20 Morphology and Aphasia

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The study of acquired language deficits can have one or more of a variety of research goals, but one that is most easily motivated is the use of the observed patterns of impairment (along with other sources of evidence) to motivate particular theories of the normal system. Given certain reasonable assumptions about the consequences of damage to the normal system (e.g. that the derived system will not involve the generation of compensatory mechanisms that themselves had no status in the premorbid condition), the possible patterns of deficit are limited to what could be derived from the normal system under a limited variety of transformations (see Caramazza 1984, Ellis and Young 1988). By identifying the constraints that acquired deficits appear to respect, one can hope to infer the character of the normal system that would impose such constraints. While there are certainly other worthwhile goals that one might wish to pursue using data from aphasia (e.g. to explain a particular language deficit in terms of where and how the language-processing system has broken down, or to use patterns of language deficit and lesion information to deduce how the cognitive mechanisms underlying language processing are anatomically distributed), these goals almost inevitably are intertwined with the first goal that we identified (that of shedding light on the functional organization of the premorbid system). Hence, for most of our discussion of acquired language impairments that appear to affect the comprehension or production of morphologically complex words, we will focus on what insight they can give us into the properties of the normal processing apparatus.

1 Morphological impairments

Morphological paraphasias – for example, producing "walking" for "walked" – are an often observed feature of language impairment. Errors of this type are prominent in the major, clinically defined disorders of sentence production –

agrammatism and paragrammatism (see Bates et al. 1987, Butterworth and Howard 1987, Caplan et al. 1972, Goodglass 1976, Jarema and Kehayia 1992, Kean 1978, Miceli et al. 1989, Saffran et al. 1980, and Tissot et al. 1973 for recent discussions) – and in various disorders of single-word production in reading, writing, and naming (see De Bleser and Bayer 1990, Job and Sartori 1984, Nolan and Caramazza 1982, Patterson 1982; see also papers in Coltheart et al. (eds) 1980). In addition, failure to differentiate among morphologically related forms has been implicated in comprehension impairments (Tyler et al. 1990; Tyler and Cobb 1987). As one might expect, these phenomena are of interest not merely because of their pervasiveness, but also because they offer an opportunity to explore the cognitive mechanisms that underlie lexical processing.

For example, from such errors one might hope to be able to determine whether a speaker's active lexicon is dealt with largely by mechanisms of storage and retrieval of whole-word forms, or whether there are also mechanisms of morphological composition that are invoked during normal processing. Unlike the domain of phrasal processing, where an individual's capacity to produce and comprehend an infinite number of novel and well-formed sentences transparently motivates rule-based processing, the productivity of word formation does not make as clear a case for active word-building operations in the production system. While the need for word-formation rules of one sort or another is necessitated by the capacity to understand and produce word forms that one has never before encountered, the processing issue is when and where these mechanisms come into play. Are they invoked only in order to give structure and content to lexical entries for complex words when they are first learned? Such an arrangement would be compatible with each word of the language having its own, independent entry in a vast lexicon of fully specified forms (see e.g. Butterworth 1983; Bybee 1988, 1995b; Halle 1973; Segui and Zubizarreta 1985). Or are the cognitive mechanisms that underlie lexical production and comprehension rule-based in much the same way that one sees sentence processing to be? As we will show, the study of acquired lexical impairments is an important source of evidence regarding such issues. Other issues that we will discuss relate to evidence from aphasia concerning the relevance of morphological productivity to the issue of compositionality, processing differences relating to the inflection/derivation distinction, and the contribution of morphological processing to the comprehension and production of sentences.

Before we can discuss these issues in detail, though, we must begin by considering the first obstacle one faces in any effort to motivate a deficit that is specific to one or another aspect of morphological processing. The mere existence of morphological paraphasias is not sufficient to show that the locus of the processing impairment actually implicates lexical morphology. One must show, for example, that paraphasias like *darkness* → *darkly* do not result from whole-word substitutions (analogous to errors like *index* → *insect*, or *center* → *cent*) or from sublexical, nonmorphological substitutions (as seen in word and nonword paraphasias like *belt* [bɛlt] → *bell* [bɛl] and *index* [ɪndɛks] → [ɪndɛk]). If morphological errors were the only variety of lexical errors that a patient

produced, the argument for a "true" deficit to lexical morphology would be relatively straightforward (although not entirely unproblematic, since even in this case we could conceivably lack any other evidence that these errors arise from a morphological processing deficit). As it is, though, there is a notable absence of such pure cases. Even when morphological lapses are the predominant type of lexical paraphasia, they do not appear to occur as the only variety of lexical error in any reported case. In an ongoing project involving the study of nearly a hundred patients who produce morphological paraphasias in reading and repetition tasks, none presented with a "pure" morphological deficit (in the sense that no other type of lexical error occurred). This may not be a matter of coincidence. Given that lexical morphology embodies the capacity to relate (in a rule-governed fashion) an extended set of lexical meanings to an extended stock of lexical forms, a deficit affecting this capacity may invariably induce semantic and/or phonological and/or orthographic errors as well. In any event, the two most common patterns of performance in reading tasks include the production of morphological errors in conjunction with visual errors (e.g. Job and Sartori 1984, Patterson 1982) or visual and semantic errors (Badecker and Caramazza 1987, Coltheart 1980, Patterson 1980); while two recent cases have been described whose paraphasias are limited to morphological and semantic paraphasias (Caramazza and Hillis 1990a). (Examples of these error types are provided in table 20.1.) Similar cases of acquired

Table 20.1 Error types observed in patients who produce morphological paraphasias in reading tasks

Patient S.J.D.			
halted	→	halts	(morphological substitution)
rustle	→	rustled	(morphological insertion)
frequently	→	frequent	(morphological deletion)
tuber	→	tumor	(phonological error)
excited	→	[ɪnsáysɛst]	(phonological nonword error)
Patient P.B.			
wanted	→	want	(morphological deletion)
cooked	→	cooking	(morphological substitution)
dig	→	dog	(visual error)
ride	→	drived	(semantic error)
Patient V.O.			
hidden	→	hiding	(morphological substitution)
upward	→	upwards	(morphological insertion)
neutral	→	natural	(visual error)
Patient H.W.			
drainage	→	drains	(morphological substitution)
huge	→	big	(semantic error)

dysgraphia present written morphological errors co-occurring with phonological paragraphias (Bub and Kertesz 1982, Shallice 1981) and semantic errors (Patterson and Shewell 1987).

Setting aside for a moment those instances where segmental errors can result in the production of forms that coincidentally are related morphologically to the target (as when consonant cluster simplification at a peripheral stage of lexical processing derives *weld* [wɛld] from the intended *welds* [wɛldz]), morphological paraphasias must be contrasted with whole-word substitutions in order to assess the possible involvement of disrupted mechanisms of morpheme composition or parsing. For example, Badecker and Caramazza (1987), Funnell (1987), and Pillon et al. (1991) argue that factors such as the relative frequency of an affixed word and its stem, semantic abstractness, and the visual similarity of lexically related forms can account for some patients' tendency to produce morphological errors on affixed words. If this were true in every patient, there would be little neuropsychological evidence for morphological composition as a normal (and disruptable) component of lexical production. What we discuss next are case studies that suggest that the picture is not all that bleak.

2 Errors of morphological composition: retrieval versus composition

Patient S.J.D. is an English-speaking patient who presents with an acquired lexical output impairment affecting spontaneous speech and a variety of single-word processing tasks such as reading and repetition (Badecker and Caramazza 1991). Morphological errors are the predominant error type in S.J.D.'s reading performance: S.J.D. also produced whole-word substitutions (e.g. reading *summit* for *summon*) and phonemic paraphasias (e.g. *shrilly* [šrɪli] → [šruli]). The fact that S.J.D. produced relatively few nonword phonemic paraphasias by comparison with the proportion of morphological errors (13 percent versus 65 percent of her reading errors, respectively) speaks strongly against the possibility that her morphological errors were merely the product of submorphemic, phonological errors. This possibility is also ruled out by the fact that she produced morphological errors (affix omissions and substitutions) in reading words like *bowled* [bold] and *links* [lɪŋks], but no comparable errors for their monomorphemic homophones *bold* [bold] and *lynx* [lɪŋks]. Had errors like *bowled* → *bowling* [bolɪŋ] arisen as the product of segmental substitutions (as opposed to morpheme substitutions), one should observe similar errors (e.g. *bold* → *bowls* [bolz]) for the monomorphemic items as well. Since errors like *bold* → *bowls* did not occur, it is implausible that the difficulty which S.J.D. encounters with affixed words could derive from whole-word phonological substitutions. Barring the use of ad hoc stipulations to derive such a pattern, there is no self-evident reason why the accessibility of whole-word forms should differ for monomorphemic words and precompiled representations for affixed

words. At a minimum, though, this pattern indicates a selective difficulty in producing affixed forms.

Other features of her performance pattern reveal that S.J.D.'s morphological output errors could not be reduced to whole-word substitutions. The most striking of these was the production of illegal combinations of morphemes (e.g. *poorest* → "*poorless, the most poorless indians have very little money*"). If S.J.D.'s morphological paraphasias were simply a special case of whole-word misselection (analogous to the substitution of monomorphemic forms in her error *fluid* → *fluent*), then one would expect all of her affix insertion and substitution errors to consist of grammatically well-formed combinations. Instead, morphologically illegal forms like *youthful* → **youthly* were evident in her reading, repetition, writing to dictation, and spontaneous speech. This leaves sublexical, phonological substitutions as the only plausible alternative to an account that says that errors like *sinking* → *sinkly* arise from compositional procedures gone awry. The competing (nonmorphological) account is seriously undermined, though, by the facts that S.J.D. produced more illegal morphological paraphasias than phonological paraphasias, and that the phonological paraphasias she did produce for morphologically complex targets tended to affect either the entire word (i.e. the stem and suffix) or the stem only, a pattern that makes it difficult to view the morphological paraphasias as simply the chance outcome of phonological paraphasias.

Furthermore, both the legal and illegal combinations of morphemes in her insertion and substitution errors tended to involve inflectional and productive derivational affixes. A preference for inflection and productive derivation over nonproductive derivation would not be expected if mechanisms of word formation were not directly implicated in the generation of the morphological paraphasias. Hence, one conclusion that can be drawn from this case is that, in some patients, the production of morphological errors reflects an impairment to mechanisms that are devoted to morphological composition (and/or decomposition) in normal performance.

2.1 Does composition reflect a primary system or a back-up component?

The pattern of performance observed in the case of patient S.J.D. clearly points to compositional procedures as part of the normal lexical apparatus. Might one still worry, though, that the apparatus in question merely represents a set of back-up procedures that are available when the normal whole-word-based system falters (either because there is a temporary failure of retrieval, or because there is no entry for the target word in the first place)? While such an account is not without its advocates (e.g. Butterworth 1983), it is difficult to reconcile this view with certain facts of the case we have discussed. The central problem for this view is that the failures of a back-up system should be observed only when the primary system fails (in this case, the whole-word-based mechanisms

hypothesized to operate over both the monomorphemic and affixed vocabularies). But unless there is some property of affixed words that can be shown to have an independent influence on the likelihood of producing an error, then the failures of the back-up system should be observable only in the range of cases in which the whole-word system would fail. In other words, if the back-up were entirely intact, then the performance on affixed words should be better than what one can get out of the whole-word system (because it should be able to do the back-up work it's there for). On the other hand, if the back-up system is completely impaired, then the level of performance will be entirely determined by the retained capacity of the whole-word system. The only chance of getting worse performance on affixed words than on monomorphemic words in such a system is if there are properties of affixed words that would make the whole-word system more susceptible to error on these words than on monomorphemic words, or if the input to such a system failed to preserve the morphosyntactic specification of marked forms.

S.J.D.'s performance on the affixed and unaffixed homophones discussed above (e.g. *bowled* and *bold*, *links* and *lynx*) bears on the likelihood of one such possible source of difficulty: namely, the properties of form that coincide with affixation. Given that these items were matched in form (and that the lists were matched for frequency, category, and length), this is not a candidate for a feature that would render a whole-word system more likely to fail for affixed words than for unaffixed words. This leaves the one lexical feature that this test did not control (since it will coincide by definition with the feature that was explicitly contrasted): the meaning that is encoded by the affixation. That is, one might suppose that it is not the affixation per se that makes the lexical system fail (because of a disruption to compositional procedures), but some feature of the content (e.g. the morphosemantic or morphosyntactic complexity) that accounts for the poorer performance of the lexical system on affixed words. This too can be excluded, though. If the input to the form-retrieval system were affected in such a way that the content associated with the morphology were not preserved, then this effect should be observed for both regular and irregular morphology (Badecker, to appear). On frequency- and length-matched lists of regularly inflected, irregularly inflected, and uninflected verbs (e.g. *walked*, *bought*, and *stand*, respectively), S.J.D. showed comparable performance on the uninflected and irregularly inflected verbs (90 and 92 percent correct, respectively), and significantly poorer performance on the regularly inflected items (60 percent correct; Badecker and Caramazza 1991). The account of normal processing that relegates compositional procedures to the status of a back-up system is seriously undermined by such performance.

2.2 *Jargonaphasia and word-formation mechanisms*

It is also possible to find evidence concerning processing of affixed words that does not crucially involve the production of morphological errors. Studies of

Table 20.2 Reported examples of neologistic jargon

. . . one of the nicest [fɛ́ndlowz]
. . . these little [trɛ́ftiz]
a lot of those [kístɪsis]
(Buckingham and Kertesz 1976)
. . . put over two [baɪlz] that were [sneɪkt] in
I was [pleizd] to see the other [dakjumen]
(Butterworth and Howard 1987)
Yes, because I'm just *persessing* to one . . .
. . . and I *persets* abowth abrow
(Caplan et al. 1972)

preserved inflectional capacity in patients who present with severe semantic and syntactic deficits have been proposed as evidence that mechanisms for inflectional morphology are functionally independent of the sentence-level mechanisms they must interact with (De Bleser and Bayer 1986). The classic cases of preserved inflection that motivate compositional mechanisms of inflection involve aphasic patients whose speech includes neologistic jargon. Examples of neologistic jargon are provided in table 20.2.

Several studies have reported patients whose neologisms cannot all be described as phonological deformations of a target word (e.g. Buckingham 1981, Butterworth and Howard 1987; Caplan et al. 1972). There is no evidence that, in every instance, abstruse neologisms require the retrieval of a phonological form from an output lexicon. One reason for holding this view is that in many instances the neologisms bear no phonological similarity to their target. In addition to being segmentally dissimilar, they may differ from a target form in the number of syllables and in stress pattern (Buckingham 1981). Nevertheless, the production of neologistic jargon often co-occurs with a preserved capacity to inflect words, and this capacity extends to neologisms as well.

In some cases, patients' use of inflections (on neologisms and on actual stems) will, on occasion, be grammatically inappropriate. However, of the five patients described by Butterworth and Howard (1987: 24), two never made inflectional errors on neologisms, and the remaining three were reported to have exhibited "good control of inflectional processes." For the latter, the number of inflections occurring in obligatory contexts (as well as the number of uninflected neologisms in syntactic contexts that excluded inflections) far outweighed the few cases where they failed to occur in contexts that required them or where they intruded ungrammatically. Regardless of their syntactic appropriateness, though, the very presence of the inflection on the nonlexical base forms suggests that the lexical system distinguishes stem and affix representations. In particular, inflected neologisms provide an additional form of

evidence for the existence of mechanisms for morphological composition in the phonological output lexicon. (See also Semenza et al. 1990 for a discussion of three Italian-speaking patients who produce prefixed and derivationally suffixed neologistic forms.)

2.3 Composition and acquired dysgraphia

Evidence that affixed forms are composed in the lexical output system has been observed in various patterns of dysgraphic performance as well. In one such case, patient B.H. (Badecker et al. 1996), an acquired dysgraphia rendered certain stem forms irretrievable from the orthographic output lexicon. When B.H. could not spell words lexically, he resorted to a sublexical approach to spelling based on regular phonology–orthography correspondences. For example, he spelled *census* as *sensis*, and *benign* as *benine*. When asked to write affixed words for which he could not retrieve a stored form, though, there was clear evidence that the stem and affix spellings are differently derived. Sublexical spelling is implicated by the phonologically plausible errors made on the stem portion of the target, while retrieval of a stored form is implicated by the absence of such errors on the suffix portion of the target. That is, B.H. would spell *surfed* as *sourphed* (not as *sourpht*) and *cabooses* as *cabuses* (not as *cabusiz*). One can verify that the selective preservation of affix spellings is not merely apparent. For example, he would spell *wolfed* as *woulphed*, but *concoct* as *concauct*, not as *concauked*, as one might otherwise expect if the suffix spelling that he used were simply the most likely phonology–orthography mapping that his sublexical mechanisms would generate.

The pattern of errors that B.H. presented would not easily be explained if the lexical system were to store the affix as part of a whole-word representation of an inflected form. If as a consequence of the patient's deficit the hypothesized whole-word representation for a word (e.g. for *surfed*) could not be retrieved, and if instead a spelling could be generated only by using mechanisms whose input–output relations are specified in terms of regular phonology–orthography correspondences, then one would expect that these correspondences would derive just the sort of misspellings that were not observed (e.g. spelling *surfed* as *sourpht*). On the other hand, the interpretation is rather straightforward on the view that affixed forms like *surfed* are normally composed in the output system. If the stem is inaccessible to the retrieval mechanisms, but the (separately stored) affix form remains available, then the orthographic form of the stem, but not the affix, will need to be generated by some other means: in particular, by the rule-based mechanisms based on phonology–orthography correspondences. On this model, then, the rule-based spellings of stems can be combined with the lexically specified spellings of the inflectional affix in virtue of the compositional approach to the production of affixed forms that is taken even when both components of a complex form are retrieved from the lexicon.[1]

The role of morphological composition in the orthographic output system also finds motivation from cases of acquired dysgraphias that arise at a somewhat more peripheral processing stage: the level of the Graphemic Buffer (Badecker et al. 1990, Caramazza and Hillis 1990b). The general pattern of performance associated with a deficit at this processing level includes (a) spelling errors that can be construed as simple letter substitutions, deletions, insertions, and transpositions; (b) similar performance on both word and nonword targets, in both written and oral spelling tasks; (c) comparable performance in spontaneous writing, writing to dictation, and written naming tasks; and (d) effects for properties such as length (but not for lexical properties like grammatical category, lexical frequency, semantic abstractness, etc.). In one such case, that of patient D.H. (Badecker et al. 1990), the distribution of spelling errors was asymmetrically bow-shaped for monomorphemic words: D.H. produced few spelling errors at the beginnings of words, with most of his errors occurring to the right of the medial letters of the target. However, for suffixed words the error rate and error distribution were significantly different. D.H. misspelled fewer suffixed words than matched monomorphemic targets; and though the asymmetric distribution of errors that was characteristic of his performance on monomorphemic words was seen on the stem portion of the target, the letters that comprised the suffix portion of the target (e.g. E-D in *handed* and I-N-G in *walking*) were much less likely to be misspelled than the corresponding letters in monomorphemic words (like *wicked* and *awning*).

The contrast between D.H.'s performance on monomorphemic and suffixed words is easily accounted for on the following analysis of his dysgraphia. The likelihood of producing a spelling error is a function of the size of the lexical unit that is placed in the buffer, and the reason why suffixed words appear to be less susceptible to error is that (at the level of the deficit) these words are processed not as a single unit, defined in terms of the whole word, but as a sequence of two such units, defined in terms of their morphemic components.[2] This account is further supported by D.H.'s performance on prefixed and compound words. Prefixed and compound words were less likely to be misspelled than matched monomorphemic items; and when they were misspelled, the probability of an error for a particular letter position was clearly affected by the morphological structure of the target. Whereas frequency- and length-matched unaffixed controls for both types induced the characteristically asymmetric error distribution across the whole word, prefixed words induced fewer errors in the initial portion of the target than their controls, and the distribution of errors in compounds clearly exhibited the bimodal pattern one would expect if the whole word were processed as a concatenation of constituent stems (Badecker et al. 1990).[3]

The processing accounts we have offered in order to explain the performance patterns of D.H. and B.H. converge on a single model of orthographic processing. On this model, monomorphemic words are retrieved from the Orthographic Output Lexicon as whole-word units, while morphemic constituents of words like *farming*, *repay*, and *drugstore* are separately retrieved and then concatenated at the level of the Graphemic Buffer.[4] The selective

preservation of suffix spellings in the case of B.H. derives from the fact that when attempting to spell an affixed word, a failure to retrieve a stored form for a lexical stem will not have as its necessary consequence that the affix spelling will also be irretrievable. The better performance on morphologically complex words than on monomorphemic items observed in the case of D.H. derives from the fact that this patient's deficit asymmetrically affects the probability of producing an error on the orthographic constituents that make up the (morpheme-sized) processing units that are deposited, and temporarily stored, in the Graphemic Buffer.

2.3.1 Productivity Productivity, the measure of a speaker's capacity to employ a particular Word Formation Rule in order to add new forms to the set of meaningful words, is a property of the lexical system that continues to receive much attention. (Cf. recent discussions in Anderson 1992, Baayen 1994, Baayen and Lieber 1991, Lieber 1992.) The predominance of a particular form for encoding a particular content has long been known to be a poor predictor of productivity (Aronoff 1976), and though there are properties of morphologically complex words that correlate most highly with the productivity of the rules that derive them – phonological transparency and semantic compositionality – it is still an open issue as to how the correlations are best understood (see Anderson 1992 and Aronoff 1976 for discussion). The present discussion will focus on neurolinguistic indications that the productivity of the morphology involved is a primary determinant as to whether the performance system uses compositional versus retrieval mechanisms for producing familiar, morphologically complex words.

In our earlier discussion of the legal and illegal morphological paraphasias produced by patient S.J.D., we indicated that the affixes that appeared in these paraphasias were inflections and productive derivations. We took the predominance of productive morphology in these paraphasias as one piece of support for the view that forms involving productive morphology may be processed compositionally, while forms involving nonproductive morphology must be listed in, and retrieved from, the lexicon in whole-word format. This processing distinction is further supported by evidence from acquired dysgraphia. When D.H. was asked to write productively derived words (e.g. *brightness*, *cloudless*), the distribution of errors showed a clear effect for the morphological structure of the target: the error rate increased from a low rate stem-initially to a high rate stem-finally, but then fell again to a very low rate at the beginning of the suffix region. By contrast, the distribution of spelling errors for derived words with nonproductive endings (e.g. *similarity*, *clearance*) showed no effect of the morphology of the target, and was in fact indistinguishable from the asymmetric distribution observed with monomorphemic targets (Badecker et al. 1990). This contrast offers a clear form of support for the view that productivity determines whether the output system takes a compositional approach to the production of morphologically complex words.

Recent studies of patients who present with acquired naming impairments – and in particular, patients who have difficulty naming objects with compound

names – also bear on the role of productivity in determining how words are processed. Unlike derivation, where productive affixation will generally encode a fully transparent extension of the meaning of the base form, the mechanism of compounding, though it is productive, can result in forms that have largely unpredictable semantic properties. In general, the meaning–form relation is not entirely arbitrary (e.g. the meanings for *clothes* and for *pin* are not wholly unrelated to the meaning of *clothespin*), although the relation is typically idiosyncratic in the sense that it is not determined by the grammar. Compounds may differ from one another in terms of the WAY in which their whole-word meaning relates to the meanings of their constituent words (compare *fertility pill*, *nausea pill*, *garlic pill*, and *horse pill*) and also in the EXTENT to which these meanings are related (cf. *butterfly*, *butterball*, *buttercup*, *butter dish*). Hence, this particular type of word formation is interesting in that evidence for or against a compositional approach to the production of compounds can give us a tool to pry apart the effects of productivity from those of semantic predictability.

In a study of twelve unselected German-speaking aphasic patients, Hittmair-Delazer et al. (1992) found that their patients had a greater tendency to produce compound responses when naming objects that had compound names than when the objects had monomorphemic names, even when their responses were incorrect. Furthermore, a single case study of English-speaking patient C.S.S. has replicated this and other features of the group tendencies reported in the Hittmair-Delazer et al. (1992) group study. Perhaps one of the most notable features of C.S.S.'s performance with regard to evidence for a compositional approach to the production of compounds is his production of compound neologisms (e.g. naming a cheerleader as *gym master*, or a trash can as a *can trash*). These substitutions and misorderings of the constituents of the target form are analogous to illegal morphological paraphasias in the extent to which they implicate composition. Interestingly, C.S.S.'s compound neologisms are not limited to targets that can be thought to be semantically compositional (e.g. butterfly → *butter flower*, south paw → *south ball*, and sundial → *sunclock*). Hence, even when there is no clear parallel between the meaning of the compound target and its form, there is at least some evidence that these words are produced by retrieving constituent lexical items and a structural specification of the target form into which the two constituents must be fit. What this suggests is that morphological productivity may be the determining factor with regard to whether morphologically complex forms are composed in the processing system, even when the productivity of the word-formation type is paired with lexical idiosyncrasy regarding the meaning–form mapping.[5]

3 Inflection versus derivation

A case of acquired impairment which provides some indication of the morphological distinctions that are made in the language-processing system is

that of patient F.S., an Italian-speaking patient who presented with a lexical impairment that resulted in morphological paraphasias in spontaneous speech and in single-word-processing tasks such as repetition (Miceli and Caramazza 1988). F.S. produced a substantial number of morphological substitution errors in a variety of tasks, but these errors predominantly affected the inflectional specification of a word (gender and number markers for nouns and adjectives; and tense, aspect, person, and number specifications of verbs). Derivational morphology was virtually unaffected. F.S.'s errors also included phonological paraphasias, but these can be distinguished from his inflectional substitutions in a relatively straightforward manner. For example, F.S.'s morphological paraphasias tended to result in the production of "citation forms" – that is, infinitival forms of verbs, singular forms for nouns, masculine singular forms for adjectives – regardless of whether the particular inflected forms were among the least frequent items of an inflectional paradigm.[6] Furthermore, the tendency to produce citation forms could not be reduced to a tendency to produce particular phonological shapes, since the preference for citation forms held constant even when the phonological form of the citation-form suffix varied. For instance, when F.S. repeated adjective forms, he exhibited a strong tendency to use the masculine singular form for those adjectives that allow a four-way inflectional contrast (masc. sg., masc. pl., fem. sg., fem. pl.), and the singular form for those adjectives which allow only a two-way contrast (sg. vs pl.). Notably, the maximally disfavored inflection for the former adjective type (fem. pl., as in *car-e*) was phonologically identical to the favored inflection for the adjectives showing a two-way contrast (sg., as in *fort-e*). Indications that these inflectional errors do not arise as simple whole-word substitutions derives from the fact that the misselected inflections that occurred in F.S.'s performance would occasionally result in the production of a morphologically illegal combination of stem and affix, as in the spontaneous speech error *studi-o* ('office', masc. sg.) → **studi-a* (*fem. sg.), where the contextually appropriate noun is inflected with the wrong gender ending; or the repetition error *mor-issimo* ('die', third conjugation inflection) → **mor-este* (second conjugation ending) (Badecker and Caramazza 1989). Hence, F.S.'s performance is significant both for the evidence it provides for morphological composition and for the motivation it provides for the lexical distinction between inflectional and derivational morphology.

Other cases of acquired language impairment have also exhibited inflection–derivation dissociations: the Finnish-speaking patients H.H. and J.S.[7] (Laine et al. 1994, 1995) and the English-speaking patients F.M. (Badecker, to appear) and P.B. (Badecker et al. 1995). It should not be assumed, however, that all impairments resulting in a disruption of inflection, but not derivation, are alike in their functional origins. Given that there are multiple ways in which derivation and inflection differ with respect to the language-processing system, current models of normal performance allow for a variety of deficits with a production and/or comprehension pattern that distinguishes these morphological types.

4 The nature of lexicality constraints: an open issue

As we have observed, it is not always the case that a patient's morphological paraphasias will result in potential word forms. S.J.D.'s **involveness* (for *involvement*) and F.S.'s **studia* (for *studio*) are clear instances of morpheme substitution that do not preserve lexicality at the level of morphotactics. Nevertheless, there does appear to be one lexicality constraint on morphological errors in spoken output: morphological paraphasias conform to the phonotactics of the language (Grodzinsky 1984, Miceli and Mazzucchi 1990). In languages such as English, morphological deficits often result in affix deletion errors (e.g. *farming* → *farm*). The occurrence of such errors is governed by the well-formedness of morphological "zero forms." In languages which lack zero forms, corresponding deletion errors are absent. Grodzinsky (1984) notes that Hebrew-speaking patients will produce inflectional substitutions like *kašarti* (tie, past tense) → *likšor* (tie, infinitive), but they will not simply omit the vocalic prosody that corresponds to the verb's inflection (**kšr*). However, evidence indicates that this constraint is not based merely on the unpronounceability (in some language-independent sense) of bare consonantal strings like **kšr*. For example, an English-speaking patient may produce morpheme-deletion errors of the form *farm-s* → *farm*, while an analogous error for an Italian-speaking patient (e.g. *fil-e* 'lines' → **fil*) does not occur. Here the phonological constraint on paraphasias exhibited by Italian aphasics must be attributed to conformity to a more abstract notion of phonotactic or morphological well-formedness than what one must invoke in the case of Semitic languages. Perhaps the constraints that are operative here are among the familiar variety of shape rules (e.g. a phonological word-edge constraint such as a condition that, in Italian, a word-final syllable must end in one of the vowels *a*, *e*, *i*, or *o*[8]); or perhaps they reflect the mechanisms that restrict, by one means or another, the occurrence of bound morphemes. For example, the fact that items in the open-class vocabulary bear morphosyntactic features that are spelled out by the morphological system, and the fact that there are no regular "zero form" options for the spelling out of these features in Italian (though there are in English) might jointly lead to the effects in question. The nature of the often observed, though poorly understood, lexicality constraints that govern aphasic production is a topic of inquiry that still awaits serious attention.

5 Morphological deficits in sentence comprehension and production

Several studies have documented cases of sentence comprehension impairment that strongly implicate morphological deficits. A case analogous to that of F.S.

(Miceli and Caramazza 1988) has been reported in which the patient, D.E., was found to be selectively impaired in processing inflections in normal speech comprehension (Tyler and Cobb 1987). For example, in a word-monitoring task, D.E. was sensitive to the contextual appropriateness of a word when the wrong derived form was used (as in *He was the most wasteful/*wastage/*wastely cook she had ever met*), but not when an inappropriate inflection intruded (as in *It often causes/*causing/*causely pain in my loose filling*). Given that different inflectional forms can often motivate diverging syntactic expectations (as when the contrast between *chasing* and *chased* signals the transitive/intransitive distinction in *The boy was chasing/chased . . .*), it is plain that D.E.'s sentence comprehension can be explained in part by this morphological impairment.[9]

In a similar study (Tyler et al. 1990), patient B.N. exhibited a more pervasive morphological impairment, in that his monitoring performance indicated an insensitivity to both syntactic ill-formedness, based on the use of inappropriate inflected or derived forms (the examples with *wastage* and *causing*), and lexical ill-formedness (the examples with **wastely* and **causely*). B.N. also failed to exhibit sensitivity to these morphological distinctions in a grammaticality judgment task. However, his lexical monitoring showed a strong effect for pragmatic, semantic, and syntactic appropriateness when the stem of a properly inflected form was varied (e.g. in the context *The crowd was very happy. John was playing/?burying/*drinking/*sleeping the guitar and . . .*). B.N.'s good performance on a lexical decision task (which included legal and illegal affixed forms like *wasteful* and *wastely* in the word and nonword stimuli respectively), along with his performance on a lexical gating task (Grosjean 1980), indicated that it was not impaired recognition of the phonological form of morphologically complex words that was implicated in his sentence-processing deficit. Instead, B.N. appears unable to integrate the syntactic and semantic information encoded in the inflectional and derivational affixes with the semantic (and grammatical) information encoded in lexical stems. It is not apparent whether this impairment arises out of a lexical impairment (i.e. to the mechanisms that derive syntactic and semantic information from affixes) or a deficit to sentence-processing mechanisms that normally exploit this lexical information. In either case, the contribution of the morphological deficit to BN's sentence-comprehension impairment appears well established.

Current theories of sentence production (e.g. M. F. Garrett 1982, 1984; Lapointe 1985) predict that morphological paraphasias (e.g. agreement errors) can result from deficits to sentence-processing mechanisms while single-word processing remains unimpaired. Two recent studies (Caramazza and Hillis 1989, Nespoulous et al. 1988) describe patients who are intact in single-word-processing tasks, but who exhibit selective deficits in processing grammatical morphemes in sentence-processing tasks. In the case of patient "Clermont" (Nespoulous et al. 1988), only free-standing grammatical morphemes were affected. Patient M.L. (Caramazza and Hillis 1989) produced some inflectional (morpholexical) substitutions in addition to omitting and substituting free-standing grammatical morphemes, although the proportion of such morphological agreement errors

was small by comparison with the number of function word errors. While the presence of agreement errors in M.L.'s speech supports the hypothesis that "morphological deficits" can arise from damage to syntactic (nonlexical) processing components, a stronger case for this position can be envisioned. Studies which document contrasting patterns of inflectional impairment (e.g. Miceli et al. 1989) have provided some indications that grammatical agreement may be differentially affected (resulting e.g. in divergent error rates for subject–verb, noun–adjective, and determiner–noun agreement), although the relative contribution of lexical and syntactic deficits in most of the reported cases has not been established. Clearly this is one distinction that deserves greater attention.

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NOTES

1 Independent considerations require the hypothesized routes of the spelling system to intersect at a point that accepts the output of both the orthographic lexicon and the nonlexical rule-based mechanisms. For discussion, see Caramazza et al. 1987, Hillis and Caramazza 1989, and Posteraro et al. 1988.

2 Note that composition at this level cannot be handled by simple concatenation, since there are several orthographic accommodations that must accompany affixation (e.g. consonant doubling as in *hit*/*hitting*, *e*-deletion as in *drive*/*driving*, etc.). For discussion of the mechanisms that might effect such accommodations at this processing stage, see Badecker 1996 and McCloskey et al. 1992.

3 For reasons that are unclear, the morphology-sensitive performance pattern observed in the case of D.H. is associated with the clinical features of attentional neglect (e.g. Hillis and Caramazza 1989): e.g. in a well-studied patient who presents with a deficit at the level of the graphemic buffer but does not exhibit signs of neglect, Italian-speaking patient L.B. (Caramazza et al. 1987), the pattern is not observed.

4 Note that this description is not meant to prejudge the issue of whether affix forms are retrieved from the lexicon in the same way that whole words or bound stems are retrieved (e.g. Lieber 1992, Selkirk 1982), or as the output of Word Formation Rules of the sort envisioned by Anderson (1992), Aronoff (1976), and others.

5 This is not to say, however, that composition in the lexical processing system is in all instances rule-derived. Whereas spellout rules that interpret morphosyntactic features would be appropriate in the case of regular inflection, the sort of compositional process evidenced in C.S.S.'s compound errors would be more aptly described in terms of a lexically driven process (e.g. the 'minor rules' of Stemberger 1985c).

6 By this term we mean the minimally marked members of the inflectional paradigm, a distinction that may have consequences throughout the grammar, which regularly serve as the base forms for the word-formation processes that derive other paradigm members. Burzio (1989) observed that phrase-level phonological processes can delete the vowel corresponding to the inflectional suffix of the citation form, but not any other. As an example, consider the four-ending adjective *buono* and the two-ending adjective *grande*:

buon ragazzo (*buono ragazzo)	masc. sg.
*buon ragazza (buona ragazza)	fem. sg.
*buon ragazzi (buoni ragazzi)	masc. pl.
*buon ragazze (buone ragazze)	fem. pl.
gran ragazzo (*grande ragazzo)	masc. sg.
gran ragazza (*grande ragazza)	fem. sg.
*gran ragazzi (grandi ragazzi)	masc. pl.
*gran ragazze (grandi ragazze)	fem. pl.

7 Patient J.S. is a bilingual subject (Finnish and Swedish) who presented with a dissociation between inflection and derivation in both languages.

8 This is not likely to be a satisfactory candidate on its own, given that there are a number of (albeit exceptional) forms that end in consonants (e.g. loan words like *golf* and *jeep*).

9 Patient D.E. was retested on these materials shortly after the study reported in Tyler and Cobb 1987, and on this occasion his monitoring performance failed to show the dissociation of inflection and derivation (Tyler 1992: ch. 12). On retest, D.E.'s monitoring performance failed to demonstrate sensitivity to morphologically inappropriate forms for both inflection and derivation. Tyler (p.c.) suggests that this difference may derive from the patient's over-familiarity with the testing materials (as evidenced by the overall faster reaction times in the retest).