Non-derivational Phonology Meets Lexical Phonology
GEERT BOOIJ

1. INTRODUCTION

A proper theory of phonology has to provide at least the three subtheories listed in (1):

(1) (i) a theory of the nature of phonological representations
(ii) a theory of the form of phonological generalizations
(iii) a theory of the organization of phonology as part of the grammar

Autosegmental phonology, Prosodic Phonology, and the theory of Feature Geometry are examples of theories that deal with (aspects of) the nature of phonological representations.

The issue of how to express phonological generalizations has become one of the foci of recent phonological research. The basic ingredients of the classical SPE approach, and of Lexical Phonology in its standard form, are rules and derivations. We now observe a shift to constraint-based approaches such as Constraints-and-Repairs Phonology (Paradis 1988–9) and Harmonic Phonology (Goldsmith 1990; 1993), in which both rules and constraints play a role, and Optimality Theory (OT). In the latter theory, rules have been completely abolished in favor of a hierarchy of constraints, and there is no derivational, serial computation of the correct phonetic form of a word (Prince and Smolensky 1993). In another approach, Declarative Phonology, rules have been replaced with stative, declarative statements that express well-formedness constraints that apply conjunctively (Coleman 1995).

Lexical Phonology (henceforth LP) in its different varieties is in essence a theory of the organization of the grammar, that is, of how phonology interacts with other components of the grammar, in particular morphology and syntax. In addition, it is a substantial theory of the form, interaction, and application of rules (Elsewhere Condition, Strict Cyclicity, and Level Ordering).

The three subtheories mentioned above are not completely independent. For instance, given a richer theory of prosodic structure and prosodic
domains, our theory about the organization of the grammar can often be simplified (Booij 1994). The enrichment of phonological representations by Autosegmental Phonology has also led to simpler formulations of phonological generalizations. Therefore, it is worthwhile to investigate to what extent the insights and generalizations of LP, which have been formulated in a rules-and-derivations-framework, carry over to, or are in conflict with, constraint-based theories of phonological generalizations. This is the main aim of this chapter. Therefore, I will first discuss the theoretical core of LP in section 2. Subsequently, I will discuss how the different claims of Lexical Phonology bear on constraint-based theories. First, LP makes use of rule ordering, in particular counterbleeding and counterfeeding order, for the expression of phonological generalizations. These devices are not available in non-derivational phonology. Cases of counterbleeding order will be discussed in section 3, those of counterfeeding order in section 4. Second, rule-based generative phonology acknowledges morpholexical rules, i.e. phonological rules of a restricted nature in the sense that they are conditioned by lexical and/or morphological properties. Can the generalizations expressed by such rules also be expressed in non-derivational phonology? This is the topic of section 5. In section 6 I give my main conclusions: There is no evidence for rule-ordering effects (in the sense of serial rule application, with extrinsic rule ordering) in Dutch that cannot be reanalysed in a way compatible with OT, and perhaps preferably so. There is, however, strong evidence for level-ordering effects. OT is compatible with this notion of derivation. Even when restated within Correspondence Theory, the facts discussed continue to argue for some degree of serial computation in phonology.

2. THE CORE OF LEXICAL PHONOLOGY

The core hypotheses of LP (cf. Pesetsky 1989; Kiparsky 1982; Booij 1981) are the following:

(2) (i) There is a systematic difference between lexical and postlexical phonology.
     (ii) Morphology and phonology apply in tandem.

The first hypothesis reflects the classical distinction between word phonology and sentence phonology, and will be discussed in section 3. Clearly, this hypothesis is not exclusive to Lexical Phonology.

The second hypothesis means, to put it simply, that you take a word, and apply the applicable phonological rules right away (= first cycle); you may then apply a morphological rule to that word, which creates a new domain of application for the phonological rules of the language, the second cycle, which
in turn can be input for another morphological operation that creates a third cycle, and so on.¹

The difference between the traditional cyclic application of phonological rules and LP is that, in the first approach, phonology is ordered after morphology, and that it has to be stipulated that phonological rules apply to the most internal morphological domain first, then to the next morphological domain, etc. It incorrectly excludes the possibility of morphology being dependent on derived phonological properties of its bases.

Hypothesis (2ii) predicts that

(3) a. the phonological rules of a language that apply to words apply cyclically, at least in principle;
   b. the morphological rules of a language may refer to both underived and derived phonological properties of their input words.

The cyclic application of phonological rules in turn predicts that

(4) phonological and morphological rules may make use of phonological information that is no longer present in the phonetic forms of words.

The claims in (2–4) are in fact a consequence of an even simpler idea, namely the following minimal assumption:²

(5) Apply a rule when possible.

This principle predicts, for instance, that the rule of word stress of a language applies immediately to a given word, before it is subject to (further) morphological operations. Thus, cyclicity of stress assignment follows from principle (5). Since words are formed in the lexical component, the rules of word phonology will apply to those words right away, before they enter the syntax, which gives the effect that word phonology precedes sentence phonology.

Why is cyclic rule application desirable? One important reason is that it accounts for the fact that morphological operations, for instance the choice of a particular affix, may be dependent on derived phonological properties of the base to which that affix attaches, for instance the stress pattern or prosodic structure. Another argument is that, as far as stress assignment is concerned, cyclic application accounts for the fact that in some languages the stress pattern of a complex word is not affected by every affix that it contains: the

¹ The formulation 'you take a word, and apply the applicable phonological rules' implies that it is words that form cyclic domains, not morphemes. This is in line with the conclusions of Brame (1974) and Harris (1983), who argue that cyclic domains must be dominated by a lexical category node. It is also in line with the lexeme-based view of morphology as advocated in Aronoff (1976) and Anderson (1992). That is, morphology is not seen primarily as the 'syntax of morphemes', but as a set of language-specific rules for the creation of complex words.

² The point that Lexical Phonology is simply a consequence of this minimal assumption is also made by Kaye (1992: 141).
distinction between stress-shifting and stress-neutral affixes can be expressed by attaching the latter after stress assignment. The question then arises how we block reapplication of the stress rule after the attachment of a stress-neutral affix. In the standard version of LP this is achieved by means of level-ordering: the main stress rule only applies on the first level, whereas stress-neutral affixes are attached on a second level. However, level-ordering has a number of problematic properties (cf. Booij 1994), and we can do without it as far as stress is concerned in the following way. Stress-shifting affixes are specified as cyclic, which means that they erase the stress pattern of their base, thus inducing reapplication of the main stress rule (Halle and Vergnaud 1987). Stress-neutral suffixes, on the other hand, are specified as non-cyclic in the sense that they do not erase the stress pattern of their base. Thus the main stress rule cannot reapply because existing metrical structure must be respected. The only kind of stress that can be assigned to stress-neutral suffixes is secondary stress, a rhythmic kind of stress (Booij 1995: 105–13).

Principle (5) does not predict that all phonological rules of a language apply in the lexicon. Rules that apply within the domain of the syllable, the foot, or the prosodic word can already apply in the lexicon because these prosodic categories are already available during the construction of words (Booij 1988; Inkelas 1989). However, many rules have domains larger than the word, e.g. the phonological phrase. Such rules are by definition postlexical (i.e. syntactic) rules, since their applicability depends on the availability of domains created on the basis of syntactic structure.

Within the lexical level some rules must be construed as postcyclic (that is, word-level) because they must apply after all morphology has been performed. For instance, the rule of Coda Devoicing in Dutch states that obstruents are voiceless in coda position. This rule cannot apply cyclically, because we would then derive wrong phonetic forms, such as [hel'tin] for held-in ‘heroine’, derived from held /held/ ‘hero’, instead of the correct [heldin]: suffixation causes the morpheme-final underlyingly voiced obstruent to appear in onset position, and hence it remains voiced. Its postcyclicity follows from a prohibition on absolute neutralization. In other words, the rule cannot apply cyclically because of Strict Cyclicity, the principle that forbids the cyclic application of rules in a non-derived environment (prosodic structure such as ‘Coda’ does not count as derived environment, since otherwise Strict Cyclicity would be made vacuous).

The distinction between lexical and postlexical rules is a reflection of the classical distinction between ‘word phonology’ and ‘sentence phonology’ that can be found in the Projet de terminologie standardisée of the Prague Linguistic Circle (‘phonologie du mot’ versus ‘phonologie de la phrase’, Travaux du Cercle Linguistique de Prague 4: 309–23), and in van Wijk (1939: 132): ‘woordphonologie’ versus ‘zinsphonologie’.
So we get in LP three levels at which phonological rules can apply (Booij and Rubach 1987):

(6) lexical level: cyclic level
    word level
    postlexical level

The theoretical discussion within the framework of LP also includes a number of related issues, such as the hypothesis of Strict Cyclicity, and the distinguishing properties of lexical rules versus postlexical rules. I will leave these issues out of the discussion, because they do not bear directly on the issues discussed in this chapter.4

3. COUNTERBLEEDING ORDER

Counterbleeding order poses a challenge to non-derivational theories because it requires an extrinsic ordering of rules, whereas the constraints of non-derivational phonology can be ranked, but cannot be ordered since they apply simultaneously. So let us investigate what kind of generalization counterbleeding order is meant to express. Our first case of counterbleeding order concerns the ordering of lexical rules before postlexical rules. The second case involves counterbleeding order within one cycle of the lexical phonology of a language.

3.1 Lexical versus postlexical phonology

The issue at hand is that of the number of levels of abstraction in phonology. Certain generalizations only hold at a certain systematic level of abstraction, and may be opaque at the phonetic surface. In OT, this kind of opacity does not necessarily lead to the postulation of levels, because constraints are violable, and therefore they are also able to express generalizations that are violated at the phonetic surface. But the point is that a certain level of abstraction, in particular the lexical level, plays a systematic role. First, I will argue that candidates have to be evaluated in two steps, at the lexical and the postlexical level. Second, certain constraints are only valid for words, which means that there is a different constraint-ranking at the postlexical level.

In this connection, I would like to stress that there is no logical conflict between Optimality Theory and (a restricted form of) serial computation. The intrinsic content of OT concerns the form of phonological generalizations, and this does not necessarily exclude each form of serialism. This is pointed out explicitly in Cohn and McCarthy (1994: 4ff., 47ff.); note, moreover, that in

4 See Hargus and Kaisse (1993) and Booij (1994) for a survey and discussion of these issues.
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the appendix to McCarthy and Prince (1993) two levels are distinguished for
the phonology of Axininca Campa.

The lexical/postlexical distinction is also acknowledged in Goldsmith
a level between the underlying level and the phonetic level, the W-level. He
gave the following characterization of these levels:

(7) M-level, a morphophonemic level, the level at which morphemes are
phonologically specified;

W-level, the level at which expressions are structured into well-formed syllables
and well-formed words, but with a minimum of redundant phonological
information; and

P-level, a level of broad phonetic description that is the interface with the
peripheral articulatory and acoustic devices.

The relevant point here is that Goldsmith acknowledges one intermediate stage
between the input level and the output level, the word level, which can roughly
be equated with the phonemic level of structuralist phonology. In LP this is the
level reached when all lexical rules have applied, and before the postlexical
rules apply.

An important motivation for the distinction between a lexical level and a
postlexical level is that at the lexical level certain generalizations hold that
may be made opaque in surface structure due to phonological processes that
apply to sequences of words in a sentence. In particular, many languages have
segments that show the effects of a syllabic position in which they do not
surface (cf. Hargus 1993). A clear example from Dutch is the following. Dutch
has a number of vowel-initial clitics, most of which begin with a schwa. These
clitics obligatorily form one prosodic word with the preceding word, since they
cannot form a proper prosodic word of their own (Booij 1995; 1996): a
prosodic word must contain at least one syllable with a full vowel. Moreover,
a prosodic word cannot begin with a schwa, which shows that syllables headed
by a schwa must have an onset. The latter constraint is only met when a schwa-
syllable occurs in non-word-initial position, where it will always have an onset
consonant. Therefore, schwa-initial clitics are predictably enclitics (except in
sentence-initial position). Consequently, word-final obstruents of the preced-
ing host word fill the onset positions of the syllables headed by the clitic-initial
vowels. Yet those obstruents that are voiced underlyingly, are voiceless in such
onset positions ($\sigma =$ syllable):

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5 In Goldsmith's view, there are intra-level and cross-level rules. Intra-level rules apply simultaneously at one particular level, and are harmonic, i.e. they only apply if they improve the phonological representation. Cross-level rules express correspondences between two levels, and are not necessarily harmonic; they are not to be seen as directional, and are not extrinsically ordered.
(8) (ik) heb 't 'I have it' /heb at/ (he)
(hij) had 'he had it' /had at/ (ha)
(ik) heb 'r 'I have her' /heb ar/ (he)

So, we first have to apply the rule of Coda Devoicing at the word level, and then, at the postlexical level, the attachment of vowel-initial clitics to the preceding words leads to resyllabification, i.e. the devoiced obstruent is shifted to onset position. This is a typical example of counterbleeding order. This order need not be stipulated, but follows from the organization of the grammar assumed in LP, and in all other models that assume the lexical/postlexical distinction.

Instead of formulating Coda Devoicing as a rule, we can also express this generalization in the form of a constraint: the feature [+voice] is not licensed for obstruents in coda position, and hence it will be delinked in that position. In OT terms we might say that this is a Coda Condition that implies that the feature [+voice] cannot be parsed for obstruents in coda position. Whatever the form of this phonological generalization, the point is that it only holds at a certain level of abstraction of the grammar, before the effects of cliticization on the syllabification of words in syntactic contexts are taken into account.

It is not possible to solve this problem by adhering to one level of application of rules/constraints and by considering the obstruents involved as ambi-syllabic when followed by such clitics, as proposed by Coleman (1995) within the Declarative Phonology framework, which does not acknowledge different levels of representation:

(9) Many standard examples of structure-changing operations can be reanalysed as purely structure-building. Analyses employing a resyllabification operation . . . which removes a consonant from coda position and attaches it to the onset node of the following syllable, can be replaced by an analysis in which the coda consonant is shared with the onset of the following syllable (ambi-syllabicity). (Coleman 1995: 360)

This solution is not viable for Dutch, because ambi-syllabicity blocks Coda Devoicing. This can easily be seen from words with a short vowel. Dutch is subject to the constraint that a rhyme has to contain at least two positions. In a word-internal VCV sequence, the C will therefore be ambi-syllabic (Van der Hulst 1984; Booij 1995: 32), as shown here for the word adder /adar/ ‘snake’:

(10) σ
    \[\text{adder /adar/}
    \]

Here, the /d/ will be realized as [d]. Coda Devoicing, formulated in (11), does not apply.
In terms of licensing we can say that in (10) the feature [+voice] of the /d/ is licensed parasitically (Goldsmith 1990), by also being linked to the onset position. In a rule-based approach, application of the rule of Coda Devoicing will be blocked by the Uniform Applicability Condition (UAC) of Schein and Steriade (1986: 727), as shown in Booij (1995: 32), or by Hayes’s Linking Constraint (Hayes 1986), which states that association lines in structural descriptions are interpreted as exhaustive.

The implication of this phenomenon for OT is that the set of candidates must be evaluated in two steps, at the lexical level and at the postlexical level. To make the discussion more concrete, let us assume the following constraints:

(12) Schwa-Onset: a syllable headed by schwa must have an onset.

Coda Devoicing: [+voice] is not licensed for obstruents in coda position.

(The Schwa-Onset constraint is not exactly the same as the general Onset constraint that requires filling of onsets, because Dutch prosodic words can begin with a full vowel.) In the derived word hebber /heb+ør/ [hebør] ‘greedy person’, the /b/ will (also) be parsed as an onset, and hence it will remain voiced. On the other hand, the /b/ of heb [hep] has to devoice, even if it becomes the onset of the following clitic syllable, as in the last example of (8), heb er ‘have her’. Therefore, evaluation must take place in two steps; otherwise, Coda Devoicing would not get a chance to apply in word+clitic combinations. In other words, as far as Coda Devoicing in Dutch is concerned, lexical morphemes and lexical combinations of morphemes must be evaluated before postlexical morpheme combinations are evaluated. Note that this is a case where the surface opacity of obstruent devoicing is not a matter of another constraint dominating Coda Devoicing: Schwa-Onset does not interact with Coda Devoicing in the sense that Coda Devoicing is violated due to the higher-ranked Schwa-Onset constraint. The minimal pair hebber—heb er [hebør]—[hepor] can only be accounted for by evaluation in two steps.

The case of Dutch is by no means an isolated example. There are many cases attested in the literature where a phonological generalization that holds at the lexical level is made opaque by resyllabification at the sentence level. Booij (1984) and Booij and Rubach (1987) mention a number of phonological generalizations concerning French that are made opaque by postlexical resyl-
labification (*liaison* and *enchaînement*), and Harris (1994: 182–3) mentions similar facts of Spanish: certain rules apply to coda consonants which subsequently become the onsets of the following vowel-initial words. These are all cases of counterbleeding order. For instance, in French connected speech word-final consonants syllабify with the initial vowel of the next word of the same phonological phrase, as in *première amie* ‘first girlfriend’ (*prَا*)(me)(ra)(mi). Yet, the second vowel of *première* is [+low] according to the rule of Closed Syllable Adjustment, which says that mid vowels are [+low] in closed syllables. So resyllabification would bleed Closed Syllable Adjustment, if resyllabification applied before Closed Syllable Adjustment. Therefore, the counterbleeding order is required. This order follows from the fact that Closed Syllable Adjustment is a rule that can already apply in the lexicon, whereas resyllabification is a postlexical rule because it applies to sequences of words in phonological phrases. Interestingly, Kenstowicz (1994) came to the same conclusion that constraint evaluation has to take place in two stages, based on analyses of stress patterns in Carib, Shanghai Chinese, and Polish.⁶

An implication of this two-stage derivation/evaluation is that we must allow for resyllabification, albeit of a restricted type: an obstruent which is at one stage in coda position shifts to an onset position in the next stage. That is, the grammar must allow for certain information to be overwritten. In Rubach and Booij (1990) it has been proposed that resyllabification has to be allowed for, but is restricted to coda erasure at the right edges of morphemes.

In his article on the organization of the grammar, Mohanan (1995: 64) makes the following comment on the issue under discussion here:

(13) One can subscribe to the hypothesis that phonological theory needs to separate the module of word-internal structure from the module of structure across words, without necessarily assuming that the former module precedes the latter in a procedural sense. In a non-sequential conception, the modules and the levels of representation that are associated with them, are ‘co-present’, as structures along a multidimensional space, where information from different ‘levels’ or dimensions of organization is simultaneously accessible to principles of the grammar.

Although I agree that multidimensional representations are necessary (see Booij and Lieber 1993 for arguments in favor of the co-presence of the morphological and the prosodic structure of words), I do see a problem for this ‘parallel’ interpretation of the lexical/postlexical distinction which is

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⁶ It is possible to avoid a two-stage evaluation by making use of empty positions which are linked to other positions. For the case under discussion, this implies that the onset obstruents in word + clitic combinations are co-indexed with an empty coda position in the host word. Onset obstruents would then be devoiced because they are co-indexed with a coda position. Such an approach is only motivated if evidence could be provided for such ‘traces’ in phonology, and I am not aware of such independent evidence. Moreover, such a solution does not explain why the onset position does not parasitically license the feature [+voice] in that position.
illustrated by the Dutch case under discussion: both modules pertain to the same dimension of structure, namely prosodic structure. Thus, the lexical and the postlexical representation of the prosodic structure of a Dutch word + clitic combination make contradictory predictions with respect to the phonetic realization of morpheme-final underlingly voiced obstruents. The question is: is an underlying /d/ that occurs in coda position in one dimension, and in onset position in another one, to be realized as a [t] or a [d]? In a derivational, i.e. serial, approach we can say that the lexical level comes first, and that therefore such an underlying /d/ is to be pronounced as a [t]. What the derivational metaphor correctly expresses is that the lexical level takes priority over the postlexical level, and this is what phonological theory has to express as a universal of grammatical organization.

3.1.1 Correspondence theory

There seems to be an alternative in OT for capturing the distinction between the lexical and the postlexical level: the generalized theory of Correspondence advocated, for instance, in McCarthy (1995), which allows for constraints on the relation between the output forms of related words. Similar ideas have been put forward by Burzio (1995; 1996) and Flemming & Kenstowicz (1995), who also argue in favor of identity constraints on the output forms of related words. The introduction of output–output constraints means that the paradigmatic relations between words play a role in the computation of the phonetic form of a word. That is, it is a form of paradigmatic phonology.

Suppose now that we assume an identity constraint that requires the phonetic forms of morphemes in different contexts to be identical. Clearly, this must be a violable constraint because otherwise morphemes would never be allowed to have allomorphs. In the case under discussion it is only featural identity that is required; the prosodic structure might be different: the /b/ of heb ‘have’ is a coda, but that of heb er ‘have her’ is an onset. The Feature Identity constraint will induce overapplication of Coda Devoicing: the /b/ in heb er is devoiced although it should not be, since it is in onset position.

Note, however, that we still have to differentiate between suffixes and clitics with respect to their effect on the phonetic forms of morphemes: the Feature Identity constraint should not apply to morphemes followed by a suffix. For instance, whereas the morpheme heb surfaces as [hep] in isolation and before clitics, it surfaces as [hɛb] before vowel-initial suffixes. If we do not have recourse to ordering of rules, we therefore have to assume co-phonologies. That is, a language then has more than one phonological system. Each sub-system is formed by a language-specific ranking of the universal constraints. Each of the co-phonologies applies to a particular domain of the language, for instance, the word domain or the domain of non-native words. In the case under discussion, we have to assume two co-phonologies for Dutch: one in which faithfulness constraints dominate the Feature Identity Constraint (the
lexical co-phonology, in which the feature [+ voice] of the relevant obstruents is parsed), and one in which the Feature Identity Constraint dominates Faithfulness (postlexical phonology, in which the relevant feature [+ voice] is not parsed).

It seems to me that using Correspondence Theory for the elimination of evaluation in two steps, at the lexical and the postlexical level, is not right, because it forces us to assume two co-phonologies with different rankings of the Featural Identity constraint, whereas the facts discussed here directly follow without different rankings if we evaluate in two steps, at the lexical level and subsequently at the postlexical level (see Inkelas, Orgun, and Zoll, Chapter 13 below, for specific discussion of the issue of co-phonologies).

3.1.2 The systematicity of the lexical level

The lexical level defended here as an intermediate step in the computation of phonetic forms has a systematic role in the grammar, in that the constraints of word phonology are different from those of sentence phonology. For instance, many constraints that apply to consonant clusters in Dutch words, do not apply to postlexical combinations of consonants in prosodic words that are clitic-host combinations:

(14) tf- 't valt ‘it falls’
kb- 'k ben ‘I am’
ks- 'k zal ‘I will’
ty- |‘t gaat ‘it goes’

Similarly, Dell (1995) pointed out that the phonotactics of French at the word level is much more restricted than that after the application of inflection and syntax, which reflects the traditional distinction between ‘phonological syllable’ and ‘phonetic syllable’.

In sum, the classical distinction between word phonology and sentence phonology, which forms part of the LP model of the grammar, should be maintained whatever the format of one’s phonological generalizations.

What the derivational metaphor of evaluation in two steps expresses is that the postlexical phonology may make the effects of the lexical phonology opaque, whereas the inverse, lexical phonology making the postlexical phonology opaque, does not occur. That is, we should not interpret the two phonologies as co-phonologies that apply simultaneously, but as sequentially ordered phonologies. In this way, we also avoid the need to assume a Feature Identity Constraint with two different rankings.

3.2 Cyclic application of rules

Cyclic rule application has been a persistent topic in generative phonology since SPE. The cyclic application of rules has been part and parcel of Lexical
Phonology, and follows from the basic claim of Lexical Phonology that phonology and morphology apply in tandem, as outlined above.

What I will not discuss here is how far cyclic application of stress rules (the classic case of rule cyclicity) is necessary in order to derive the correct stress patterns of complex words. I will focus on two other aspects of the cyclicity hypothesis in LP:

(15) (i) morphological rules may refer to derived phonological properties of their inputs;
(ii) morphological and phonological rules may refer to phonological properties that never come to the surface.

The question, then, is how far these insights concerning the organization of the grammar imply a derivational approach to phonology.

A straightforward example of the dependence of morphology on derived phonological properties of its inputs is the case of German past participles, which are formed by suffixation of -en (strong verbs) or ü/d (weak verbs), and by simultaneous prefixation of ge- if the first syllable of the verbal stem carries main stress:

(16) | Verb stem   | Past participle         |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>lauf ‘walk’</td>
<td>gelaufen</td>
</tr>
<tr>
<td>filtrier ‘filter’</td>
<td>filtriert</td>
</tr>
<tr>
<td>reaktivier ‘reactivate’</td>
<td>reaktiviert</td>
</tr>
</tbody>
</table>

Such a generalization can, but need not necessarily, be expressed in the form of a cyclic derivation in which first stress is assigned to the verbal stem, and subsequently past-participle formation takes place. It is also possible to express this generalization as an output constraint which states that the presence of ge- is only licensed by a following syllable with main stress, because the information on the stress pattern of the verbal stem will be present at the surface.

Another illustration of the first of these two implications of the LP model is noun pluralization in Dutch. Dutch has two competing suffixes for pluralization, -s /s/ and -en /ən/. The selection of the correct suffix is determined by the stress pattern of the base word:

(17) -en after a stem ending in a stressed syllable
     -s after a stem ending in an unstressed syllable

The following examples illustrate this selection pattern:

(18) (a) dam ‘id.’     dámm-en
     kanón ‘gun’    kanónn-en
     kanáal ‘channel’    kanál-en
     lédikánt ‘bed’    lédikánt-en
     ólífant ‘elephant’    ólífant-en

A survey and analysis of the discussions of this topic can be found in Cole (1995).
Although there are a number of complications with respect to the pluralization of loanwords and certain types of complex word, this generalization concerning the role of stress is an established insight in Dutch morphology (cf. Booij and van Santen 1995: 64ff.).

The basic properties of the Dutch stress system are as follows. Main stress falls on the penultimate syllable of a word, unless its last syllable is superheavy (i.e. contains a VVC- or VCC-rhyme); in the latter case main stress falls on the final syllable. However, certain French loan words such as kanón 'gun' and trompet 'trumpet' have final stress although they do not end in a superheavy syllable, and therefore have to be diacritically marked as [+ F] (monemically for [+ French]). We also find words with antepenultimate stress, in which the last syllable has to be marked as extrametrical. So, unless its last syllable is superheavy, marked as [+ F], or extrametrical, a Dutch word ends in a syllabic trochee. Secondary stress is determined by a lexical rule of alternating stress. Furthermore, syllables headed by schwa never bear stress. Thus to a large extent the stress patterns of Dutch words are predictable.

The facts concerning the selection of the correct plural suffix given above form a perfect illustration of LP’s claim that phonology and morphology apply in tandem, and that morphology may be dependent on derived phonological properties. On the first cycle, stress is assigned to the nominal stem. On the second cycle, where the plural suffix is attached, the rule can make use of the relevant, predictable information concerning the stress pattern of the nominal stem.

These plural suffixes, like all inflectional suffixes of Dutch, are stress-neutral: they do not influence the stress pattern of their stems. We have to create some provision for this. For instance, if the -s of toga’s ‘gowns’ counted for stress assignment, the last syllable of this plural form would be superheavy, since its rhyme consists of a long vowel followed by a consonant /s/, and hence carry main stress. This is incorrect, since it is the first syllable of this word that carries main stress. In LP stress neutrality can be expressed by the ordering of rule blocks: the rules of inflectional morphology are ordered after the Main Stress Rule of Dutch. Alternatively, we may not assume ordered rule blocks, but mark stress-neutral suffixes as noncyclic suffixes in the sense of Halle and Vergnaud (1987), which implies that they do not trigger reapplication of the

8 For instance, in some types of complex word with a suffix ending in schwa, the derivational suffix may determine the selection of the plural suffix: diminutive nouns, which end in schwa, always require -s as their plural suffix. English loans often have a plural suffix -s even when they end in stressed syllable, as in tram-s.
Main Stress Rule of Dutch, as outlined in section 2. This latter alternative is to be preferred, because there exist complex words in Dutch in which a stress-neutral suffix precedes a stress-shifting one (Booij 1995), which is an obvious problem for the ordered-blocks analysis.

Is a non-derivational account of these facts possible? To begin with, the prosodic constraint involved in the selection of plural suffixes can be used as an argument for output constraints instead of rules that select the correct allomorph. The effect of the generalizations given in (17) is that a plural noun will always end in a disyllabic trochee. That is, the following (violable) output constraint can be assumed for Dutch:

(19) Words end in a syllabic trochee.

The advantage of such an output constraint is that the functional motivation for the conditions on the choice between -s and -en is expressed, whereas a generalization such as (17) does not express this: if the inverse conditions applied (-s after stressed syllables, -en after unstressed syllables), the rules would not be more complicated.

A consequence of this OT-type of approach to allomorphy is that GEN generates two candidate sets for each plural noun, one for the noun ending in -s and one for the same noun ending in -en. Similar arguments for such an output constraint-based approach to prosodically determined allomorphy are provided by Tranel (1994) for French and by Kager (1995) for Estonian.

Given a constraint-based account of the plural suffix allomorphy of Dutch, the question remains how we account for the fact that the plural affixes do not affect the location of the main stress. In computing the prosodic structure of a plural noun, the plural suffix must be ignored as far as the location of main stress is concerned. Otherwise, a plural form such as toga's /toːyaːs/ 'gowns' would get final stress, just like soláas /soːlaːs/ 'solace', because both words end in a superheavy syllable. Stress neutrality can be accounted for in derivational theories by cyclic derivation:

(20) 1st cycle /toːyaː/
Main Stress Rule 6:
2nd cycle
Suffixation +s
Main Stress Rule [blocked; see below]
phonetic form [t6ːyaːs]

Application of the Main Stress Rule on the second cycle is blocked because the suffix -s is marked as a suffix that does not induce stress erasure, and therefore the existing metrical structure is respected.

It is not possible to obtain this cyclicity effect by an alignment constraint (McCarthy and Prince 1994) which requires the right edge of a stem to align with the right edge of a foot. This kind of solution is proposed in Cohn and
McCarthy (1994) for Indonesian. As they point out, this works for cases in which the stem is followed by a suffix of the CV form. Vowel-initial suffixes of Indonesian, on the other hand, do not allow for such an alignment because the suffix-initial vowel forms a syllable with the stem-final consonant, and Cohn and McCarthy (1994) claim that it is precisely in such cases that there is no cyclicity effect. In the Dutch case under discussion here, however, there is preservation of the location of main stress of the stem, although there is no alignment of the right edge of the stem and the right edge of a foot, as the following examples illustrate (the right stem edge is indicated by []):

(21) tóga-s ‘gowns’

[Diagram]

kanál-en ‘channels’

[Diagram]

That is, the stress-neutral suffixes must be incorporated into the prosodic structure of the words they belong to after the initial determination of the prosodic structure (including main stress assignment). Subsequently, the prosodic structure will be partially recomputed. This is necessary because the output constraint on plural nouns that they must end in a trochee must evidently be evaluated with respect to the prosodic structure of the whole plural form, including the inflectional suffix. Therefore, the cyclicity effect under discussion here cannot be obtained through alignment.²

So it seems that we have to assume two stages here within word phonology, which can be characterized in terms of alignment differences: at the first level the right edge of prosodic structure must align with the morphological boundary before the inflectional suffix; at the second level the right edge of the prosodic structure must align with the right word edge. That is, we have to assume two steps in the computation of the proper form of a word.³

An alternative for cyclic derivation is the use of anti-allomorphy constraints (Burzio 1995; 1996), also called identity constraints (Flemming and Kenstowicz

² The same problem holds for the solution suggested by Kenstowicz (1994: 21).

³ Orgun (1994) reaches the same conclusion that not all cyclicity effects can be accounted for by means of alignment conditions, on the basis of data from Turkish.
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1995), or correspondence constraints (McCarthy 1995). The idea is that there is a class of constraints that require the output form of the stem of a complex word to be maximally similar to the output form of the corresponding lexical item. For example, we might assume an identity constraint (Head Identity) that requires the head of the prosodic word of *toga*’s ‘gowns’, the vowel /o:/, to match the head of the prosodic word of *toga*.

Stress neutrality is not a property of all Dutch suffixes, however: non-native suffixes do affect the location of the main stress, and such stem + non-native suffix combinations behave with respect to stress assignment as if they are underived. Therefore, the Head Identity constraint does not apply to the non-native part of the morphological system of Dutch. We are thus forced to assume two co-phonologies for Dutch: a native and a non-native co-phonology, with different constraint rankings. In the native co-phonology, the constraint that final superheavy syllables are the heads of prosodic words (Superheavy) is dominated by the Head Identity constraint that requires identity with respect to prosodic headship. In the non-native co-phonology, the ranking of these two constraints is the inverse. Compare the evaluation of *toga*’s with the evaluation of the de-adjectival noun *absurditeit* ‘absurdity’, derived from the adjective *absúrd* ‘id.’ with the non-native suffix *-iteit* ‘-ity’:

\[
\begin{array}{|c|c|}
\hline
& \text{Head Identity} & \text{Superheavy} \\
\hline
\rightarrow \text{tóga-s} & \star & \\
\hline
\text{togá-s} & \star & \\
\hline
\end{array}
\]

\[
\begin{array}{|c|c|}
\hline
& \text{Superheavy} & \text{Head Identity} \\
\hline
\text{absúrd-iteit} & \star & \\
\hline
\rightarrow \text{absúrd-itéit} & \star & \\
\hline
\end{array}
\]

The existence of co-phonologies implies cyclic evaluation of constraints: each suffix in its turn determines which co-phonology governs the evaluation. For instance, the plural form of *absurditeit* ‘absurdity’ is *absurditeit-en*. For the evaluation of this word we have to use the native co-phonology because the plural suffix induces native phonology. In order to check Head Identity, we have to look at the output form of its stem, *absurd-iteit*. The output form of this word can only be computed by first computing the output of its base *absurd*. Crucially, we cannot directly compare *absurditeit-en* with *absurd*, because then we would have to conclude that the Head Identity Constraint is violated (in *àbsurditéiten* the part *absurd* does not bear main stress). That is, the introduc-
tion of correspondence constraints involves cyclic evaluation of complex words in languages with co-phonologies, a form of serial computation.

4. COUNTERFEEDING RULE ORDER

Counterfeeding order is a form of extrinsic rule ordering that is clearly at odds with non-derivational phonology. I should add, however, that it is also a form of rule ordering that should be avoided as much as possible in derivational phonology. It is to be avoided since it is essentially stipulative, and does not follow from the organization of the grammar, unlike the application of lexical rules before postlexical ones, or the application of a rule on a cycle before the application of another rule on the next cycle.

Whereas cyclicity is not necessarily in conflict with a constraint-based approach, the extrinsic ordering of rules within a cycle clearly is. So the question is whether we can do away with this kind of extrinsic ordering. The combination of cyclic application and extrinsic ordering of rules that is often found in LP analyses can be illustrated on the basis of the following facts of Dutch discussed in Booij (1995: 80 ff.). Non-native words ending in a syllable with a VC rhyme that does not bear main stress exhibit vowel lengthening; the vowel of the last syllable is lengthened before non-native suffixes, which are all vowel-initial. Consider the following examples:

(23) kán[ɔː]n ‘canon’  kan[ɔː]nːék ‘canonical’
    mót[ɔː]r ‘engine’  mot[ɔː]:nr ‘engine’
    sá[t]n ‘id.’  sat[ɔː]nizh ‘satirical’
    álfab[ɛ]t ‘alphabet’  alfab[ɛ]:tisch ‘alphabetical’
    proféss[ɔː]r ‘id.’  profess[ɔː]:ral ‘professorial’

organisát[ɔː]r ‘organizer’
álcoh[ɔː]l ‘id.’  alcoh[ɔː]:lisch ‘alcoholic-A’
álcoh[ɔː]:líst ‘alcoholic-N’

The crucial condition is that the syllable that is lengthened does not bear main stress in the base word. Given this stress condition on vowel lengthening, the vowels of monosyllabic base words will never be lengthened because they always have main stress. The stress pattern of the base word, however, is not preserved in the complex word: as pointed out above, non-native suffixes erase the stress pattern of the base word when the stress pattern of the derived word is computed. In the complex words, main stress falls on the last stressable syllable (except for words with the suffix -isch, where main stress falls on the last syllable before the suffix). We also find near-minimal pairs such as
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kànôníék [kaːnɔːniːk] ‘canonical’ derived from kànón ‘canon’ versus kànôn-nier [kaːnɔːniːr] ‘gun man’, derived from the word kanón ‘gun’:

(24) No lengthening

<table>
<thead>
<tr>
<th>Word</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>tón</td>
<td>‘id.’</td>
</tr>
<tr>
<td>blók</td>
<td>‘block’</td>
</tr>
<tr>
<td>kanón</td>
<td>‘gun’</td>
</tr>
<tr>
<td>modél</td>
<td>‘id.’</td>
</tr>
<tr>
<td>libréto</td>
<td>‘id.’</td>
</tr>
<tr>
<td>t(ɔ)nnáge</td>
<td>‘number of tons’</td>
</tr>
<tr>
<td>bl(ɔ)kkéer</td>
<td>‘to block’</td>
</tr>
<tr>
<td>kan(ɔ)nnier</td>
<td>‘gun man’</td>
</tr>
<tr>
<td>mod(ɛ)lléer</td>
<td>‘to model’</td>
</tr>
<tr>
<td>libr(ɛ)ttíst</td>
<td>‘id.’</td>
</tr>
</tbody>
</table>

The stress of all base words involved is regular, and hence predictable by rule (except for disyllabic words such as kanón ‘gun’: this word forms a minimal pair with the regularly stressed kànón ‘canon’). So the basic ingredients of rule-based LP for expressing the generalization involved are: cyclic assignment of stress, and extrinsic ordering of vowel lengthening before stress assignment. These rules have to be ordered in counterfeeding order, because otherwise Stress Erasure would feed Vowel Lengthening, with incorrect results (lengthening of the second vowel) for a word like kanonnier derived from kanón. For instance, the LP derivation of kanonnier runs as follows:

(25) 1st cycle

<table>
<thead>
<tr>
<th>Rule</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Stress Rule</td>
<td>[kaːnɔn]</td>
<td>ʃ</td>
</tr>
<tr>
<td>2nd cycle</td>
<td>[[kaːnɔn]niːr]</td>
<td>ɔ</td>
</tr>
<tr>
<td>Vowel Lengthening</td>
<td>blocked</td>
<td></td>
</tr>
<tr>
<td>Stress Erasure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Stress Rule</td>
<td>f:</td>
<td></td>
</tr>
<tr>
<td>Secondary Stress</td>
<td></td>
<td></td>
</tr>
<tr>
<td>output</td>
<td>[kàːnɔnfiːr]</td>
<td></td>
</tr>
</tbody>
</table>

This derivation presupposes again that non-native suffixes are cyclic suffixes in the sense of Halle and Vergnaud (1987), which means that they erase the stress pattern of their base word, after which the Main Stress Rule is reapplied to the whole string including the suffix. This nicely illustrates the idea that phonological rules may refer to phonological properties that never come to the surface.

Note that the blocking of vowel lengthening cannot be made dependent on the presence of the diacritic feature [+ F] that is necessary to get exceptional main stress on words such as kanón and trompét. The reason is that there are also words such as tón and librétto with regular stress, where the stressed vowel also resists lengthening.

If this type of analysis were the only possible account, it would form a strong case in favor of a rule-based approach to phonology, in the spirit of Bromberger and Halle (1989), who claim that it is extrinsic ordering of rules that distinguishes phonology from the other components of the grammar. However, as has been pointed out by e.g. Lakoff (1993) and Coleman (1995), it is possible to reanalyse the Bromberger–Halle data without making
use of extrinsic ordering. Generally, the use of extrinsic ordering of rules should be avoided as much as possible in a constrained theory of phonology, since extrinsic ordering adds to the number of stipulations in the grammar of a particular language. It is preferable to have a theory of rule or constraint interaction that can do without the device of stipulated extrinsic ordering. In this respect extrinsic ordering is different from cyclic rule application, because the latter need not be stipulated, but follows from the principle ‘apply a rule when possible’. It is also the goal of LP to reduce the order of application of rules as much as possible to universal principles such as the Elsewhere Condition.

4.1 Correspondence constraints?

One possible solution to this descriptive problem within the correspondence theory proposed by Flemming and Kenstowicz (1995) is the following: ‘the constraint requiring a stem final vowel to be long is dominated by a constraint that matches the head of the prosodic word of the base with the corresponding vowel in the derived structure’. What this formulation implies is the following: in a word such as *kanonnier* (derived from *kanón*) the vowel of the second syllable may not be lengthened because it may not be different from the vowel of the second syllable of *kanón*, this vowel being the head of the prosodic word of the base (i.e. it bears main stress). On the other hand, the vowel of the second syllable of *kanoniek* can be lengthened because this vowel does not correspond to the head of the prosodic word of the base, which is the first vowel of the base, the /a/. This is a typically paradigmatic solution: although there is no primary stress on the second syllable of *kanonnier* that can block the lengthening, there is such a primary stress on the corresponding base word.

Although I do not want to exclude the possibility that paradigmatic relations may play a role in phonology, it is at present a very unconstrained device. Therefore, it is worthwhile to investigate whether an alternative analysis without correspondence constraints is possible. Such an analysis would run as follows. Non-native words in Dutch often appear to have two different forms in derivational morphology, one for non-native suffixation and one for native suffixation. Sometimes, the allomorph that is used in non-native suffixation is not even pronounceable as such, that is, it is not a proper prosodic word, as is the case for the allomorph *filtr* of the word *filter* ‘id.’. Also, it is often impossible to derive one allomorph from the other by means of a phonological rule. Consider the following examples (from Booij 1995: 83):

(26) orkest ‘orchestra’
gymnasium ‘grammar school’
trauma ‘id.’
functie ‘function’
horizon ‘id.’
orgel ‘organ’
orkestr-eer ‘to orchestrate’
gymnasi-ast ‘grammar school pupil’
traumat-isch ‘traumatic’
function-eer ‘to function’
horizont-aal ‘horizontal’
organ-ist ‘organ player’
The conclusion to draw from these examples is that for such (non-native) words two stem allomorphs have to be listed, one that is subcategorized for non-native suffixation and one that has no subcategorization, the default allomorph. The default allomorph is chosen when the word is used as a simplex word, in prefixation, and in native suffixation.

We might then use the same strategy for cases such as *kánon—kànoníék*, and list two stem allomorphs in the lexicon for the relevant word: */kaːnɔn/* and */kaːnoːn/*. The only disadvantage of this solution is that we do not derive one allomorph from the other by means of a regular rule of phonology, as was possible in the analysis presented above. Note, however, that the rule of vowel lengthening does not have the character of an automatic phonological rule anyway, since its application is restricted to non-native complex words. It also has exceptions such as *claxonneer* 'to sound one’s horn', derived from the English loan *kláxon* 'horn'.

As argued by Aronoff (1994), there is ample evidence from a number of languages for lexical rules that derive one stem allomorph from another one in a systematic way (see also Spencer 1988). In the case under discussion here, this rule would have the following form:

(27) Non-native morphemes ending in ... VC₁VC have an allomorph in ... VC₁V₁VC subcategorized for non-native suffixation.
Condition: the morpheme does not bear the diacritic feature [+ F].

By requiring the absence of [+ F] (= [+ French]), we ensure that only those morphemes in -VC₁VC that do not carry main stress get an allomorph with a long vowel in the final syllable. So *kánon /kaːnɔn* ‘canon’ has an allomorph */kaːnoːn/*, but *kanón* ‘gun’, with the exceptional word-final stress triggered by the feature [+ F] does not. Monosyllabic words such as *ton* and polysyllabic words such as *librétto* do not have the phonological form required by the allomorphy rule, and hence do not exhibit vowel lengthening.

There is independent evidence for a stem allomorphy analysis in these cases. Non-native nouns ending in *-on* or *-or* also exhibit this vowel-length alternation optionally in singular–plural pairs:

(28) **Singular**  
démon ‘demon’   
eléktron ‘electron’   
mótőr ‘engine’   
dóctőr ‘doctor’  

**Plural**  
démons/dem[ɔː]nen   
eléktrons/elektr[6]ːnen   
mótőrs/mot[6]ːren   
dóctőrs/doct[6]ːren  

**Derived word**  
dem[6]ːnisch ‘demoniac’   
mot[6]ːrisch ‘engine-’   
doct[ɔː]ːráal ‘doctoral’

---

11 Note that Spencer (1988) uses the term ‘morpholexical rule’ for lexical redundancy rules that relate two or more listed allomorphs, whereas I use the term, like Anderson, as a synonym of ‘morphophonological rule’, i.e. a phonological rule conditioned by non-phonological (morphological and/or lexical) properties.
The crucial observation is that a difference in plural suffix correlates with a difference in the location of the main stress, although normally plural suffixes do not affect the stress patterns of their base words. These facts follow directly if we assume two allomorphs for these words, as proposed above. The only exceptional aspect of the behavior of these words in -on and -or, then, is that the allomorph that is normally used only for non-native suffixation may also be used for inflectional suffixation. When the allomorph *demon* is used, the prosodic output constraint on plural nouns requires *-s*, because the predictable stress pattern is *démon*. The allomorph *demoon*, on the other hand, will receive main stress on its final syllable, because this syllable is superheavy, and thus forms a foot of its own. After prosodic integration of the suffix *-en*, the word will end in a trochee, as required.\(^{12}\)

In sum, what we have seen here is that in some cases the extrinsic ordering of rules can be avoided by making use of rules of stem allomorphy. Thus, these data do not constitute decisive evidence in favor of a rule-based approach to phonology.

### 4.2 Non-native allomorphy

Another relevant case of allomorphy is the following. When a Dutch non-native word has two allomorphs, one of them may be unpronounceable, i.e. it does not form a proper phonological word. The generalization is that, unlike non-native suffixation, native suffixation always requires its inputs to be fully prosodically licensed. Consider the following examples:

\[(29)\]

<table>
<thead>
<tr>
<th>Word</th>
<th>Native</th>
<th>Non-native</th>
</tr>
</thead>
<tbody>
<tr>
<td>filter</td>
<td>‘id.’</td>
<td>- native: filtr-eer ‘to filter’, filtr-aat ‘filtrate’</td>
</tr>
<tr>
<td></td>
<td>[+ native]: filter-en ‘to filter, inf.’, filter-ing ‘id.’</td>
<td></td>
</tr>
<tr>
<td>regel</td>
<td>‘rule’</td>
<td>- native: regl-ement ‘rules’</td>
</tr>
<tr>
<td></td>
<td>[+ native]: regl-en ‘to arrange, inf.’, regel-ing ‘arrangement’</td>
<td></td>
</tr>
<tr>
<td>exempel</td>
<td>‘example’</td>
<td>- native: exempl-arisch ‘exemplary’</td>
</tr>
<tr>
<td></td>
<td>[+ native]: exempel-en ‘examples’</td>
<td></td>
</tr>
<tr>
<td>arbiter</td>
<td>‘id.’</td>
<td>- native: arbitr-age ‘referee’ing’, arbitr-eer ‘to referee’</td>
</tr>
<tr>
<td></td>
<td>[+ native]: arbitrer-en ‘to referee’, inf.’</td>
<td></td>
</tr>
<tr>
<td>center</td>
<td>‘id.’</td>
<td>- native: centr-eer ‘to center’, centr-aal ‘central’</td>
</tr>
<tr>
<td></td>
<td>[+ native]: center-en ‘to center’, inf.’</td>
<td></td>
</tr>
<tr>
<td>cilinder</td>
<td>‘cylinder’</td>
<td>- native: cilindr-ish ‘cylindrical’</td>
</tr>
<tr>
<td>integer</td>
<td>‘honest’</td>
<td>- native: integr-eer ‘to integrate’, integr-iteit ‘integrity’</td>
</tr>
<tr>
<td></td>
<td>[+ native]: integer-e ‘honest’, inflected form</td>
<td></td>
</tr>
</tbody>
</table>

A [- native] stem allomorph such as *filtr* cannot be completely licensed prosodically: a coda /tr/ of this monosyllabic stem would violate the Sonority...
Sequencing Generalization, and hence the /t/ will remain extrasyllabic unless some action is taken. In the case of non-native suffixation, the vowel-initial suffix triggers resyllabification, as in (ftl)_{t_e:}r_{o}. Thus, the /t/ is prosodically licensed. When the morpheme filtr is to be realized as a word, the default vowel of Dutch, the schwa, is inserted before the /t/, and hence we get the form /filtar/. It is this form that feeds native suffixation. So, although a native vowel-initial suffix could have saved the /t/ of filtr, this is not the proper solution for words with native suffixes, and the schwa has to be inserted.

In a classical LP approach this array of facts can be accounted for by assuming two morphological levels: a level of non-native suffixation followed by a level of native suffixation. The rule of schwa insertion will then be ordered after the first, and before the second level of suffixation. That is, a form of extrinsic ordering seems to be necessary.

In constraint-based phonology it is possible to analyse these facts by making use of constraints of correspondence.\(^{13}\) The schwa insertion in a word such as filter-en can be seen as a case of overapplication of schwa epenthesis, triggered by an output–output identity constraint that holds for the native phonology of Dutch: the phonetic form of a stem used in native suffixation must be identical to the phonetic form of that stem when realized as a word in isolation. In a rule-based approach without extrinsic ordering, on the other hand, the two allomorphs cannot be derived from a common underlying form.

Again, the use of correspondence constraints does not eliminate serial computation completely. For instance, if we have to evaluate the candidates for the complex word filtr-eer-ing ‘filtration’, the native suffix -ing induces evaluation on the basis of the constraint-ranking of the native phonology, in which the relevant identity constraint is undominated. However, in order to evaluate this constraint we cannot directly compare filtr-eer-ing to the phonetic form of the morpheme /filtar/, [filtar]. This would give the wrong conclusion that the relevant identity constraint has been violated. Instead, we have to evaluate filtr-eer-ing with respect to the phonetic output of the stem filtr-eer which the grammar also computes. The conclusion will then be that there is no violation of the identity constraint. However, in order to compute the proper phonetic output of filtr-eer, we have to check the candidates with respect to all constraints, including the (now dominated) identity constraint in the ranking as defined for the non-native phonology: the constraint appears to be violated, but that does not matter in non-native phonology, where faithfulness between input and output is apparently ranked higher than the identity constraint.

In short, if we interpret phonological strata (level ordering) as co-phonologies, complex words must be evaluated cyclically, and hence we have to allow for serial computation.

\(^{13}\) This solution was suggested to me by Bernard Tranel.
Generative phonology deals not only with purely phonological generalizations, in the derivational model in the form of automatic phonological rules, but also with morpholexical rules, i.e. phonological generalizations that only hold for a specific lexical or morphological class of words.

An interesting consequence of the LP model is that morpholexical rules need not necessarily precede automatic phonological rules. The effect of an automatic phonological rule on a cycle can be relevant for the application of a morpholexical rule on the next cycle (within a cycle, morpholexical rules apply before phonological rules). The allomorphy of the Dutch diminutive suffix can be used to illustrate this point. The Dutch diminutive suffix has five allomorphs, -tje, -je, -etje, -kje, -pje. The allomorphs -etje and -kje both appear after a stem that ends in a velar nasal; the allomorph -etje appears after stems ending in a sonorant consonant, if the last syllable bears (primary or secondary) stress; after an unstressed syllable ending in the velar nasal the allomorph -kje appears:

(30) ríng ‘id.’
     seríng ‘lilac’
     hórízón ‘id.’
     wándel-ing ‘walk’
     óefen-ing ‘exercise’
     stróm-ing ‘stream’
     lélid-ing ‘pipe’
     kóning ‘king’
     pálíng ‘eel’

As pointed out above, the native suffixes of Dutch, including the inflectional suffixes, are stress neutral. This also applies to the deverbal nominalizing suffix -ing. The determination of the location of main stress in Dutch depends on the segmental structure of the last (three) syllables (Kager 1989). However, as amply motivated in Booij (1995), the assignment of secondary stress is a completely rhythmical matter in which notions like syllable weight and stress neutrality do not play a role. The rule of Secondary Stress creates an alternation of stressed and unstressed syllables without creating stress clashes. Therefore, in a word like wandeling (a deverbal noun derived from the verb wandel ‘to take a walk’) the last syllable receives secondary stress.

In the classical LP model, the form of the diminutive noun wandelingetje is derived as follows:

(31) 1st cycle
     Main Stress       [wandöl]
     Sec. Stress      á
     not applicable
On the third cycle, no stress rule applies. The Main Stress Rule does not apply because the diminutive suffix, like -ing, is stress-neutral. The rule of Secondary Stress does not apply because syllables headed by schwa can never bear stress.

In a non-derivational framework, there are two possibilities for analysing these data. The problem that must be solved is that the schwa epenthesis in words such as *wandelingetje* is not triggered by an automatic phonological rule of schwa epenthesis; it only applies to diminutive words. This can easily be seen from the pair *stil-te* /stiltə/ ‘silence’ versus *stil-etje* /stilətə/ ‘chamberpot’: although these words have the same adjectival stem, *stil* ‘silent’, and both contain a /l/-initial suffix, it is only before the diminutive suffix that a schwa is inserted. Therefore, in a constraint-based non-derivational phonology we have to assume a specific co-phonology for diminutives, a set of constraint rankings that is unique to the diminutive suffix. Alternatively, since we certainly want to avoid a proliferation of morpheme-specific co-phonologies, we may list the five allomorphs of the diminutive suffix, and provide each with the relevant phonological subcategorization. The relation between the five allomorphs is then to be expressed by allomorphy rules, i.e. lexical redundancy rules that relate these forms to each other. Thus, the choice for a constraint-based phonology appears to favor a non-phonological analysis of that kind of allomorphy that is not conditioned by ‘pure’ phonology.

As pointed out above, the allomorph -etje requires the preceding syllable to bear (primary or secondary) stress. In a theory of phonology based on output constraints this is no problem: the phonological subcategorization functions as an output constraint that checks the stress pattern of the diminutive. Thus, when GEN generates both *wandelingetje* and *wandelingkje*, it is the first form that is selected, whereas for a noun such as *koning* it is *köninkje* that is selected, not *köningetje*, because in this latter word the second syllable does not bear stress.

Interestingly, these conclusions concerning allomorphy support the conclusion reached above as to how to account for the phenomenon of vowel lengthening in non-native words: the allomorphs must be listed, and related by means of redundancy rules, instead of being derived from a common underlying form.

We thus see that the category of morpholexical rules does not form a problem for non-derivational theories of phonology if we accept an allomorphy analysis for the alternations involved.
6. CONCLUSIONS

The empirically attested types of rule interaction that form part of the motivation of the LP model of phonology show that a non-derivational conception of phonology, in which there is only one set of ranked constraints that apply simultaneously, is problematic.

First, all phonological theories must distinguish generalizations within the word phonology from generalizations concerning sentence phonology. The effects of prosodically conditioned rules of word phonology may be made opaque by resyllabification effects at the sentence level, and therefore evaluation in two steps appears to be necessary.

Second, although we can probably do without extrinsic ordering of individual phonological rules, the most typical case of ‘serial’ phonology, certain phenomena require there to be more than one stage at which rules can apply or constraints can be evaluated: we need cyclicity.

This implies that the three levels of LP—the cyclic level, the postcyclic (= word) level, and the postlexical level—cannot be given up in constraint-based phonologies. Moreover, we still need a principle such as Strict Cyclicity that tells us which constraints must be evaluated cyclically, and which constraints should only be evaluated at the word level.

The insights concerning the interaction of phonology and morphology that have been expressed in the LP model of the organization of the grammar have to be preserved, whatever one’s theory of the form of phonological generalizations. In an OT framework, they can be partially expressed by means of alignment and correspondence constraints, but evaluation in more than one step remains necessary. A restricted form of serialism appears to be necessary, even in primarily parallel models of phonology.

Finally, we have seen that in non-derivational phonology the generalizations expressed by morpholexical rules lead to a proliferation of morpheme-specific rankings of constraints. The only way to avoid this is another analysis of this kind of allomorphy. Instead of deriving the allomorphs from a common underlying form, the classical strategy of generative phonology, each allomorph is lexically represented. As Goldsmith (1995a: 9) rightly points out, we should not take the classical (= phonological) approach to allomorphy which Goldsmith summarizes in the formula ‘minimize allomorphy’ for granted. Thus constraint-based phonology may contribute to a principled choice as to which allomorphy belongs to the domain of phonology, and where morphology, the module that deals with the selection of morphemes, takes over.

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