., SUPRISE for SURPRISE, LIHGT for LIGHT, and KITCKEN for KITCHEN). The first two kinds of errors have been described as resulting from a strategy based on analogy with known words in visual memory (Marsh, Friedman, Desberg & Welch, 1980). Errors of the third kind have been called "visual image errors" (Nolan & McCartin, 1984). In general, errors that do not seem sound-based have been taken to indicate the occurrence of a print-based or visual strategy (e.g., DiStefano & Hagerty, 1985; Nolan & McCartin, 1984).

In sum, speculation about strategies that result in nonstandard spellings seems to be about whether spellings (written products) reflect the matching of writing to sound or the (delayed) matching of writing to print. That is, nonstandard spellings apparently reflect either the nonstandard variants possible when writing is matched to sound (e.g., REELIZE, REELISE, REALEYES, REALYZE, or REALLIZE for REALISE; Dixon, 1976, p. 3), or the nonstandard variants possible when writing is matched to print (EXPLAINE, EXPLANE, EXPLIAN, and so on, for EXPLAIN), or both. That is, the phenomena that developmental theorists describe in terms of strategies, discoveries, hypotheses, and the like, might turn out to involve problems of stimulus control. This possibility relates to the proposal that problems of cognition might be reformulated as problems of stimulus control (e.g., Sidman, 1978). We need to develop ways to bring the stimulus control of nonstandard spellings into the laboratory.

CONCLUSION

The nonoperant literature on spelling does contain something of use to an experimental

analysis of verbal behavior. Most centrally, it directs us to the possibility that a repertoire of standard spellings might emerge collateral to a high frequency of writing-for-a-reader. This possibility seems congenial to a radical behaviorist, since it tacitly recognizes the centrality of contingencies in conduct. People interested in the practice of process writing are ahead of us in having developed a sensitivity to the contingencies of the process writing classroom. Their practice raises a scientific problem for us. It is to fully explore by experiment the contingencies of process writing and the effects of those contingencies on spelling. For some of us, the placing of practice ahead of research in this matter will be uncongenial. But that reaction might reflect more the ideology of application that pervades academic psychology than the history of how the other experimental sciences developed. For, after all, the experimental sciences did arise out of a convergence of craft and speculation (e.g., Kranzberg, 1968; Van Melsen, 1961; Ziman, 1976). In the case of process writing, we have a craft under development. This craft can occasion speculation based on the concept of the contingencies, and that speculation might, in turn, lead to an experimental analysis of the development of spelling repertoires. We could begin such an analysis by exploring the read-write cycle, the separable contingencies that constitute the read-write cycle, the acquisition of units and classes of spelling, the occurrence and functional significance of an awareness of morphographs and word families, and the stimulus control of invented spellings.

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