Chapter 5

THE BALANCE BETWEEN STORAGE AND COMPUTATION IN PHONOLOGY

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Abstract This article discusses two kinds of phonological evidence concerning the balance between storage and computation: allomorphy and phonological change. It is shown that even allomorphs that can be derived by a productive phonological rule are sometimes stored in lexical memory because these allomorphs are preserved although the relevant phonological process has been lost. Phonological processes that are subject to lexical diffusion also require lexical storage of the effects of these processes. This implies that the notions 'underlying form' and 'lexically stored form' should not be equated: surface forms are stored, and underlying forms are computed when they are needed for coining new words.

Keywords: Allomorphy, Auslautverhaertung, final devoicing, lexical diffusion, Optimality Theory, paradigmatic leveling, phonological change, rule opacity, underlying form, vowel lengthening, vowel reduction.

1. Introduction

The dominant view in classical generative phonology with respect to the kind of phonological information that is stored in the lexicon, can be summarized as follows: what can be computed should not be stored (cf. Kenstowicz, 1994, p.60). This view implies that predictable information about words is omitted from lexical representations. In case there are alternations in the shape of morphemes, the preferred solution is to assume one underlying form for all alternants, listed in the lexicon, and to derive the different surface allomorphs by means of one or more phonological rules. This kind of lexicon can be characterized as the Bloomfieldian lexicon, since Bloomfield, 1933, p.274 defined the lexicon as "a list of basic irregularities".

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This view of the division of labour between lexicon and grammar has come under attack from a number of different perspectives. First, this view suffers from what has been called the 'rule/list fallacy' by Langacker, 1987, p.29: it is not necessarily the case that what can be computed by rule, should not also be stored in the lexicon. In the realm of morphology, Jackendoff, 1975 already argued that morphological rules have in principle two functions: they create new forms, but they can also function as redundancy rules with respect to existing complex words listed in the lexicon. This also applies to syntactic rules, for instance the rule of NP formation for English. There are adjective + noun phrases that function as names such as *yellow pages, red tape, green card, black hole, hard disk, little toe* which have an unpredictable meaning aspect, and hence have to be listed in the lexicon (Jackendoff, 1997, Chapter 7). Nevertheless, there is also a productive syntactic rule of English that creates new NP's that consist of an adjective and a noun.

This issue is quite an actual one for our view of the nature of the language faculty. In a recent paper, Clahsen, 1999 argues in favour of a dual structure of the human language faculty, a lexicon and a set of rules. His view is based on the analysis of inflectional rules of German, and he argues that it is only irregularities that are listed: regular forms are always derived by rule. As I pointed out in my commentary on this paper (Booij, 1999), this position cannot be completely correct. For instance, past participles of Dutch that are fully regular from the formal point of view must nevertheless be stored because of semantic irregularities. Examples of such participles are *gezet* 'fat' (from the verb *zetten* 'to put)', and *gesmeerd* 'fast, fluent' (from the verb *smeren* 'to smear'). The meanings of these participles are not predictable from their verbal stems, and therefore, they have to be lexically stored. Note, however, that this does not weaken Clahsen's view of the language faculty: his basic point is that there are rules besides lexical representations (contra the connectionist view), but in order to maintain that position he does not have to take the position that the outputs of regular processes are never stored.

There is also a wealth of psycholinguistic evidence that predictable information is sometimes stored in the lexicon. For instance, in the area of morphology, Baayen et al., 1997 showed that in Italian completely regular but frequent plural forms of nouns are stored in lexical memory.

In the realm of phonology similar considerations apply. A clear example is syllable structure. In most phonological analyses it is assumed that syllable structure should not be encoded in the lexical representation of words because it is fully predictable from the segmental structure of a word. The basic reasoning behind this view is that we should account

for the fact that in most cases syllable structure is not distinctive; hence it should not be stored. However, there is psycholinguistic evidence that the syllable templates of words are stored independently from their segmental structure. In speech errors one often finds that segments are exchanged that occupy the same position in syllable structure, for instance the onset position, as in the speech error *peel like flaying* instead of *feel like playing.* This shows that syllable structure must be lexically represented independently from segmental structure (Levelt, 1992, p.9-10).

The lexical presence of syllable structure is also presupposed in linguistic analyses of stress patterns that make use of the concept of syllable extrametricality. For instance, in Polish, a language with penultimate stress, there are a few words with antepenultimate stress, such as *uniwérsytet* 'university'. The last syllable of this word has to be marked as extrametrical in the lexicon in order to derive the correct stress pattern of this word. This implies that at least the last syllable (*tet*) is present as such in the lexicon. That is, the lexical presence of predictable syllable structure is implied by the necessity of lexical markings for stress.

In this article I will focus on two kinds of phonological evidence that throw light on the balance between storage and computation in the lexicon: allomorphy and phonological change. As to allomorphy, I will argue in section 2 that in many cases the surface allomorphs of a morpheme cannot be derived by phonological rule, and hence have to be stored in the lexicon, because there are no productive phonological rules that account for that allomorphy. In section 3 I will take a more radical step and argue that even when alternations are fully predictable by means of general and productive phonological rules, the facts of phonological change suggest that the outputs of such rules may nevertheless be stored in lexical memory. Both kinds of phenomena show that much more is lexically represented than what is assumed in classical generative phonology.

2. Allomorphy

Allomorphy is the phenomenon that morphemes exhibit certain alternations in form. The traditional generative approach is assuming one underlying form for a morpheme, and to compute the surface allomorphs by means of a set of rules.

In quite a number of cases, however, the actual variation in form, though predictable, is specific for only one or a small set of morphemes. For example, the Dutch diminutive suffix exhibits five surface forms,-*tje,*

-je, -pje, -kje and *-etje*. These five forms can be derived by rule from one underlying form by means of rules (cf. Trommelen, 1984, Booij, 1995). However, these rules have to mention the feature [+ diminutive] in their structural description because it is only the diminutive morpheme that triggers these rules. That is, they are, in terms of Anderson, 1974, morpholexical rules, and stand in opposition to phonological rules whose application is triggered by phonological conditions only, the so-called automatic phonological rules.

Recently, the insight has re-emerged that output constraints are essential for a proper account of phonological regularities. In Optimality Theory, such output constraints are seen as a set of universal constraints, ranked on a language-specific basis. This poses a problem for a phonological analysis of allomorphy because the equivalent of morpholexical rules in OT-phonology is a morpheme-specific ranking of constraints. Although the possibility of morpheme-specific constraint ranking is accepted by some linguists (cf. Plag, 1998; Raffelsiefen, 1999), it is quite implausible from the learnability point of view. Therefore, Mester, 1994, Kager, 1996, and Booij, 1998 proposed analyses in which the different allomorphs of a morpheme are lexically listed, and the choice of the correct allomorph follows from the set of ranked output constraints.

Let us make the discussion of this issue more concrete by having a look at the Dutch nominal suffix allomorphs *-er* /ər/ and *-aar* /aːr/ '-er'. Historically, both derive from the Latin suffix *-arius*. Synchronically, they are in complementary distribution: *-aar* occurs after verbal and nominal stems ending in schwa plus a coronal sonorant consonant, *-er* occurs in all other cases, except after /r/ where a third allomorph *-der* is chosen:

(5.1)

stem	*noun*
luist[ə]r 'to listen'	luister-aar 'listener'
twijf[ə]l 'to doubt'	twijfel-aar 'doubter'
rek[ə]n 'to compute'	reken-aar 'computer'
bel 'to ring'	bell-er 'ringer'
spin 'to spin'	spinn-er 'spinner'
klier 'to nag'	klier-der 'nagger'

Attempts to derive one of the allomorphs from the other have always caused problems: if /ər/ is the underlying form we need a rule that changes a schwa into /aː/ but this rule should apply to this suffix only. If we want to derive /ər/ from /aːr/ by means of a rule of vowel reduction that changes the full vowel /aː/ into a schwa, the problem arises that, although there is a rule of vowel reduction in Dutch (cf. Booij,

1995), it never applies to the last syllable of a word, whereas here the relevant vowel does form part of the last syllable. Therefore, we have to conclude that both allomorphs are to be listed in the lexicon. Thus, they function as competing suffixes, and the choice is made in terms of optimal outputs. In this case, the relevant output condition is that of Optimal Parsing: preferably, a word is parsed into trochaic feet. Given a verbal stem such as *bedel* /beːdəl/, the addition of the suffix *-er* would result in a rhythmic lapse because it will create a sequence of two unstressed syllables, of which the second cannot be parsed into a foot, and hence remains unparsed. On the other hand, if we add *-aar*, the syllable corresponding to this suffix can form a foot of its own because it has a full vowel, and hence it will have two feet, (beːdə) and (laːr).

The nice point of this solution is that, unlike the common underlying form approach, it also explains the reason behind the complementary distribution of these two suffixes: it is no coincidence that *-aar* is chosen after a stem that ends in a syllable headed by schwa because that is the only way to avoid a rhythmic lapse. In an approach in which we derive one allomorph from the (underlying form of) the other, there is no explanation of why the nature of the last vowel of the stem (full vowel versus schwa) plays a crucial role as a trigger of the alternation (Booij, 1998).

In sum, what I have done here so far is giving theoretical and empirical reasons for lexical listing of two allomorphs. Their status has thus become that of two competing affixes with a phonological similarity. Diachronically, there is a phonological relation between the two, but synchronically, this is no longer the case. This implies that as far as the balance between storage and computation in phonology is concerned, we move into the direction of storage: both allomorphs have to be stored, they have become competing morphemes.

This analysis is confirmed by the fact that the suffix *-aar* exceptionally also occurs in other phonological environments, i.e. after a syllable with a full vowel, as in *ler-aar* /leːraːr/ 'teacher' and *dien-aar* /dinaːr/ 'servant'. This is to be expected if *-aar* is a suffix of its own because affixes sometimes appear with other types of bases than the regular ones. Similarly, a number of diminutive nouns exhibit the 'wrong' allomorph, for instance *bruggetje* 'small bridge' (diminutive of *brug* 'bridge') instead of the regular *brugje*. Such a situation could never arise if the surface forms of the diminutive suffix were derived by automatic phonological rules. Thus, the existence of exceptional forms supports the individual listing of the five allomorphs of the diminutive suffix.

The implication is that an account of allomorphy in terms of derivation from a common underlying form is only possible if the rules that compute

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