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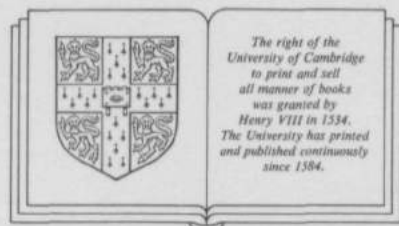
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Contents

Morphological and prosodic domains in Lexical Phonology	1
Geert Booij (Vrije Universiteit, Amsterdam) and Jerzy Rubach (University of Warsaw)	
Explaining Natural Phonology	29
Wolfgang U. Dressler (University of Vienna)	
Declination: a review and some hypotheses	53
D. Robert Ladd (Cornell University/University of Edinburgh)	
Vowel system universals and typology: prologue to theory	75
Roger Lass (University of Cape Town)	
Prosodic phonology and phonetics	113
John Ohala (University of California, Berkeley) and Haruko Kawasaki (MIT)	
The fundamentals of particle phonology	129
Sanford A. Schane (University of California, San Diego)	
<i>Review Article:</i>	
Review of H. van der Hulst and N. Smith (eds.), <i>The structure of phonological representations</i>	157
Grzegorz Dogil (University of Bielefeld)	

*Morphological and prosodic domains in Lexical Phonology**

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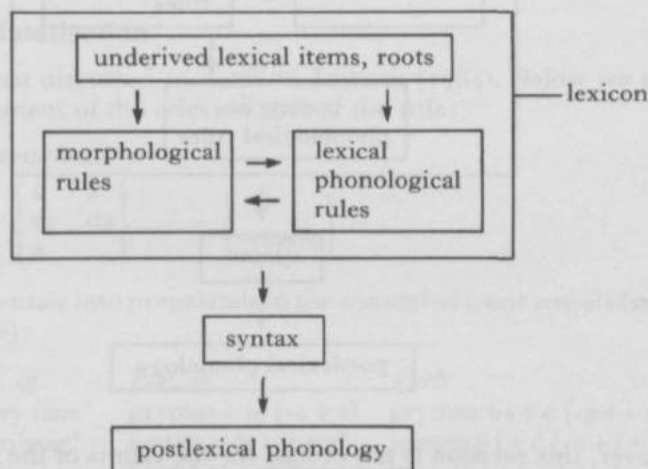
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1 Introduction: the basic claims of Lexical Phonology

The theory of Lexical Phonology proposed in Kiparsky (1982a) is a major step forward in generative phonology with respect to the problem of the interaction of phonology and morphology. Its basic claim is that morphological rules and word level phonological rules are interspersed. A rule of word phonology (i.e. a lexical phonological rule, which exclusively applies within words) may apply as soon as the required environment for its application has been created by some morphological rule. That is: 'morphology and phonology go hand in hand'. If we omit for the moment the subtheory of level ordering,¹ Kiparsky's model is the following:

(1) The model of Lexical Phonology

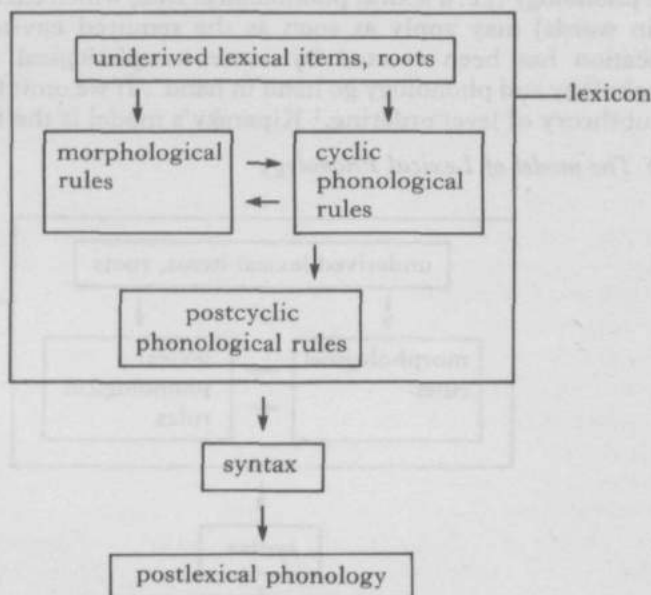


We want to make one refinement here with respect to Kiparsky's model. In his theory all lexical rules are cyclic, i.e. they apply in derived environments only (at least in their feature-changing applications). Yet it is clear that within the class of lexical rules we have to distinguish between

cyclic and postcyclic rules. The following simple example may serve to illustrate this. Dutch has a rule of syllable-final devoicing of obstruents, cf. *held* /hɛld/ 'hero' [hɛlt], *helden* /hɛld+ən/ 'heroes' [hɛlʂdɛn]. Although this rule is a lexical rule, it cannot apply in a cyclic fashion. For instance, in *heldin* /hɛld+ɪn/ 'heroine' [hɛldɪn], derived from *held*, the underlying stem-final /d/ should not be devoiced on the first cycle, because then we would derive the wrong phonetic form *[hɛltɪn].² Thus the rule of Final Devoicing must be considered a postcyclic rule, ordered after the block of morphological and cyclic phonological rules. Note that we do not want to consider Final Devoicing a postlexical rule, since then we can no longer predict that this rule has to apply before all rules of phrase phonology.

In Rubach (1984) one can also find several examples of word level rules of Polish which must be postcyclic. Moreover, in that work it is also shown that all postcyclic rules must apply in one block after the cyclic rules, a claim that is exactly expressed by our revised model of Lexical Phonology presented in (2):

(2) *Revised model of Lexical Phonology*



However, this revision is not crucial for the claims of the present paper.

The problem that we want to discuss and solve in this paper is that, working within the framework of Lexical Phonology, we encounter certain paradoxes, i.e. cases for which it seems that phonological rules must apply in a way different from that predicted by the morphological structure of such complex words. For instance, it appears that Polish prefixes must be

operated upon by cyclic phonological rules on the last cycle, whereas from the morphological point of view they belong to earlier cyclic domains.

This paper is structured as follows. In section 2 we present the descriptive background that is necessary for a proper understanding of the paradoxes, particularly certain complicated facts of Polish. In section 3 we will show how the model of Lexical Phonology makes correct predictions with respect to certain crucial cases of phonology-morphology interaction in Dutch and Polish. In section 4 we present the paradoxes and provide a solution for them by arguing that we have to assume two different kinds of hierarchical organisation of the linear strings of phonological segments: a syntactic/morphological hierarchy and a prosodic one. Thus, this paper aims to show that these paradoxes do not refute the claims made by Lexical Phonology, and also support the theory of prosodic phonology.

2 Descriptive background: some facts of Polish

In this section we wish to introduce briefly some background information about the structure of Polish in order to facilitate our discussion in the subsequent sections of this paper. Attention will be drawn only to those portions of Polish phonology which are relevant to the presentation of the theoretical concepts that we spell out in sections 3 and 4 below. In particular, we shall look at the rules of Coronal Palatalisation and Lower as well as at some principles of syllabification and stress assignment in Polish.

2.1 Coronal Palatalisation

This rule has been discussed in detail in Rubach (1984). Below we give an informal statement of the relevant part of the rule:

(3) Coronal Palatalisation

$$\left\{ \begin{matrix} s & z \\ t & d \\ n \end{matrix} \right\} \rightarrow \left\{ \begin{matrix} \text{ɕ} & \text{ʑ} \\ tɕ & dʑ \\ ɲ \end{matrix} \right\} \quad / - \left[\begin{matrix} V \\ -\text{back} \end{matrix} \right]$$

Cor. Pal. turns dentals into prepalatals in the context of front vowels (stops become affricates):

(4) <i>Masc. nom. sg.</i>	<i>Loc. sg.</i>	<i>Verb</i>
grymas 'wry face'	grymas + ie [-ɛ + e]	grymas + i + ć [-ɛ + i + tɕ]
nawóz 'fertiliser'	nawoz + ie [-z + e]	nawoz + i + ć [-z + i + tɕ]
kształt 'shape'	kształc + ie [-tɕ + e]	kształc + i + ć [-tɕ + i + tɕ]
głód 'hunger'	głodz + ie [-dz + e]	głodz + i + ć [-dz + i + tɕ]
ukłon 'bow'	ukłon + ie [-ɲ + e]	ukłon + i + ć [-ɲ + i + tɕ]

The morphological structure of the verbs in (4) is noun + verbalising suffix + infinitive ending.

Cor. Pal. is a classic example of a 'derived environment' type of rule. It applies in an exceptionless manner in the presence of a morpheme boundary, as shown in (4). At the same time, it systematically fails to apply to morpheme-internal structures. Thus the dentals in (5) below remain unaffected in spite of the fact that they are followed by front vowels:

- (5) *protest* 'protest', *ultimat* + *um* 'ultimatum',³
desant 'landing', *dinosaur* 'dinosaur',
sekund + *a* 'second', *maksim* + *um* 'maximum', etc.

It is shown in Rubach (1984) that Cor. Pal. is ordered among the cyclic rules.⁴ In Lexical Phonology cyclic rules form one block, i.e. no postcyclic rule can be ordered among them. It therefore follows from the facts of ordering that Cor. Pal. is itself a cyclic rule. Observe that the application of Cor. Pal. to the data in (4) but not to the data in (5) is now seen to fall out from the theory of Lexical Phonology. We shall illustrate this further in section 3 below.

2.2 Lower

Polish exhibits a complex pattern of vowel-zero alternations.⁵ The mid vowel /e/ alternates with zero in some words, but not in others:

- (6) a. *posel* 'envoy' – *posł* + *a* (gen. sg.)
mech 'moss' – *mch* + *y* (nom. pl.)
sen 'dream' – *sn* + *y* (nom. pl.)
versus
 b. *fotel* 'armchair' – *fotel* + *a* (gen. sg.)
grzech 'sin' – *grzech* + *y* (nom. pl.)
basen 'pool' – *basen* + *y* (nom. pl.)

Clearly the *e*'s in (6a) which alternate with zero must be distinct at the underlying level from the *e*'s in (6b) which do not.

More light on how to effect this distinction is cast by the fact that the *e*'s which alternate with zero may also alternate with either [i] or [ɪ], for instance:

- (7) *posel* 'envoy' – *posł* + *a* (gen.) – *pośl* + *ij* 'send' (imp.) – *posył* + *aj*
 [-si-] 'send' (Derived Imperfective, imper.) (from Gussmann 1980: 39)

Needless to say, there are also instances of [i] and [ɪ] which do not exhibit any alternations.

Thus the alternating *e*'s seem to be intermediate between the mid vowel //e// and the high vowels //i i//. Following a suggestion by Gussmann (1980) we represent the alternating *e*'s as high lax vowels //ĩ i//: one is

front (palatalising) and the other back. The vowel system of Polish is therefore as follows:⁶

(8)

high	i	ĩ	u
	ĩ	ĩ	
mid	e		o
low		a	

For easier reference we shall call //ĩ// and //ĩ// yers. We shall also assume with Gussmann (1980) that the nom. sg. ending of the masculine declension is a back yer //ĩ//. The pattern of /e/-zero alternation can now be interpreted as governed by the application of either of the following two rules:

(9) *Lower* (cyclic)

$$\begin{Bmatrix} \text{ĩ} \\ \text{ĩ} \end{Bmatrix} \rightarrow e / - C_0 \begin{Bmatrix} \text{ĩ} \\ \text{ĩ} \end{Bmatrix}$$

(10) *Yer Deletion* (postcyclic)

$$\begin{Bmatrix} \text{ĩ} \\ \text{ĩ} \end{Bmatrix} \rightarrow \emptyset$$

In other words, yers lower to /e/ if followed by a yer in the next syllable, otherwise they delete context-free.

The alternations of *e*-zero-*i*/*ĩ* (the latter spelt <y>) require yet another rule. Observe that the yer surfaces phonetically as [ĩ] in (7) when it is followed by the Derived Imperfective (= DI) morpheme //aj//. The relevant rule is DI Tensing:

(11) *DI Tensing*

$$\begin{Bmatrix} \text{ĩ} \\ \text{ĩ} \end{Bmatrix} \rightarrow \begin{Bmatrix} \text{i} \\ \text{i} \end{Bmatrix} / - C_0 \text{aj}]_{\text{DI}}$$

In (12) below we show how our rules operate: //ĩ// is the nom. sg. ending, //a// the gen. sg. suffix and //aj// the imperative morpheme:

(12)

	posel	'envoy'	posl + a (gen.)	posyl + aj ⁷ (DI imp.)	
UR	posil + ĩ		posil + a	posil + aj	
	—		—	posil + aj	DI Tensing (11)
	posel + ĩ		—	—	Lower (9)
post-cyclic	posel		posl + a	—	Yer Deletion (10)

In Rubach (1984) it is argued that Lower is a cyclic rule. Six arguments are given to substantiate this assumption. Of these we shall briefly

summarise four here and the fifth will be dealt with at length in section 4.

- (i) The cyclicity of Lower follows from its ordering among cyclic rules. In particular, it precedes the rule of Labio-velar *j*-insertion, which is cyclic (a classic example of a derived environment rule, cf. Rubach 1984). Lower must therefore be cyclic: cyclic rules as a block precede all postcyclic rules.
- (ii) In diachronic terms Lower has undergone a change in the direction of application. It used to apply from right to left (the so-called Havlik's Law), whereas it must now be interpreted as applying from left to right (see section 4). The change of directionality receives a natural explanation if we assume that in the course of history Lower has become a cyclic rule: it applies from the root (the innermost constituent) to the outer constituents as dictated by Word Formation Rules (WFRs), which add suffixes.
- (iii) The assumption that Lower is cyclic leads to a more constrained and hence a more explanatory theory of Polish phonology. In order to see what we have in mind here, let us assume for the moment that Lower is not a cyclic rule. Now, given words such as *test* 'test', *też* 'also', etc., we are free to derive them from *//tĩtĩ//* and *//tĩżĩ//* via Lower (9) and Yer Del. (10). These highly abstract representations seem to be motivated by a need to explain why in surface terms *test* and *też* are exceptions to Cor. Pal. (3): we have [te] rather than [tce]. The explanation then is that Cor. Pal. is ordered before Lower and at the stage when it applies *//t//* is followed by a back yer: the palatalisation is blocked. It is only later that *//ĩ//* is turned to */e/* by Lower:

(13) <i>test</i>	<i>//tĩtĩ//</i>	
	—	Cor. Pal. (3)
	<i>testĩ</i>	Lower (9)
	<i>test</i>	Yer Deletion (10)

Observe that the derivation in (13) is possible only on the assumption that Lower is not a cyclic rule, since both the input yer and the environment yer are in the same morpheme (they would have been in the domain of a single cycle in a cyclic analysis). If Lower is cyclic, (13) is incorrect. The underlying representation of *test* must be the same as its surface representation: *//test//*, since the [e] cannot be derived by cyclic Lower. We are forced then to look for another explanation of why Cor. Pal. does not apply to *//test//*. As mentioned in § 2.1, the true generalisation is that Cor. Pal. is cyclic and hence does not affect morpheme-internal structures. Incidentally, let us observe that the strategy of deriving non-palatalising morpheme-internal [e] from *//ĩ//* would not fare well anyway.⁸ In polysyllabic words such as *temat* 'subject' the [e] could not come from *//ĩ//* since the vowel of the second syllable is *//a//* and not a yer, hence Lower would be inapplicable.

- (iv) The cyclicity of Lower accounts for what would be unexplained

exceptions in a non-cyclic theory. The relevant example here is the nominal morpheme *-stw-*, whose underlying representation is unquestionably $//\text{ist}\check{\text{v}}//$ (cf. Gussmann 1980). The first yer of $//\text{ist}\check{\text{v}}//$ is motivated by, for example:

- the palatalisation of consonants occurring before *-stw-*: $//\text{n}/ \rightarrow / \text{n} /$ in *pań* 'sir' - *pań + stw + o* 'Mr and Mrs'. This palatalisation follows from rule (3) if we assume that *-stw-* starts with a front yer $//\text{i}/$.
- the rule of *j*-deletion ($\text{j} \rightarrow \emptyset$ before consonants) is inapplicable before *-stw-*, e.g. *zabój + stw + o* $//\text{zabuj} + \text{ist}\check{\text{v}} + \text{o} //$ 'murder'. This is readily explained by ordering *j*-del. before Yer Del. and assuming that *-stw-* has an initial yer at the underlying level. The deletion of $//\text{j}/$ is then blocked by the yer which stands between $//\text{j}/$ and the $//\text{s}/$ of *-stw-* at the stage when *j*-del. applies:

$$\begin{array}{rcl} (14) & //\text{zabuj} + \text{ist}\check{\text{v}} + \text{o} // & \\ & \text{—} & j\text{-deletion (see above)} \\ & \text{zabuj} + \text{stv} + \text{o} & \text{Yer Deletion (10)} \end{array}$$

The second yer of $//\text{ist}\check{\text{v}}//$ has a direct motivation from alternation: compare *-stw-* vs. *-stew-* in *pań + stw + o* 'state' - *pań + stew + k + o* $//\text{pan} + \text{ist}\check{\text{v}} + \text{ik} + \text{o} //$ (dimin.).⁹ The suffix $//\text{ist}\check{\text{v}}//$ is peculiar in that the first yer never lowers to $/\text{e}/$ in spite of the fact that it is always followed by a yer, the second yer in this morpheme. If Lower is not a cyclic rule, then this is an unexplained exception. With cyclic Lower things are different: the first yer can never surface as $[\text{e}]$ since it is in the same morpheme (cycle) as the second yer: the environment is not derived.

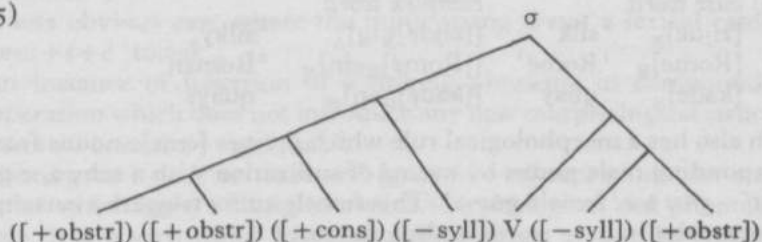
Thus, Lower (9) is a cyclic rule. On the other hand, Yer Del. (10) must be postcyclic since otherwise it could never apply: it is a context-free rule.

2.3 Syllabification

The details of Polish syllabification need not concern us here (but cf. Rubach in preparation). For the purposes of this paper it is sufficient to give the following two principles:

- (i) Polish syllabification complies with the universal open syllable principle.
- (ii) The basic syllable template has the structure in (15) below:

(15)



Thus words such as *wod + a* 'water' and *sejm + ik* 'parliament' (dimin.) are syllabified as follows: *wo-da* (principle i) and *sej-mik* (principle ii).

2.4 Stress

Polish has penultimate primary stress with initial secondary stress and an alternating weak stress pattern between the initial and the primary stresses:

$\overset{2}{CV} \overset{2}{CV} \overset{2}{CV} \overset{1}{CV} \overset{1}{CV}$. The basic principles of metrical tree construction are given in (16) below:

- (16) a. construct a binary foot at the right edge of a phonological word;
- b. construct maximally binary feet from left to right;
- c. at the foot level the labelling of the syllables is *s(trong) – w(eak)*;
- d. above the foot level, i.e. in phonological words, compounds and phrases, label branching constituents *w-s*.

We might also add that there is a defooting rule which de-stresses a syllable if it stands immediately before a stressed syllable in phonological words, compounds and phrases: hence words such as *serwet + a* 'napkin' do not have initial secondary stress. The details of Polish stress are discussed in Rubach & Booij (in preparation).

3 Evidence for Lexical Phonology

In this section we will provide some evidence from Dutch and Polish in favour of the basic tenet of Lexical Phonology: 'morphology and phonology go hand in hand'.

3.1 Rule ordering in Dutch

Our first illustration comes from Dutch. This language has a rule of Pre-vocalic Schwa-deletion that applies within (phonological) words:

- (17) $\text{ə} \rightarrow \emptyset / \text{ — V}$

The following examples illustrate the effect of this rule (the word-final <e> stands for schwa):

- | | | | |
|-----------------------|--------|--|---------|
| (18) <i>base word</i> | | <i>complex word</i> | |
| [zijde] _N | 'silk' | [[zijde] _N ig] _A | 'silky' |
| [Rome] _N | 'Rome' | [[Romē] _N ein] _N | 'Roman' |
| [kade] _N | 'quay' | [[kadē] _N en] _N | 'quays' |

Dutch also has a morphological rule which derives female nouns from the corresponding male nouns by means of suffixation with a schwa, e.g. *gast* 'guest' – *gast + e* 'female guest'. This female suffix triggers a certain kind of allomorphy in base words ending in *-eur*:

- (19) direct + eur 'director' direct + ric + e [dirɛktrisa] 'female
director'
inspect + eur 'inspector' inspect + ric + e [inspektrisa] 'female
inspector'

Therefore, we assume an allomorphy rule in the sense of Aronoff (1976) that changes the morpheme *-eur* into *-ric* before the female suffix *-e*, after dental obstruents.

Let us now have a closer look at the interaction of the rule of Pre-vocalic Schwa-deletion and this allomorphy rule in the derivation of the complex word *ambasadrice* 'female ambassador' with the underlying morphological structure [[[ambassade]_Neur]_Ne]_N. In the model of Lexical Phonology the derivation of the phonetic form of *ambasadrice* will be as follows:

- (20) 1. morphology: *-eur*-suffixation ambasadə + ø:r
phonology: schwa-deletion (17) ambasad + ø:r
2. morphology: schwa-suffixation ambasad + ø:r + ə
phonology: allomorphy rule ambasad + ris + ə

Thus the theory of Lexical Phonology correctly predicts a rather unexpected order in the application of rules: a purely phonological rule (the rule of Pre-vocalic Schwa-deletion) applies before an allomorphy rule. Note that this is exactly the required ordering, since the allomorphy rule removes the environment that triggers Schwa-deletion. The same reasoning applies even if one prefers to consider *-rice* as a single suffix that replaces the suffix *-eur*. In such an analysis a phonological rule has to precede a morphological rule, since the substitution of *-eur* by *-rice* will remove the proper environment for the application of Pre-vocalic Schwa-deletion.¹⁰

3.2 Morphological domains in Polish

Kiparsky (1982a: 146) makes a cautious suggestion that strings bounded by cyclic brackets need not be independent words or stems. He thus counters a proposal made by Brame (1974). Kiparsky's further suggestion is that domains in which cyclic rules apply should be delimited by the lexical categories N, A, V. The analysis of Polish basically supports this claim. However, some caution is necessary.

Below we consider three types of case:

- (i) a straightforward example of denominal verbalisation: *groz + i + ć* 'to threaten';
- (ii) a less obvious case where the input string is not a lexical category: *pros + i + ć* 'to ask';
- (iii) an instance of insertion of a linking phoneme in compounds, an operation which does not introduce any new morphological structure: *pas + i + brzuch + y* 'gluttons'.

The word *groz + i + ć* 'to threaten' [groz + i + tɕ] represents the class of examples which have a straightforward morphological and phonological analysis. It is a verb which has been derived from a noun by adding the

verbalising suffix //i// (*ć* //tɛ// is the infinitive morpheme). The input string is *groz* 'terror' (compare *groz* + *a* where *-a* is the ending of the nom. sg.):

- (21)
- | | | |
|----------|--|--------------------|
| | [groz] _N | |
| | no rule applies | |
| cycle 2: | [[groz] _N i] _V | WFR: Verbalisation |
| | z | Cor. Pal. (3) |
| cycle 3: | [[[groz] _N i] _V tɛ] _V | WFR: infinitive |
| | no rule applies | |

Words such as *pros* + *i* + *ć* 'to ask' exemplify the class of cases mentioned cautiously by Kiparsky (1982a: 146): word formation has as its input a root which is not a member of any lexical category.

The morphological structure of *pros* + *i* 'ask' (we ignore the infinitive ending *-ć*) is best analysed by comparing this word with the noun *proś* + *b* + *a* 'request'. The *-a* of the noun is the fem. nom. sg. ending, and hence, like all inflectional morphemes, it plays no role in word-formation: it cannot form part of a stem which functions as a base for further word-formation. The nominalising suffix in the word for 'request' is *b*. At the underlying level *b* is represented as //ib//. The front yer of this suffix is responsible for the palatalisation of e.g. //z// to [z] in *groź* + *b* + *a* 'threat': //groz + ib + a// → /groz + ib + a/ by Cor. Pal. (3) → [groz + b + a] by Yer Del. (10). The yer of *b* //ib// surfaces as [e] via Lower (9) if //ib// is followed by a suffix which contains a yer: compare *wróź* (+ *y* + *ć*) 'to tell fortunes' (the morphemes in parentheses are not relevant from the point of view of word-formation) – *wróź* + *b* (+ *a*) 'fortune telling' – *wróź* + *eb* + *n* (+ *y*) 'prophetic', where *n* is //in// (cf. Gussmann 1980; Rubach 1984).

In sum, the comparison of *pros* + *i* 'ask' and *proś* + *b* + *a* 'request' leads to the isolation of the morpheme *pros*. This morpheme is an example of a root which cannot be specified for any lexical category. Yet it functions as a base for the processes of word-formation: the verbalisation in *pros* + *i* 'ask' and the nominalisation in *proś* + *b* + *a* 'request'. The derivation of *pros* + *i* 'ask' is as follows:

- (22) Root: *pros*
 no rule applies
- | | | |
|----------|------------------------|--------------------|
| cycle 2: | [[pros]i] _V | WFR: Verbalisation |
| | ɛ | Cor. Pal. (3) |

Derivations such as the one given in (22) are not at all uncommon in Polish.

Let us now turn to compounding. This is an area of fairly regular and very productive morphology. Compounds are endocentric in Polish, and the rightmost constituent is the head of the compound. Here we are interested in the compound linking rule which inserts the linking phoneme //i// or //o// depending on the category of the constituent on the left. We state this informally as (23):

(23) *Linking*

In a compound insert //i// if the constituent on the left is a verb, otherwise insert //o//.

Consider now the compound *pas+i+brzuch* 'glutton' (literally 'feed-belly'), or rather its nom. pl. form *pas+i+brzuch+y*. It is made up of two lexical constituents: the verb *pas* 'feed' and the noun *brzuch* //bžux// 'belly'. The derivation of *pas+i+brzuch+y* 'gluttons' proceeds as follows:

(24)	[pas] _V [bžux] _N	
	no rule applies	
cycle 2:	[[pas] _V [bžux] _N] _N	WFR: Compounding
	no rule applies	
cycle 3:	[[pas] _{Vi} [bžux] _N] _N	WFR: Linking (23)
	ε	Cor. Pal. (3)
cycle 4:	[[[paε] _{Vi} [bžux] _N] _N] _N	WFR: nom. pl.
	no rule applies	

The point of theoretical interest here is that the linking phoneme //i// does not introduce any new morphological information, i.e. it does not create a noun, a verb, etc. or some new grammatical shape of a lexical category. Yet it creates a domain for the application of cyclic phonological rules, here Cor. Pal. (3), which turns //s// into [ε].

In general our analysis lends support to the claim made by Lexical Phonology that WFRs create domains for the application of cyclic phonological rules. However, it seems entirely irrelevant whether the particular form which is derived by a given word-formation rule is a lexical category or not. In Polish, from what we have seen so far, phonological cycles coincide with the division of words into morphemes, i.e. there are as many cycles as there are morphological boundaries. This conclusion runs contrary to the results of the analysis of Spanish by Harris (ms). In Spanish, morphologically complex strings (two morphemes) may form a single cyclic domain if they function together as a lexical category. The evidence from Polish shows that such situations are language-specific and cannot be generalised.

4 Paradoxes and prosodic domains

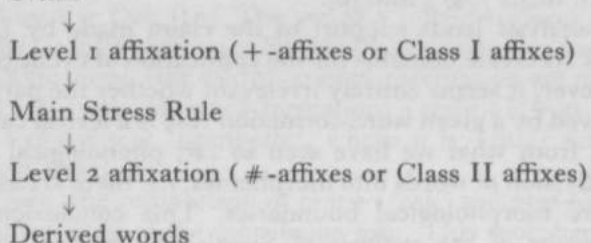
In this section we argue that there are certain cases of application of phonological rules for which the theory of Lexical Phonology seems to make wrong predictions. In other words, there are cases in which phonological domains are not isomorphic to morphological domains. We will discuss examples from English and Polish, and show how these paradoxes are solved by the theory of prosodic phonology.

4.1 Paradoxes in English

A well-known example of the type of paradox we are discussing here, i.e. the asymmetry between phonological and morphological structure, is the English word *ungrammaticality*, which has been extensively discussed in recent morphological literature.¹¹ From the morphological point of view the structure of this word is $[[[un[grammatical]]_A]_A]_{ity}]_N$, and not $[un-[[grammatical]_A]_{ity}]_N$. Why is this so? First, *un-* does not attach to nouns, but only to adjectives. Second, the semantics of this word also indicates that the first structure is the correct one, because *ungrammaticality* means 'the property of being ungrammatical'. If we assume the Fregean principle of compositionality for the interpretation of complex words, it is only the first structure that is correct.

The theoretical problems that the word *ungrammaticality* gives rise to are both phonological and morphological, and these are intertwined. In a well-known approach to English morphology, Siegel (1974) proposed two levels of affixation for affixes: affixes of level 1 can change the stress patterns of their bases, whereas affixes of level 2 are stress-neutral. The level 1 affixes are associated with a + -boundary, and the level 2 affixes with a # -boundary, which – by convention – blocks the application of the English Main Stress Rule. That is, Siegel assumes the following model:

(25) Stems



The model also predicts that level 2 affixes are always peripheral to level 1 affixes.

The word *ungrammaticality* now poses a problem, because *un-* is a stress-neutral, i.e. level 2 affix, whereas *-ity* is a stress shifting, level 1 affix, and yet *-ity* must have been added after *un-*. So the morphological problem here is the order of affixation. The phonological problem is that *-ity* shifts the main stress of its base although this base contains an internal word boundary (# of *un* #) which blocks the application of the Main Stress Rule.

It has been pointed out in the literature (Booij 1977: 146; Strauss 1979) that Siegel actually uses two mechanisms in order to account for the differential stress behaviour of the two classes of affixes: a distinction between + and #, and level ordering. Strauss (1979) and Kiparsky (1982a) therefore proposed level ordering as the only mechanism. This, of course, does not solve the problem of how to derive *ungrammaticality*.

Ungrammaticality is not the only word that poses this problem. Selkirk (1982: 101), for instance, also mentions the following cases:

- | | |
|------------------|-------------------|
| (26) un-real-ity | un-popular-ity |
| un-learnabil-ity | un-analysabil-ity |
| un-desirabil-ity | un-receptiv-ity |
| un-convivial-ity | un-productiv-ity |

And Kiparsky (1982b) mentions other cases where a level 2 morpheme is added before a level 1 morpheme, for instance:

- (27) underestimation, renegotiable, polysyllabicity, extrametricality, bilaterality, vice-consulate, self-consistency

Several proposals have been made to solve this problem. In Selkirk's morphological theory (Selkirk 1982) *un-* and similar affixes are considered to be both Class I and Class II affixes, although normally an affix belongs to only one class.¹² In Kiparsky (1982b) it is proposed that *ungrammaticality* is derived as follows. The noun $[[[\text{grammatical}]_A \text{ity}]_N]$ is formed at level 1. At level 2 *un-* is prefixed. Synchronic reanalysis of the resulting structure $[\text{un}[[[\text{grammatical}]_A \text{ity}]_N]]_N$ as $[[[\text{un}[\text{grammatical}]_A] \text{ity}]_N]$ is then permitted since, according to Kiparsky, 'the requirement that *-ity* be attached to an adjective is still satisfied, and *forced* by the requirement that *un-* must be attached to an adjective'.

Neither Selkirk's nor Kiparsky's account is very satisfactory. Selkirk's solution is ad hoc in that it assigns certain affixes to two classes whereas others belong to only one class. Kiparsky's solution is ad hoc too. First, it has to assume *synchronic* reanalysis. Second, this reanalysis may only apply in a very restricted class of words. Third, note that not only the hierarchical structuring but also the node labelling has to be changed. Finally, this analysis has to admit *un-*prefixation to nouns, although normally *un-* requires adjectival bases.

Our solution to the problem of how to account for the phonological properties of *ungrammaticality* and similar words, in particular their stress patterns, is based on the idea that there may be a certain asymmetry between the morphological and prosodic structure of words. We assume that *ungrammaticality* and similar words consist of more than one phonological word ('m' for *mot*),¹³ as illustrated in (28):

- (28) $(\text{un})_m(\text{grammaticality})_m$
 $(\text{under})_m(\text{estimation})_m$
 $(\text{extra})_m(\text{metrality})_m$

As argued in Booij (1983, forthcoming a, c), we have to distinguish between COHERING and NON-COHERING affixes. Cohering affixes fuse with the preceding or following phonological word into one new phonological word. An example is the suffix *-ity*. As is well known, the domain of syllabification is the phonological word. In Selkirk's hierarchy of prosodic constituents this follows from the fact that the phonological word node dominates syllable nodes, i.e. two tautosyllabic segments cannot belong to two different phonological words. Note that in, for example, *grammaticality* the boundary before *-ity* does not coincide with a syllable boundary; instead,

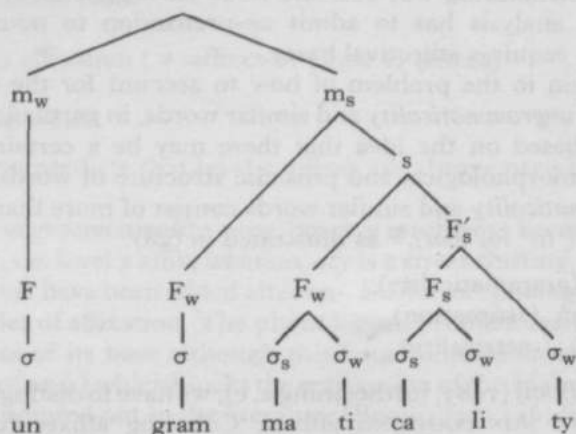
the final *l* of *grammatical* is the onset of the syllable with the *i* of *-ity* as its nucleus. On the other hand, *un-* is a non-cohering prefix. This is clear from the fact that here the morphological boundary after *un-* always coincides with a syllable boundary, at least in careful speech, while we would expect a different syllabification pattern if *un-* were a cohering prefix; compare:

- (29) *un*áble $(\Delta n)_\sigma(ej)_\sigma(b)_\sigma$
 *un*áltered $(\Delta n)_\sigma(\text{ɔ:l})_\sigma(təd)_\sigma$
 *un*érring $(\Delta n)_\sigma(\text{ɜ:})_\sigma(rɪŋ)_\sigma$

The non-cohering nature of *un-* explains why the examples in (29) seem to violate the Maximal Onset Principle. It is also confirmed by the fact that the rule of Nasal Assimilation that applies obligatorily within phonological words does not apply obligatorily to the final *n* of *un-* in *ungrammatical*. The *n* behaves here like the final *n* in the first part of compounds such as *rain glass*, *rain gauge*, *tin kettle*, etc. (optional assimilation), whereas we can get only a velar nasal in words such as *Ringo* and *tinker*.

As far as the stress pattern of *ungrammaticality* is concerned, the crucial point is that the English Main Stress Rule specifies prominence relations between syllables in phonological words (cf. Selkirk 1980a; Hayes 1982). Thus the relevant domains for stress assignment in *ungrammaticality* are *un* and *grammaticality*. This explains why the presence of the stress-neutral prefix *un-* does not affect the stress-shifting potential of the suffix *-ity* (*grammátical* – *grammaticá*lity). The prosodic representation of *ungrammaticality* will be as follows:

(30)



The same analysis can be applied to words such as *underestimation*, *extrametricality*, etc. (cf. 27), since *under-*, *extra-*, etc. can also be assumed to form independent phonological words. The only statement we have to make with respect to prefixal phonological words is that they are weak, whereas in simple compounds the first of the two phonological words is strong.¹⁴

In Pesetsky (1979) we find a second paradox in which *un-* is involved. Pesetsky notes that adjectives with *un-* behave as if *un-* were not there with respect to Comparative Formation. The suffix *-er* only attaches to monosyllabic adjectives and to some disyllabic adjectives with light final syllables, but not to adjectives with three or more syllables:

(31) red–redder, happy–happier, excellent–*excellenter

However, *unhappy* admits the comparative form *unhappier*, although it contains three syllables. Thus Pesetsky notes a conflict here between phonology and morphology: from the morphological point of view, the structure is $[[un[happy]_A]_A]_A$, but from the phonological point of view it should be $un[[happy]_A er]_A$. This paradox can again be solved in the approach that we are advocating here, i.e. an approach in which asymmetries between morphological and phonological structure are admitted. The prosodic structure of *unhappy* will be $(un)_m(happy)_m$. Note that the condition on *-er*-suffixation is a prosodic condition since it counts syllables, and thus refers to the prosodic structure of the base words. Furthermore, *-er* becomes part of the final phonological word of its base; from the syllabification of words like *redder* and *dearer* it is clear that *-er* is a cohering suffix. It seems natural then to assume that prosodic conditions on affixation refer to the prosodic constituent in which the affix is integrated. Consequently, in the case of *unhappy* the syllable *un-* is not seen by the prosodic condition, and therefore the comparative suffix *-er* can be attached to *unhappy*. Thus, Comparative Formation provides independent evidence for the non-cohering nature of the prefix *un-*.¹⁵

4.2 Paradoxes in Polish

We now return to Polish, in particular the rule of Lower. Again, as we shall see, a conflict arises between the requirements of a correct phonological derivation and an adequate morphological analysis, a conflict that is solved by assigning a proper prosodic structure to complex words. It is claimed that Lower applies in two prosodic domains, *m(ot)* and *mot prime (m')*.

4.2.1 Phonological derivation. In §2.2 we gave four arguments to substantiate the claim that Lower should be regarded as a cyclic rule. Now we present the fifth argument. This is not to say that the four arguments in §2.2 are insufficient evidence. The point is different. We want to see how Lower applies to complex structures which involve prefixes. We look at two closely related words: *roze + jm + u* 'truce, gen.'¹⁶ and *roz + jem + c + a* 'truce maker' (nom. sg. of the feminine paradigm). The phonological structure of the morphemes which these words consist of is as follows:

- (i) Both the prefix and the root morpheme have a yer at the underlying level: $//rozi//$ and $//jĩm//$. The motivation for the yers is straightforward: we have $[e]$ -zero alternation in *roze + jm + u* 'truce, gen.' – *roz + jem + c + a* 'truce maker'.

- (ii) In *roz+jem+c+a* 'truce maker' we also have a yer in the agentive suffix *-c-* //its//. Compare the [e]-zero alternation in the same morpheme in *most+ow+iec* 'bridge builder' - *most+ow+c+a* (gen.), both derived morphologically from *most+ow+y* 'bridge' (adj.: -y is an inflectional ending) and further from *most* 'bridge'.
- (iii) -u and -a are inflectional endings of the gen. sg. and the nom. sg. respectively.

We will now try to discover the algorithm for the application of Lower. We assume that Lower is not a cyclic rule. Suppose we apply Lower from left to right:

(32)	rozĩ+jĩm+u	rozĩ+jĩm+ĩts+a	
	e	e e	Lower (9)
	ϕ	ϕ	Yer Deletion (10)
	roze+jm+u	*roze+jem+ts+a	

We end up with the incorrect form **roze+jem+c+a* instead of the correct *roz+jem+c+a* 'truce maker'.

Let us therefore apply Lower in the opposite direction, from right to left:

(33)	rozĩ+jĩm+u	rozĩ+jĩm+ĩts+a	
	e	e e	Lower (9)
	ϕ	ϕ	Yer Deletion (10)
	roze+jm+u	*roze+jem+ts+a	

The result is the same. Suppose, however, we apply the rule from right to left in an iterative fashion to successive portions of the word. This in effect means that we apply the rule cyclically. We look only at those cycles which are relevant to the application of Lower:

(34)	rozĩ+jĩm+u	rozĩ+jĩm+ĩts+a	
input:	rozĩ+jĩm+u	jĩm+ĩts+a	
	e	e	Lower (9)
	ϕ	ϕ ϕ	Yer Deletion (10)
	roze+jm+u	roz+jem+ts+a	

The result is correct. Yet our algorithm does not work with other examples.

Consider the word *po+krew+ień+stw+o* 'relatedness'. It is derived from underlying //po+krĩv+ĩn+ĩstĩv+o//. The yers of the root morpheme *krew* //krĩv// and the adjectivising suffix *n* //ĩn// are motivated by the [e]-zero alternation in *krew* 'blood' - *krw+i* (gen.) and *po+krew+n+y* /n/ 'related' - *po+krew+ień+stw+o* /en/ 'relatedness'. The yer of //ĩn//, the third morpheme in *po+krew+ień+stw+o* 'relatedness', surfaces as [e] via Lower in the context of the yer in the nominalising suffix

-*stw*- //ištiv//, whose structure was discussed in §2.2 (iv). Now let us try to use the algorithm employed in (34) for the derivation of *po + krew + ien + stw + o* 'relatedness':

- (35)
$$\begin{array}{lcl} \text{po} + \text{kriv} + \text{in} + \text{ištiv} + \text{o} & & \\ \text{input:} & \text{ištiv} + \text{o} & \\ & *e & \text{Lower (9)} \end{array}$$

We interrupt the derivation since it is clear that the output will be incorrect: -*stw*- should not surface as -*estw*-. Suppose the first yer of //ištiv// is marked as an exception to Lower. Even with this assumption the derivation is incorrect:

- (36)
$$\begin{array}{lcl} \text{po} + \text{kriv} + \text{in} + \text{ištiv} + \text{o} & & \\ \text{input:} & \text{in} + \text{ištiv} + \text{o} & \\ & e & \text{Lower (9)} \\ \hline \text{input:} & \text{po} + \text{kriv} + \text{en} + \text{ištiv} + \text{o} & \\ & \phi & \text{Lower (9)} \\ & \phi & \text{Yer Deletion (10)} \\ & \phi & \\ \hline & *po + \text{krv} + \text{en} + \text{stv} + \text{o} & \end{array}$$

The applicational paradox exhibited by this derivation can be resolved by making two assumptions:

- (i) Lower is a cyclic rule;
- (ii) prefixes are processed phonologically as the last cycle of the derivation.

Assumption (ii) requires that there be a bracketing convention which assigns cyclic brackets starting from the root, first to all suffixes and only then to prefixes. The derivations are now correct:

- (37)
$$\begin{array}{lcl} \text{roze} + \text{jim} + \text{u} \text{ 'truce'} & \text{roz} + \text{jem} + \text{c} + \text{a} \text{ 'truce maker'} & \\ [\text{roz}\tilde{\text{i}}[[\text{jim}]\text{u}]] & [\text{roz}\tilde{\text{i}}[[[\text{jim}]\text{its}]\text{a}]] & \\ \text{cycle 2} & \text{jim} + \text{u} & \text{jim} + \text{its} \\ & \text{jem} + \text{its} & \text{Lower (9)} \\ \hline \text{cycle 3} & \text{roz}\tilde{\text{i}} + \text{jim} + \text{u} & \text{jem} + \text{its} + \text{a} \\ & \text{roze} + \text{jim} + \text{u} & \text{Lower (9)} \\ \hline \text{cycle 4} & \text{roz}\tilde{\text{i}} + \text{jem} + \text{its} + \text{a} & \\ & \text{Lower (9)} & \\ \hline \text{postcyclic} & \text{roze} + \text{jim} + \text{u} & \text{roz} + \text{jem} + \text{ts} + \text{a} \\ & & \text{Yer Deletion (10)} \end{array}$$

Compare also the derivation of *po + krev + ień + stv + o* 'relatedness':

(38)	[po[[[[krĭv]in]istĭv]o]]	
cycle 2	krĭv + ĭn krev + ĭn	Lower (9)
cycle 3	krev + ĭn + istĭv krev + en + istĭv	Lower (9)
cycle 4	krev + en + istĭv + o —	Lower (9)
cycle 5	po + krev + en + istĭv + o —	Lower (9)
postcyclic	po + krev + en + stv + o	Yer Deletion (10)

The principle that prefixes must come on the last cycle is also supported by inflectional morphology. Consider the masculine and the feminine form of the 3rd pers. sg. past tense: *roz + sech + l* 'he dried' and *roze + sch + l + a* 'she dried'. The prefix here is the same as in the word for 'truce': *//rozĭ//*. The root has a yer *//sĭx//*: compare the [e]-zero alternation in the masculine and feminine forms above and the Derived Imperfective *wy + sych + aj* [sĭx] 'dry' (imper.). The past tense morpheme is *//l//*. It is followed by gender suffixes: the back yer *//ĭ//* in the masculine form (for motivation see Gussmann 1980: 93 and Rubach 1984) and *//a//* in the feminine form. The derivations are as follows:

(39)	roz + sech + l (masc.)	roze + sch + l + a (fem.)	
	[rozĭ[[[sĭx]l]ĭ]]	[rozĭ[[[sĭx]l]a]]	
cycle 2	sĭx + l —	sĭx + l —	Lower (9)
cycle 3	sĭx + l + ĭ sex + l + ĭ	sĭx + l + a —	Lower (9)
cycle 4	rozĭ + sex + l + ĭ —	rozĭ + sĭx + l + a roze + sĭx + l + a	Lower (9)
postcyclic	roz + sex + l	roze + sx + l + a	Yer Deletion (10)

It is clear from (39) that the gender suffixes must find themselves on an earlier cycle than the prefixes. Had this not been the case, the masculine form would have been **roze + sech + l*.

4.2.2 *Morphological derivation.* There is no question that prefixes cannot be on the last cycle from the morphological point of view. The generalisation is that prefixed stems may, while inflected forms may not, function as bases for further word-formation.

There is an abundance of examples of prefixed stems which are inputs to WFRs. The word *wy+klad+ow+c+a* 'lecturer' is one such case. Its morphological structure is established by looking at the data in (40):

- (40) *klad* 'put', e.g. *klad+a* 'they put'
wy+klad+aj 'put out' or 'lecture', e.g. *wy+klad+aj+a* 'they lecture'
wy+klad 'lecture' (n., by back-formation)
wy+klad+ow 'lecture' (adj.), e.g. *wy+klad+ow+y* (masc. nom. sg.)
wy+klad+ow+c 'lecturer', e.g. *wy+klad+ow+c+a* (nom. sg.)

The output of the successive steps of word-formation is given in (41), where numbers refer to cycles:

- (41) [[[[*wy[klad]*]₁]₂*ow*]₃]₄*a*]₅

In fact *roz+jem+c+a* 'truce maker', our main example in this section, is also an instructive case. It is an inflected agentive noun from the word *roze+jm* 'truce'. The order of morphological operations is the following:

- (42) [[[*roz[ijim]*]₁]₂*its*]₃*a*]₄

We now face a problem. It is claimed in Lexical Phonology that cyclic rules apply after every single word-forming operation, i.e. phonological cycles are determined by WFRs. The cyclic structure of *roz+jem+c+a* 'truce maker' would thus have to be the one given in (42). However, this structure is unacceptable from the point of view of phonology: as shown in (37) the prefix //roz*i*// must come on the last and not on the second cycle of the derivation. We have a paradox then: the requirements of a correct phonological derivation are incompatible with the requirements of an adequate morphological analysis.

4.2.3 *A prosodic solution.* Let us take a closer look at the behaviour of Polish prefixes. They are peculiar in two ways:

- (i) All phonological rules, no matter whether cyclic or postcyclic, are blocked by prefix junctures. The only exceptions to this generalisation are the rules of Surface Palatalisation ($C \rightarrow C'$ before /i j/), Devoicing before voiceless obstruents,¹⁷ and Lower. The former two are post-lexical and apply both word-internally and across word boundaries.
- (ii) Syllabification is blocked by prefix junctures.

To substantiate the generalisation in (i), we will look briefly at three examples: one cyclic rule and two postcyclic rules.

Polish has a well-known rule of Vowel Deletion (cf. Jakobson 1948):

$V \rightarrow \phi / -V$ in verbs. As a cyclic rule it operates at morpheme junctures (cf. Rubach 1984). However, it systematically fails to apply at prefix junctures: *wy* + *obrazić* 'imagine', *prze* + *analizować* 'reanalyse', etc.

A postcyclic assimilation rule inserts glides to break up a vowel hiatus (cf. Rubach 1982): /j/ is inserted if the structure is /Vi/, where V is any vowel, and /w/ breaks up the cluster /Vu/, e.g. *Kore* + *i* [-e + ji] 'Korea' (gen.), *muze* + *um* [-e + wum] 'museum'. Glide insertion does not apply if the environment is divided by a prefix juncture: *po* + *informować* 'inform', *za* + *uważać* 'notice'.

Third, a postcyclic assimilation rule turns, inter alia, /s/ to [ɕ] before the prepalatal nasal /ɲ/, e.g. *radosn* + *y* 'joyful' (masc. nom. sg.) - *radośn* + *i* [-ɕɲ + i] (nom. pl.). The rule never applies if the fricative is part of a prefix: *z* + *niszczyć* 'destroy': [z + ɲi-] and not [z + ɲi-].

The generalisation in (ii) that syllabification is blocked by prefix junctures is best illustrated by inspecting the operation of the open syllable principle (see §2.3 above). This principle works in an exceptionless manner without regard to morphological structure. Thus *brod* + *a* 'beard' and *podest* 'landing' are syllabified in the same way in spite of the fact that in the former there is a morpheme boundary between the //d// and the vowel while in the latter there is none: /bro-da/, /po-dest/. At prefix junctures, however, the open syllable principle does not apply; compare *przed* + *operac* + *yj* + *n* + *y* 'pre-operational' /pʃed-o-pe-ra-tsij-ni/, *nad* + *uż* + *y* + *ć* 'abuse' /nad-u-życ/, etc.

The peculiar behaviour of prefixes with respect to phonological rules and to syllabification can readily be accounted for by assuming that prefixes are phonological words. Both the syllabification and the phonological rules which we discussed above operate in the domain of a single phonological word, hence structures which involve prefix junctures, i.e. junctures between phonological words, are left intact. The question now is how to interpret prosodically prefixed words. We suggest that they be treated as phonological compounds (*m'*, that is, *mot prime*). Lower must now be specified as a rule which applies in two domains, *mot* and *mot prime*.¹⁸

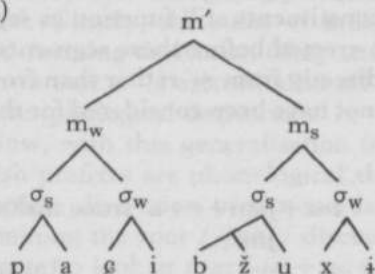
Observe that with this interpretation we arrive at a discrepancy between prosodic and morphological words. The word *roz* + *jem* + *c* + *a* 'truce maker' is one morphological but two phonological words (square brackets mark morphological structure, while parentheses refer to prosodic structure):

$$(43) ((([(roz\bar{i})_m]([j\bar{i}m])]\bar{i}ts)a])_m)_m'$$

As we saw above, the lack of a one-to-one correspondence between morphological and prosodic structure is not a particularly surprising fact. It is known to occur in a variety of situations (cf. Selkirk 1978, 1980a; Booij 1983, forthcoming a, c). In fact, morphological compounds in Polish are yet another example of such a case. Recall that in terms of morphological structure the linking phoneme //i// does not belong to any constituent and the *y* //i// is an ending of the whole compound in *pas* + *i* + *brzuch* + *y* 'gluttons' in (24) above. Prosodically, however, there is no doubt that the

//i// goes only with the first constituent, and the //i// only with the second. This is best shown by syllabification and stress:

(44)



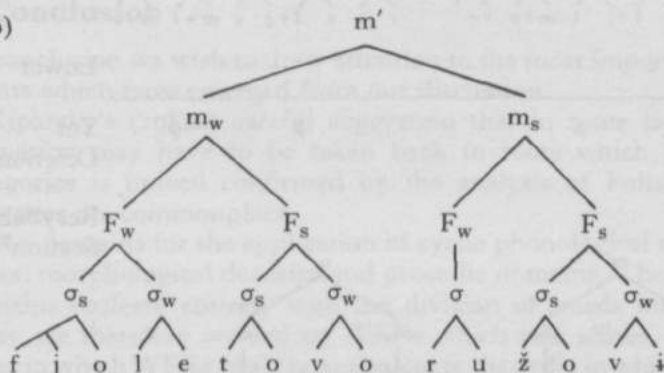
That is, //i// syllabifies with the second consonant of the first constituent and //i// with the final consonant of the second constituent. The stress pattern is *pasibrzuchy*, as predicted by the principles given in §2.4.

That the linking phoneme plays a significant role in the assignment of stress (prosodic tree) to the first constituent of a compound is shown better by examples of multisyllabic compounds.¹⁹ Consider *fiolet + ow + o + róž + ow + y* 'violet rosy' (nom. sg.). It has a complex morphological structure, since both the first and the second constituent are denominal adjectives derived by adding the adjectivising morpheme *-ow-* //ov// to the nouns *fiolet* //fjolet// 'the colour of violets' and *róž* //ruž// 'rouge'; *-o-* is the linking phoneme and *-y* //i// the nom. sg. ending:

(45) [[[[fjolet]_Nov]_Ao[[ruž]_Nov]_A]i]_{nom. sg.}

The syllabification ignores morphological structure: /fjo-le-to-vo-ru-žo-vi/. The stress patterns shows that //o// counts with the first constituent: /fjo³le²to¹vo-ru-žo-vi/. The tree diagram is given in (46) below:

(46)

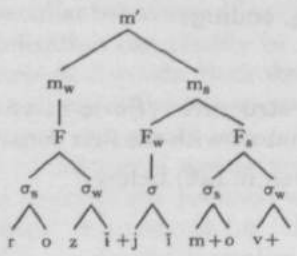
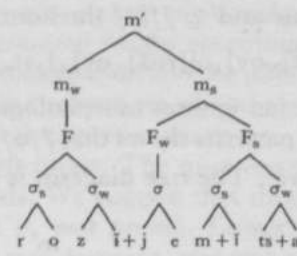


The foot structure on /ru/ is later erased by the defooting rule mentioned in §2.4.

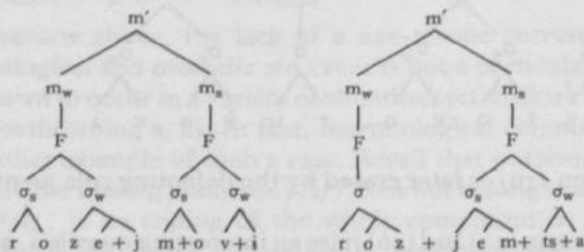
The examples given in (44) and (46) raise an interesting question: at what

point in the morphological derivation is m' erected? Another look at (44) and (46) prompts the answer. Notice that the linking phoneme and the inflectional ending must be integrated prosodically into the constituents on their left at the stage when these constituents still function as separate phonological words. Had the m' been erected before these segments were added, they would have had to hang directly from m' rather than from the respective m -nodes. Thus they could not have been considered for the tree

(47)	a.	roze + jm + ow + y (adj.)	b.	roz + jem + c + a 'truce maker'	
cycle 1		jīm		jīm	Lower (9)
cycle 2		(rozĩ) _m (jīm) _m		(rozĩ) _m (jīm) _m	WFR Lower
cycle 3		(rozĩ) _m (jīm + ov) _m		(rozĩ) _m (jīm + ĩts) _m jem + ĩts	WFR Lower
cycle 4		(rozĩ) _m (jīm + ov + ĩ) _m		(rozĩ) _m (jem + ĩts + a) _m	WFR Lower
					m' erection

					
	e		—		Lower
post-cyclic	ϕ		ϕ		Yer Deletion(10)

Resyllabi-
fication²¹



construction at the level of *m*. As we have already seen, these segments play a crucial role in the tree construction for each *mot*. Consequently, *m'* must be erected after the linking phoneme and the inflectional ending have been added. Clearly, the rules of inflectional morphology apply last in the word-forming derivation (they attach 'closing morphemes'). It therefore follows that *m'* is erected after all WFRs have applied, i.e. at the end of the morphological derivation.

Now, with this generalisation in mind and with the information that Polish prefixes are phonological words, we are in a position to present a complete derivation of the words which are morphological derivatives containing the root //jɨm// discussed at length earlier in this paper. We propose to look at *roze+jm+ow+y*, the adjective from *roze+jm* 'truce' (-*ow* is the adjectivising suffix and -*y* is the nom. sg. ending)²⁰ and at *roz+jem+c+a* 'truce maker'. To simplify matters we shall use pluses instead of cyclic bracketing and we omit the assignment of *mot*-internal prosodic structure until the relevant stage is reached in cycle 4 (see (47) opposite).

The derivation in (47) shows how the requirement of a correct morphological analysis and a correct phonological analysis are reconciled. From the point of view of WFRs, prefixes have the status of ordinary morphemes. With respect to phonological rules, they are words. Lower, which carries the specification that it operates in the domains of both *m* and *m'*, applies whenever its environment is met. However, it can process prefix plus stem structures only when these find themselves in a single domain. This happens at the end of the word-forming derivation, as it is only then that the *m'* is erected. As mentioned earlier, the decision as to when to erect *m'* is motivated independently by the analysis of the morphological compounds given in (44) and (46).

5 Conclusion

In conclusion we wish to draw attention to the most important theoretical points which have emerged from our discussion.

Kiparsky's (1982a) careful suggestion that in some languages word-formation may have to be taken back to roots which are not lexical categories is indeed confirmed by the analysis of Polish, where such instances are commonplace.

The domains for the application of cyclic phonological rules are of two types: morphological domains and prosodic domains. The morphological domains coalesce entirely with the division of words into morphemes. They are therefore created by WFRs which add affixes. Normally, the order in which WFRs apply is equivalent to the order in which phonological cycles need to be effected. In some instances, however, this equivalence does not hold: the addition of prefixes in Polish does not create a domain for the immediate application of cyclic phonological rules. The explanation here is that prefixes are separate phonological words, and hence prefix plus

stem structures become available to cyclic rules only when phonological words are put together to form a phonological compound, i.e. an *m'*. It is only then that cyclic rules which are permitted to apply to both phonological words and their projections can take effect (Lower in the case of Polish). In such instances cyclic domains are said to be prosodic, since they are created by prosodic and not by morphological operations: the erection of *m'* is not connected in any direct way with WFRs. The possibility of a discrepancy between the morphological and the prosodic domains arises as a consequence of the fact that the morphological hierarchy (morphemes, words, morphological compounds, etc.) may but need not overlap with the phonological hierarchy (syllables, feet, phonological words, compounds, etc.).

Similarly, the phonological and morphological behaviour of the English prefix *un-* demonstrates that an independent prosodic hierarchy is necessary. Consequently, the theory of prosodic phonology also functions as a well-motivated 'protective belt' for the theory of Lexical Phonology.

NOTES

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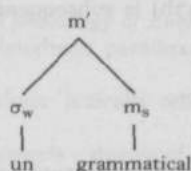
- [1] See Booij (forthcoming b) for critical remarks with respect to the theory of level ordering.
- [2] We use double slashes to denote underlying representations, single slashes for intermediate stages and square brackets for phonetic representations. The phonetic symbols used are:
 /ts/ - alveolar affricate
 /tʃ dz/ - prepalatal affricates
 /s z/ - prepalatal fricatives
 /ɲ/ - prepalatal nasal

Note that the application of syllable-final devoicing to *held* on the first cycle is not blocked by the Strict Cycle Condition, since the syllabification rules that apply on the first cycle created a derived environment (*held*) in which the rule could apply.

- [3] Before /i/ the consonants are palatalised allophonically by a postlexical rule of Surface Palatalisation which palatalises all consonants inside words and across word boundaries. Thus, phonetically, we have [tʃ] rather than [t]. This, however, is irrelevant. The point is that here, unlike in (4), //t// does not change to the prepalatal affricate [tʃ].
- [4] For example, it is ordered before Iotation and *j*-deletion (cf. Rubach 1984).
- [5] A generative interpretation of this problem was first discussed in an inspiring study by Gussmann (1980). In what follows in this section we draw heavily on Gussmann's insights. See also Rubach (1984), who gives a reanalysis of the same facts in the framework of cyclic phonology.
- [6] For the interpretation of the feature [$\pm$ tense], see Wood (1975). Very crudely, tense vowels are upper high and upper mid while lax (i.e. [-tense]) vowels are lower high and lower mid.
- [7] As a matter of fact, //aj// is still followed by //i//, the imperative morpheme. We ignore this fact here, but see Gussmann (1980).
- [8] Gussmann (1980: 42-43), who works in a non-cyclic *Sound pattern of English* (Chomsky & Halle 1968) type of framework, suggests that this strategy be used in case the vowel of the last syllable is a yer. He thus derives the first morpheme

of *desk* + *a* 'board' from //dɛsɪk//. The second yer is well motivated: compare *dese*k (gen. pl.; the yer surfaces as [e] before the gen. pl. yer). However, the first yer is there only in order to explain the lack of palatalisation: *[dze]. As we have pointed out, this is an incorrect explanation. The representation is //desɪk//, and Cor. Pal. (3) does not apply to //de// because it is a cyclic rule.

- [9] The diminutive suffix *-k* comes from //ɪk//; compare [ek] in *pań* + *stew* + *ek* 'state' (gen. pl.) – see Gussmann (1980).
- [10] See Booij (1981) for other examples of this kind of phonology-morphology interaction.
- [11] Cf. Aronoff (1976); Kiparsky (1982a, b); Selkirk (1982); Strauss (1982a, b); Williams (1981).
- [12] The distinction between Class I (or Root) and Class II (or Word) affixes is the correlate in Selkirk's rewriting grammar for complex words of the level 1–level 2 distinction in a level-ordered morphology.
- [13] Selkirk (1978, 1980a, b) uses the symbol 'ω' instead of *m*.
- [14] We are not concerned here with the claim that *ungrammaticality* is also exceptional from the morphological point of view because a stress-shifting affix is added after a stress-neutral one. As a matter of fact we think that *ungrammaticality* is morphologically completely regular: *grammatical* is the head of *ungrammatical* (cf. Williams 1981) and is [+linate]. Therefore, *-ity* can be attached to *ungrammatical*. This analysis presupposes that we use stratal features instead of level ordering for the expression of restrictions on affix combinations. See Booij (forthcoming b) for a defence of this position.
- [15] The non-cohering nature of monosyllabic prefixes can also be expressed by assigning them the status of 'syllable appendix to a phonological word'. For instance, the representation of *ungrammatical* could have the following form:



In this representation there is still a phonological word boundary between *un-* and *grammatical* that can explain the observed properties of *un-* with respect to syllabification, nasal assimilation, stress and Comparative Formation. We will leave this question open here (but see Booij forthcoming c).

- [16] We take the gen. sg. form as an example since the nom. sg. *rose* + *jm* 'truce' involves an additional complication. It belongs to the class of words which in one way are exceptions to Lower: the yer of the root morpheme //jɪm// does not surface as [e] before the nom. sg. ending //ɪ//.
- [17] These rules are discussed in Rubach (1984).
- [18] The idea that Lower applies also in the domain of *mot prime* is supported additionally by lexicalised prepositional phrases. These are phrases such as *ze ws* + *i* in e.g. *on pochodzi ze wsi* 'he comes from a village' (figurative sense 'from the country'), *we krw* + *i* 'in blood' in e.g. *ma te nawyki we krwi* 'he has these habits in his blood' (compare the [e]–zero alternation in *wies* 'village' – *ws* + *i* (gen.), *krw* 'blood' – *krw* + *i* (gen.)). The [e] of the preposition is derived by Lower: /zɪ vɪs + i/ → /ze vɪs + i/ by Lower (9) → /ze vɛ + i/ by Yer Del. (10); /vɪ krɪv + i/ → /ve krɪv + i/ by Lower → /ve krɪv + i/ by Yer Del. These expressions must be treated as lexicalised phrases which have the status of (both morphological and phonological) compounds. It is this status that distinguishes them from the regular syntactically derived prepositional phrases involving the same lexical items, e.g. *jaki jest procent cukru w krwi chorego?* /v krɪv + i/ 'what is the percentage of sugar in the blood of the patient?'. The prepositional compounds

are processed phonologically in the lexicon and hence Lower is applicable. On the other hand, the prepositional phrases arise in the syntax, i.e. outside the lexicon. Consequently, Lower, being a lexical rule, is no longer available and the preposition surfaces without [e]: *w krwi + i* 'in the blood'. Observe too that the prepositional compounds have developed an idiomatic meaning here, 'from the country', 'in blood'. This is not surprising given the interpretation that they are derived in the lexicon rather than in the syntax.

- [19] In the case of compounds such as *pas + i + brzuch + y* 'gluttons' one might argue that the stress on *pas* is assigned in the same way as in the case of monosyllables and *i* does not count.
- [20] Taking *roze + jm + ow + y* 'truce' (adj.) rather than *roze + jm* 'truce' as an example we avoid getting involved in a complex discussion of some detailed rules of Polish stress. Briefly, Polish has a foot erasure (de-stressing) rule which erases foot and *mot* structure in disyllabic and trisyllabic compounds. The prosodic tree is subsequently reassigned using the principles of word-internal stress. Consequently, di- and trisyllabic compounds are stressed as if they were single words: *częst + o + skurcz* 'tachycardia', *roze + jm* 'truce', *ze + ws + i* 'from the country', etc. These examples show that foot erasure applies in equal measure to morphological compounds, to prefixed words and to lexicalised prepositional phrases. This is yet another reason for analysing these three types of cases under the common heading 'phonological compounds'. There is no foot erasure if the compound has more than three syllables; compare the instr. pl. *częst + o + skurcz + ami* 'tachycardia'.
- [21] There are three points that require explanation. First, syllabification takes place after every rule which adds or deletes phonological material. Second, in (47a) the glide /j/ is syllabified with the prefix to avoid the violation of the syllable template given in (15) and, less importantly, to avoid the violation of the sonority hierarchy. Third, the prefix *roz* in (47b) is subsequently defooted by the defooting rule mentioned in §2.4.

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