

Lexical Morphology and the Two Orthographic Routes

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We report a case of dysgraphic performance in which we have documented the selective preservation of suffix spelling in the context of the phonologically plausible spelling of word stems (e.g. surfed spelled as *sourphed*, and not as *sourpht*). The preservation of suffix spelling is observed consistently in spite of the fact that the spelling for the suffix corresponds to more than one phonological form. We argue that the interpretation of such an error pattern requires that we assume that the stem material is processed via phonology-to-orthography conversion, whereas the suffix material is processed lexically. We conclude that the results are incompatible with an exclusively whole-word view of lexical representation and processing and requires, instead, that we assume a lexical orthographic system in which morphologically complex forms are represented in a compositional manner.

INTRODUCTION

Current accounts of the ability to generate orthographic forms provide two spelling mechanisms—one which retrieves a stored representation of the desired spelling, and another which exploits the regularity of sound-to-spelling correspondence in order to assemble a spelling (e.g. Beauvois & Derouesné, 1981; Ellis, 1982; Shallice, 1981; but see Campbell, 1983, for discussion of a different hypothesised architecture). Retrieval of stored

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orthographic representations would clearly be required when, as is often the case in English, the application of the correspondence rules would not result in the correct lexical spelling (e.g. the application of correspondence rules to a lexical item such as [hɛd] may yield the spelling *hed*). Another quite obvious situation where retrieval is needed is the task of spelling members of homophone groups (e.g. their vs. there). In addition, a stored representation may well be established whenever a word has been spelled often enough. On the other hand, when a target spelling cannot be recovered from the lexicon (either because a stored representation cannot be accessed, or because there is no stored representation to begin with), the nonlexical system of sound-to-spelling correspondences can still provide an interpretable orthographic form. Thus, faced with the task of spelling a nonsense form like [klæf], for example, the use of sound-to-spelling regularities will license unattested orthographic forms like claff or klaph (but not clafe).¹ Evidence for this dual-route model of the writing system derives from the double dissociation observed in studies of acquired dysgraphia: One can find cases where nonword spelling abilities are lost whereas lexical spelling is preserved (e.g. Bub & Kertesz, 1982; Shallice, 1981), as well as patients who present with preserved ability to spell nonwords as well as words for which the sound-to-spelling correspondences are perfectly regular and unambiguous, but who cannot spell words with less regular (or with ambiguous) sound-to-spelling mappings (e.g. Beauvois & Derouesné, 1981; Goodman & Caramazza, 1986; Hatfield & Patterson, 1983; Roeltgen & Heilman, 1983; Sanders & Caramazza, 1990).

The two routes for writing are hypothesised to converge at the Graphemic Buffer—a device for the temporary storage of retrieved or assembled orthographic representations. These representations are subsequently transformed by modality-specific procedures such as those required for oral spelling or for writing. Evidence for this shared buffer derives from patients whose acquired dysgraphia affects word and nonword spelling alike in both written and oral spelling tasks. In such cases, spelling errors are usually clearly identifiable as letter substitutions, deletions, insertions, or transpositions (cf. Caramazza, Miceli, Villa, & Romani, 1987; Hillis & Caramazza, 1989; Posteraro, Zinelli, & Mazzucchi, 1988). In broad outline, the architecture of the spelling system can be schematised as in Fig. 1.

Patterns of spelling errors have also provided information about the nature of the representations that spelling procedures operate on (e.g. Badecker, Hillis, & Caramazza, 1990; Caramazza & Miceli, 1990;

¹Of course, there is nothing to prevent this system from coming up with a spelling for an attested word. For example, when a stored representation is either transiently or systematically unavailable, then it is quite plausible that the nonlexical route can take over.

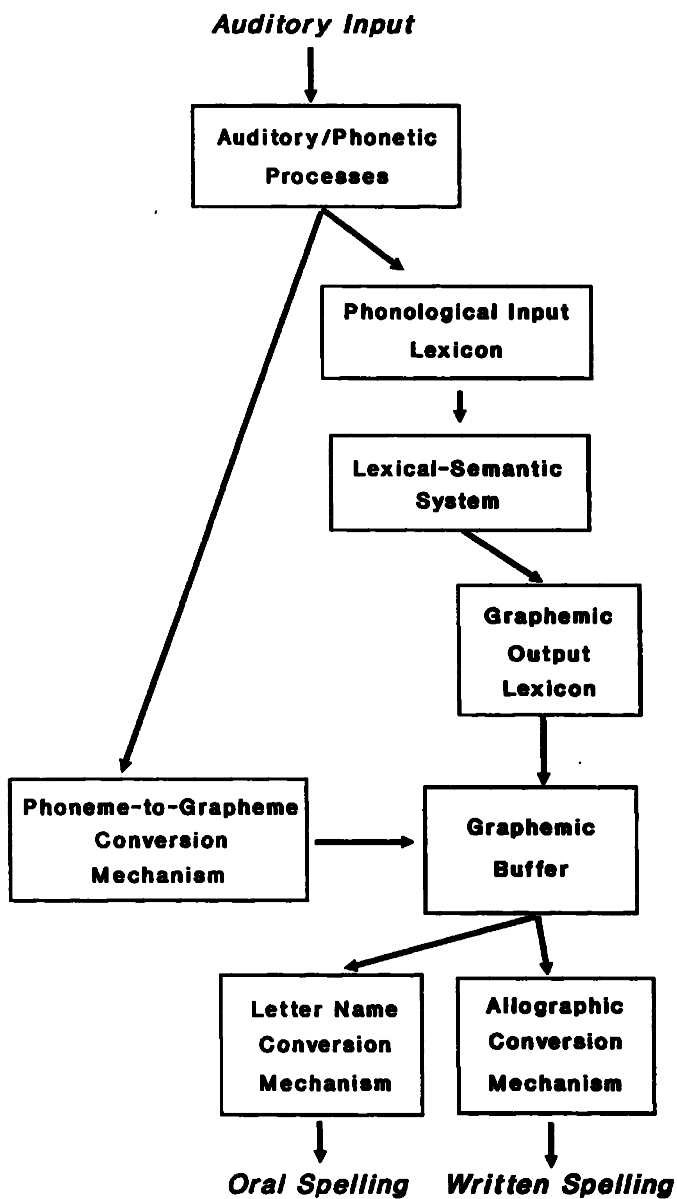


FIG.1. A schematic representation of the cognitive components engaged in written and oral spelling to dictation tasks.

Goodman & Caramazza, 1986; McCloskey, Badecker, Goodman-Schulman, & Aliminosa, 1994). Of interest to the present paper is the role of morphological structure in the spelling system. Evidence that the representations of the orthographic output lexicon are passed along to the graphemic buffer in morphemic units comes from a subject, DH, who presents with a deficit at the level of the graphemic buffer (Badecker et al., 1990, Hillis & Caramazza, 1989). The features of DH's performance that are most salient with respect to this point are: (1) a significant length effect, and (2) an asymmetric distribution of spelling errors. The accuracy of DH's performance decreased significantly as word length increased; and, with monomorphemic targets, errors were more likely to occur at the end rather than at the beginning of the word. When the positions of spelling errors in morphologically complex words were similarly analysed, however, a different pattern emerges. DH produced fewer errors on suffixed words than on monomorphemic words matched for frequency and length. More importantly, the probability of producing a spelling error in one position or another differed for suffixed and monomorphemic items. In productively suffixed,² prefixed, and compound words, the asymmetric distribution of spelling errors is observed not with regard to the entire word, but in terms of the morphemic units that make up the whole word. Error rates increased toward the end of the word-stem (e.g. at the end of weight in the target weightless), but then dropped off for the initial letters of the suffix to the level of performance that was observed for the beginnings of words. Badecker et al. (1990) argue that this pattern is interpretable if the processing units at the level of the damaged buffer can be morpheme-size grapheme sequences (rather than grapheme sequences for whole words). That is, the output units of the orthographic lexicon are the productive morphemes of the language. In the case presented here we identify converging evidence for this analysis.

CASE STUDY

BH is a 45-year-old right-handed male with a Masters degree in management and excellent pre-morbid oral and written language skills (extensive pre-morbid writing samples are available). BH suffered a severe traumatic brain injury six years prior to testing as a result of an aeroplane accident. CT scans at that time indicated right frontoparietal and left frontal lobe white matter and right internal capsule haemorrhages.

BH has a left hemiparesis and although the use of the right hand is largely normal, mobility of his right leg is severely limited. He suffers from

² By productively suffixed we refer both to regularly inflected forms like walking, and productively derived forms like darkness.

severe memory problems that primarily affect his ability to retain information over the medium to long term. He exhibits indications of left-sided neglect in reading, word copying, and line-bisection tasks (though no evidence of neglect was observed in his written output) and he also shows some signs of visual agnosia. He has great difficulty in producing audible speech and, although he will occasionally mouth words, he prefers to communicate via writing, which he performs fluently, quickly, and with few revisions.

It was not easy to assess BH's comprehension abilities as his performance on simple word-picture matching tasks was affected by his neglect and agnosia. In addition, he had great difficulty following all but very simple task instructions. In light of these limitations, the task that was more revealing of his syntactic comprehension abilities was a sentence completion task where he was asked to write down an ending to an auditorily presented sentence (initial) fragment. Although 54% of the total responses in this task were semantically anomalous, 83% (88/106) of the responses were syntactically appropriate. His completions typically indicated correct agreement in number and tense (e.g. She drank four . . . "bottles of alcohol"; Someday we . . . "will go because there isn't a problem"; and Yesterday we . . . "played the games") and this included cases in which BH's responses incorporated neologistic forms that required inflection (e.g. Just a minute ago . . . "we *turked* every thing"; She drank four . . . "of the *yallards*"; and The man is being . . . "*dresswracked*"). Likewise, lexically determined syntactic features were also usually respected (e.g. My wife persuaded . . . "somebody to do something"; Ann told . . . "my mother something"; and He mentioned that . . . "the yard was all *toxod* up").

In written picture naming, BH occasionally produces neologistic written responses (e.g. clock → *porpet*). In written picture description, although his responses are almost always syntactically correct and often semantically appropriate, he sometimes produces syntactically correct but empty responses (a picture of a girl kicking a ball → *That picture is of some kid*) or even semantically bizarre responses (a picture of a box in front of a cube → *The box has been negated by the misused staff*). It was also observed in preliminary testing that BH's ability to write words to dictation seemed largely preserved, with only a small proportion of phonologically plausible errors (e.g. soap is spelled as *sope*). The focus of this investigation is on BH's performance in writing single words to dictation.

BH presents with a dysgraphia that is strongly affected by the frequency and orthographic regularity of a target. BH was asked to write a list of 110 words, 80 of which were composed of letter sequences with low-probability phoneme-to-grapheme correspondences (Goodman & Caramazza, 1985). Half of the total items were high-frequency (*U* value greater

than 195 in the Carroll, Davies, & Richman, 1971, distribution) and half low-frequency target words (less than 9 in the Carroll et al. *U* distribution), ranging in length from four to six letters. High-probability words were defined as those having a greater than 50% chance of being spelled when the most frequently occurring phoneme-to-grapheme correspondence rules in English orthography were used (e.g. bribe).³ Words were considered as low-probability items if the chance of success using this method was less than 10% (e.g. dead). BH performed at 100% accuracy for high-frequency targets, but only at 80% for low-frequency words ($N = 55$ in each category): $\chi^2 = 10.10$, $df = 1$, $P < 0.01$. His performance on low-frequency items can be analysed further in terms of the regularity of the phoneme-to-grapheme correspondences in the target: BH was 100% accurate on the high-probability set ($N = 15$), but only 73% accurate for the items with low-probability phoneme-to-grapheme mappings ($N = 40$): $P = 0.025$, Fisher's Exact Test (with adjustment for two-tailed comparison of unequal N s). Most of the errors for the low-frequency items consisted of phonologically plausible nonword errors (PPEs; e.g. spelling glue as *glew* and hammer as *hamar*).

Similar performance was observed when BH was asked to spell items from a separate list of 30 words with highly irregular sound-to-spelling correspondences (e.g. gauge, sword, tongue) and 30 items with regular spelling-to-sound correspondences matched on frequency and length to the irregular items.⁴ BH's performance is summarised in Table 1. BH's performance on this task showed a marginally significant effect for ortho-phonological regularity. In particular, BH produced more errors on the exceptional than on the regular spelling-to-sound items ($\chi^2 = 3.54$, $df = 1$,

TABLE 1
BH's Spelling of Words with Regular and Exceptional
Spelling-to-Sound Correspondences

	<i>Regular</i> <i>Spelling-to-Sound</i> (<i>greed</i>)	<i>Exceptional</i> <i>Spelling-to-Sound</i> (<i>gauge</i>)
Correct	27	20
Errors		
PPE	2	7
Other	1	3

³Phoneme-to-grapheme probability measures were obtained from norms provided by Hanna, Hanna, Hodges, and Rudorf (1966).

⁴These stimuli were taken from experiment 4 of Seidenberg, Waters, Barnes, and Tanenhaus (1984).

$P = 0.06$, 2-tailed). Most importantly, the difference in error rate is largely attributable to a greater number of phonologically plausible nonword errors.

Clearly, one would not suppose that forms like *sope* or *sozz* (BH's spellings for the targets soap and sauce, respectively) are retrieved from the orthographic output lexicon. Rather, this pattern indicates, on the model that we have discussed here, that when BH cannot recover a stored orthographic representation, he employs a nonlexical mechanism based on sound-to-spelling correspondences to generate a spelling.

This impairment profile—what many would label “surface dysgraphia”—is not entirely uncommon (cf. Baxter & Warrington, 1987; Beauvois & Derouesné, 1981; Goodman & Caramazza, 1986; Sanders & Caramazza, 1990). However, there was one particularly noteworthy feature of BH's performance regarding the operation of the spelling system—viz. phonologically plausible errors did not occur on the word final letters of suffixed words. As the examples in Table 2 indicate, there appeared to be a tendency to spell the inflection of a word properly even when the stem portion of that word was spelled using sublexical phonology-to-orthography mappings. The tendency is remarkable because the spelling for the suffix does not always reflect the morpheme's pronunciation unambiguously. That is, the spelling for the past tense suffix is invariant in passed, pulled, and handed, despite the fact that the phonological form of the affix differs in these three words (/t/, /d/, and /ɪd/, respectively). (Cf. the final phonemes in [pæst], [pʊɪd], and [hændɪd].) Hence, if the entire word were being spelled by the phonology-to-orthography conversion system, one would expect errors like surfed spelled as *sourpht* (instead of BH's rendering of this target as *sourphed*). What the errors in Table 2 indicate is that something quite different is taking place. In particular these errors suggest that when a stem cannot be retrieved

TABLE 2
BH's Misspellings for Uninflected and Inflected
Targets

Uninflected Targets		
<u>cupboard</u>	→	<i>coubard</i>
<u>rhythmic</u>	→	<i>rethmick</i>
<u>census</u>	→	<i>senis</i>
<u>chord</u>	→	<i>cordd</i>
Inflected Targets		
<u>caboozes</u>	→	<i>cabuses</i> (not: <i>cabusiz</i>)
<u>surfed</u>	→	<i>sourphed</i> (not: <i>sourpht</i>)
<u>kneeled</u>	→	<i>neiled</i> (not: <i>neild</i>)
<u>wolfed</u>	→	<i>woulphed</i> (not: <i>woulpht</i>)

from the lexical system, it is processed by the nonlexical route; but this alternate approach that is taken to the spelling of the stem does not seem to affect the retrieval of the stored form of the inflectional ending. Thus, misspellings like surfed → *sourphed* and kneeled → *neiled* point to the involvement of *both* the contents of the orthographic output lexicon (which is invoked for the retrieval of the stored form of the inflectional ending) and the computational apparatus devoted to submorphemic phonology-to-orthography mappings (which must compose a spelling for the inaccessible stem form).

In order to test the reliability of this performance feature, BH was administered a list of 104 regular past tense verb forms in which the phonology of the suffix varied but the orthography remained constant. Forms in which the suffix corresponded to the voiceless phoneme /t/ comprised 56% of this list; forms in which the suffix corresponded to the voiced /d/ and to the "syllabic" /ɪd/ made up 38% and 6% of the list, respectively. If phonology alone guides the spelling of the suffix when BH resorts to nonlexical mechanisms, then this should be reflected in phonologically plausible errors on this portion of the word (i.e. we should observe errors such as surfed → *sourph*t). On the other hand, if BH is able to retrieve the suffix portion from the lexical system (reflecting the compositional nature of inflectional processing), then the fact that the stem is spelled by nonlexical mechanisms should not entail a phonologically plausible misspelling for the suffix. This list was presented along with a frequency- and (orthographically) length-matched list of unaffixed words whose final sounds were graphemically ambiguous (e.g. traffic, peacock, chef, epitaph, tariff) in order to verify that BH's ability to spell the suffixed region of the inflected words was not attributable to a selective preservation of the spellings of the ends of words. BH's overall performance was better on the suffixed words (63% correct) than on the control words (44% correct): $\chi^2 = 4.27$, $df = 1$, $P < 0.05$. In order to assess the effect of the suffix status of the final segments of the targets, though, one must compare the within-word position of the Phonologically Plausible Error (PPEs) that BH produced in the two types of words. As the results in Table 3 indicate, there was a marked contrast in BH's ability to spell the inflections properly in comparison to his tendency to produce incorrect though phonologically plausible spellings for the ends of the uninflected words. The values of interest are the proportion of errors involving misspellings of the final segments in words for which there is evidence of nonlexical processing. As can be seen clearly, the two stimulus types differed markedly with regard to final segment error distributions. The final letters of the monomorphemic targets with ambiguous sound-to-spelling correspondences were involved in 17 of the 24 errors scored as PPEs for this target type (e.g. epitaph → *epita*f, benign → *benine*), but the

TABLE 3
BH's Spelling of Regular Past-tense Verbs and
Monomorphemic Controls

	<i>Regular Past Verb Forms (N = 104)</i>	<i>Phonological Match (N = 52)</i>
<i>Correct</i>	62%	44%
<i>Errors</i>		
PPE		
Non-final only	25%	13%
Including final letter	4%	33%
Other Spelling Errors	9%	10%

endings of the inflected words, which were also ambiguous in their spelling-to-sound mapping, were generally not subject to this type of error (only 4 of the 30 errors scored as PPEs for the suffixed words implicated the final letters): $\chi^2 = 16.21$, $df = 1$, $P < 0.001$. This was the case in spite of the evidence that 29% of the stems of the inflected words were derived through sublexical procedures (e.g. golfed → goulphed). Hence, phonologically motivated misspellings in PPEs rarely include an incorrect rendering of the suffix region for the affixed targets, whereas the final letters of the monomorphemic targets are clearly not insulated from phonologically plausible misspellings.

One might suppose that the selective preservation of the suffixed region of the target was merely the result of BH's preference for spelling the final alveolar stops (both voiced and voiceless) using the E-D grapheme sequence. That is, perhaps the correspondence rules regularly assigned E-D to the phonemes /t/ and /d/ when they appeared in word-final position. In order to examine this possibility, BH was administered a list of 104 uninflected words ending in /t/ and /d/ (e.g. tempt, coward, and custard). These new items, which were matched in length to the suffixed forms used in the previous task, were presented embedded in a larger list of words with other characteristics. Although BH made 36 PPEs, he never made E-D errors for uninflected words ending in the voiceless stop, and he only twice misspelled a final voiced stop with this sequence in an uninflected word (sordid → sourded). Clearly this rate of /d/ → E-D usage cannot account for the large proportion of correct spellings of the E-D suffix described in Table 3.

Alternatively, one might ascribe to BH the use of a more specific strategy based solely on the grammatical category of the target. For example, faced with a target ending in the phonological segments /t/ or /d/, BH could select the E-D spelling option whenever he recognised the

target word as a verb. That is, BH might not be processing the final portion of the word as a suffix, but might instead have a strategy for spelling verb-final alveolar sounds with the E-D spelling. If this account were true, though, then one would expect that there would be corresponding misspellings of the final letters in verbs like adjust, erupt, draft—where E-D would be used to represent the final voiceless consonant. BH was asked to spell 51 such words (again embedded in a larger list). He produced four PPEs on verbs of this form but in no case did he select the E-D option for the final, non-suffix /t/ or /d/ (e.g. adjust → *ajust* and not *ajused*).

Hence, the selective preservation of the suffix form in BH's misspellings cannot be accounted for simply by a preference for this spelling option on the part of the nonlexical mapping system, nor can it be explained by a grammatical-category-based spelling strategy. Instead, it would appear that the lexical system can supply the unit of form corresponding to the suffix even under circumstances when the target stem cannot be similarly retrieved.

A comparison of BH's performance on regularly suffixed forms like surfed and chirped with his performance on targets like adjust, erupt, and draft also helps to establish that his failure to recover the stored form for particular targets is not merely a consequence of an input problem (i.e. where the spoken stimulus simply does not activate a lexical entry at the input stage of processing). If in writing to dictation BH spells surfed as *sourphed* (and not *sourpht*), but adjust as *ajust* (and not *ajused* or *ajused*), then it must be the case that phonological processing of the input has proceeded at least as far as would be required in order to establish that these words have differing morphological structures. What about the meaning of the target, though? One might suppose that the nonlexical route is taken only in those instances when BH cannot access a target's semantics. In that case, a writing task paired with a comprehension task should reveal a link between the production of PPEs and comprehension failures. To deal with this issue, BH was administered a spoken list of 100 picturable words (45 inflected verbs, 15 uninflected verbs, and 40 nouns). Corresponding to each target word, BH was presented with a picture that depicted the word and a distractor picture. Half of the distractors were close semantic foils (e.g. target = *begged*, distractor = *robbed*), half were unrelated (e.g. target = *followed*, distractor = *spilled*). BH was presented with the spoken target word and asked to point to the appropriate picture and then write the target form (*begged*, *followed*, etc). BH produced 10 PPEs and 2 other errors; 7 of the PPEs were on past tense forms (the other 3 on nouns and uninflected verbs). As in the previous lists, BH produced the E-D spelling for the suffix on all seven of these items (e.g. stitched → *stich*ed).

The issue of whether the nonlexical route was taken only when semantic processing failed is addressed by comparing the proportion of comprehension errors for the words that elicited PPEs with the proportion of such errors for words that were spelled correctly. BH made 2 comprehension errors for the 10 misspelled targets (20%), vs. 17 comprehension errors on the correctly spelled words (19%). Although these results cannot tell us with certainty how completely BH processes the misspelled words at a semantic level, they at least indicate that his performance on inflected words is not merely a consequence of failure at the early stages of lexical processing.

Finally, there is modest evidence indicating that the preservation of the orthographic forms of inflectional suffixes is not limited to verb inflections. BH was asked to spell 20 regular plural nouns and 3rd-person singular verb forms ending in the /Iz/ allomorph (e.g. caboozes and harasses). Although the number of PPEs that BH produced on these items was admittedly small ($N = 3$), these errors all preserved the appropriate spelling for the plural ending (e.g. caboozes → *cabuses* and not *cabusiz*, as might be expected were BH to have used a rule-based approach to spelling the word-final portion of the target).

DISCUSSION

Considered for its broadest implications, the case we have presented here is noteworthy for the argument it provides for morphological decomposition in the lexical system. BH's preserved spelling ability with regard to inflection stands in contrast to the nonlexical approach he must sometimes resort to for the spelling of word stems. We have shown that the preservation of the suffix material in the context of a phonologically plausible spelling of the stem cannot be attributed to a selective preservation of word-final positions. We do not observe incorrect but plausible spellings of the suffix when there is evidence of sublexical processing of the stem (i.e. we do not see surfed → *sourpht*) yet there is evidence that the final positions of monomorphemic words are subject to sublexical processing (i.e. we see yacht → *yaught*, benign → *benine*, cord → *cordd*). Furthermore, the preservation of the inflectional endings cannot be attributable to a tendency to spell final voiced and voiceless alveolar stops with the E-D sequence (i.e. we observe that cupboard is misspelled as *coubard* and not as *coubared*; and that crypt is spelled as *cript* and not as *cripped*); nor to a tendency to spell verbs with final voiced and voiceless alveolar stops with the E-D sequence (i.e. we observe that the verb concoct is misspelled as *concauct* but not as *concauked*).

In the case of BH we have concluded that damage to the output lexicon (or to relevant retrieval mechanisms) has rendered certain entries

unavailable. However, since morphologically complex words like kneeled can be processed in terms of their morphemic components, the unavailability of a stored form need not be an all-or-none matter. The letter sequence for the inflectional constituent (the suffix ed) can be retrieved even when the retrieval process fails for the stem. This selective preservation of inflectional forms could not be accounted for in a system in which lexical items are stored and retrieved only in terms of whole-word units. Either the entire word will be retrieved, or the entire form should be submitted to the nonlexical spelling mechanism. Hence, the pattern of spelling performance that we observe—containing both evidence for a nonlexical approach to spelling of unaccessed stems, and a lexical approach to the spelling of affix forms—motivates a compositional approach to the spelling of affixed words.⁵

Interestingly, our interpretation of BH's performance mirrors a classic argument for morphological composition in the lexical output system based on the observation that patients who produce neologistic jargon nonetheless inflect their neologisms (cf. Buckingham & Kertesz, 1976). The following excerpts contain representative examples of this performance feature:

... one of the nicest [f⁶ɛndlowz]
 ... these little [tr⁶ɛftiz]
 a lot of those [k¹ɪstɪsɪs]

Buckingham and Kertesz, 1976

... put over two [baɪlɪz] that were [sneɪkt] in
 I was [pleɪzd] to see the other [dakjumen]

Butterworth and Howard, 1987

Yes, because I'm just *persessing* to one ...
 ... and I *persets* abowth abrow

Caplan, Kellar, and Lock, 1972

The argument for morphological composition based on such examples runs as follows: The neologism isn't something you would store, so the inflection must be something added to the neologism. Standardly, the data used to support this argument concern the rate at which one observes the

⁵ It is not possible to determine from the data we have available just why the inflectional suffixes are preserved when certain stem forms are not. One possibility is that the output lexicon is divided into partitions defined in terms of the morphological status of their occupants. That is, there may be separate lexicons for stems and affixes. Alternatively, the contrast between the preserved suffix form and the inaccessible stem form in an error like kneeled → *neiled* may simply represent the frequency of the constituent morphemes. On either account, though, one must posit separate processing representations for stems and affixes.

expected phonological ending in obligatory syntactic contexts. The problem with most instances of this argument (actually, all the instances of the argument that we have seen) is that the assumption that there is no lexical retrieval in the case of neologisms is simply not tenable in many cases (and unverifiable in the others). For example, when one looks at neologisms like those shown earlier, there is often enough phonological material in the putative stem portion of the neologism that corresponds to an interpretable target (e.g. [pleizd] for the intended form 'pleased') to suggest that some phonological material *is* retrieved.⁶ Hence, the argument for composition founders because of a failure to differentiate the preserved inflection from whatever other phonological material is preserved in these forms. For example, if the neologism results from a partially recovered form, then the observation that the suffix is often preserved might simply derive from a tendency for the final syllable of the intended form to be relatively less affected by the impairment. Although we are not advocating such an analysis of inflected neologisms, the failure to rule it out undercuts the force of this classic argument for morphological composition.

In the present study we have attempted to rule out this possible alternative account with reference to a case of acquired dysgraphia. As we have emphasised, in the case of BH, the rate at which inflectional word-final forms are preserved (e.g. *sourphed* is produced but not *sourpht*) is clearly distinguishable from the rate at which non-inflectional, word-final letter sequences are preserved (e.g. we see errors such as *yaught*, *benine*, and *cordd*); the former but not the latter are usually spelled correctly. Hence, the preservation of the inflectional ending cannot be attributed to some unexplained advantage that word-final letters might have in a partially preserved, whole-word representation.

In summary, we have presented a case of dysgraphic performance whose interpretation, we argue, requires that we assume a lexical orthographic system in which morphologically complex forms are represented in a compositional manner. This account is notable for its convergence with the evidence from DH regarding the nature of the processing units at the level of the graphemic buffer (Badecker et al. 1990). In that case a deficit at the level of the buffer resulted in an asymmetric degradation (or neglect) of the orthographic representations that were retrieved from the output lexicon. When the pattern of errors in words composed of stems and productive affixes were examined, the distribution

⁶ It is worth noting that patients who produce more abstruse neologisms (i.e. where one cannot determine a possible lexical form) often fail to produce an expected inflection, such as in the second example from Caplan et al. (1972); or the expected neologism appears to have undergone a phonological mutation along with the stem, as in the third example from Buckingham and Kertesz (1976).

resulting from this deficit indicated quite strongly that the asymmetry was defined over the morphemic components of the word, and not over the word as a whole. Badecker et al. (1990) argue that this result provides evidence that orthographic sequences are retrieved from the output lexicon in morpheme-sized packages, and that whole-word forms are composed from these retrieved units at the level of the buffer. This same compositional account lies at the heart of the present account of BH. In developing our analysis of BH's performance we have ruled out a number of alternative explanations of the selective preservation of suffix spelling in the context of the phonologically plausible spelling of word stems. We conclude that this performance pattern is incompatible with an exclusively whole-word view of lexical representation and processing.

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