An Overview of Lexical Phonology

Jerzy Rubach*

Department of Linguistics, University of Iowa, and Instytut Anglistyki, University of Warsaw

Abstract

This article reviews Lexical Phonology, a theory of rules and derivations. Rules are of three types: cyclic rules, postcyclic rules, and postlexical rules. Various diagnostic properties of rules are discussed, including the phonological cycle, word vs. phrase domain application, the Strict Cyclicity Constraint, derived environments, the Structure Preservation Constraint, lexical conditioning, and the interaction of phonology and morphology. The data are drawn from English, Dutch, Polish, Russian, and Slovak.

Lexical Phonology grew out of The Sound Pattern of English (SPE hereafter; Chomsky and Halle 1968) as a refinement of the structure of the phonological and the morphological components of the grammar. The roots of Lexical Phonology go back to Kiparsky (1973), Mascaró (1976), Halle (1978), and Rubach (1981). The opening paper for the theory was Kiparsky’s (1982) ‘From Cyclic to Lexical Phonology’. The lexical framework inspired the research of the 1980s and 1990s, as I explain in Section 6. Today, Lexical Phonology remains the source of insight especially in two lines of phonological investigation: Distributed Morphology (DM) and Derivational Optimality Theory (DOT). It is for this reason that the theory merits attention in spite of the fact that it is no longer practised in the form as described in this article.

Lexical Phonology is a theory of rules and derivations. It is a theory of rules, because it claims that rules are universally of three types: cyclic rules, postcyclic rules, and postlexical rules. It is a theory of derivations, because it claims that the way in which the derivation is organized is crucial to phonological analysis. In particular, some derivations proceed in steps, called cycles, while others do not. Non-cyclic derivations are of two types: word level derivations and postsyntactic derivations.

Lexical Phonology is an extreme embodiment of Chomsky’s (1970) lexicalist hypothesis. It is extreme because it claims that all word formation, including inflection, takes place in the lexicon. Furthermore, word formation rules (WFR hereafter) interact with a subset of phonological rules called cyclic rules. This interaction is possible, because cyclic
rules, like WFRs, are placed in the lexicon, so they are called lexical rules.

This article is organized as follows. Section 1 considers postlexical rules and identifies the properties that characterize these rules. Section 2 reviews arguments for cyclic rules. Section 3 discusses the Strict Cyclicity Constraint (SCC) by focusing on the concept of derived environments. The understanding of lexical rules is sharpened in Section 4 by demonstrating that they fall into two disjoint classes: cyclic lexical rules and postcyclic lexical rules. Section 5 reviews the level ordering hypothesis in morphology. The conclusions are summarized in Section 6 with a view to the current state of the art.

1 Postlexical Rules

The distinction between postlexical and lexical rules is illustrated by the interaction of Palatalization and Retraction in Russian.

The Russian vowel inventory includes five vowels /i i u e o a/. The consonantal inventory is much richer than the vocalic inventory, because consonants exhibit a contrastive opposition of soft (palatalized) vs. hard (velarized) consonants, as exemplified in (1). Soft consonants contrast with hard consonants in the feature [±back]: soft consonants are [–back], whereas hard consonants are [+back].

(1) Russian consonants

<table>
<thead>
<tr>
<th>Russian consonants²</th>
<th>nom.sg</th>
<th>loc.sg</th>
<th>diminutive</th>
</tr>
</thead>
<tbody>
<tr>
<td>l'uk [l'uk] ‘hatch’</td>
<td>stol [stol] ‘table’</td>
<td>– stol + e [stol'+e]</td>
<td>– stol + ik [stol'+ik]</td>
</tr>
<tr>
<td>z'at' [z'at'] ‘son-in-law’</td>
<td>vagon [vagɔn] ‘carriage’</td>
<td>– vagon + e [vagɔn'+e]</td>
<td>– vagon + ik [vagɔn'+ik]</td>
</tr>
<tr>
<td>d’ad’a [d’ad’a] ‘uncle’</td>
<td>brat [brat] ‘brother’</td>
<td>– brat + e [brat'+e]</td>
<td>– brat + ik [brat'+ik]</td>
</tr>
<tr>
<td>n’an’a [n’an’a] ‘nanny’</td>
<td>nos [nɔs] ‘nose’</td>
<td>– nos + e [nɔs'+e]</td>
<td>– nos + ik [nɔs'+ik]</td>
</tr>
<tr>
<td>m’aso [m’asɔ] ‘meat’</td>
<td>dom [dɔm] ‘house’</td>
<td>– dom + e [dɔm'+e]</td>
<td>– dom + ik [dɔm'+ik]</td>
</tr>
</tbody>
</table>

The occurrence of palatalization is predictable in the context of front vowels, as the following alternations show.

(2) | nom.sg | loc.sg | diminutive |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>stol [stol] ‘table’</td>
<td>– stol + e [stol'+e]</td>
<td>– stol + ik [stol'+ik]</td>
</tr>
<tr>
<td>vagon [vagɔn] ‘carriage’</td>
<td>– vagon + e [vagɔn'+e]</td>
<td>– vagon + ik [vagɔn'+ik]</td>
</tr>
<tr>
<td>brat [brat] ‘brother’</td>
<td>– brat + e [brat'+e]</td>
<td>– brat + ik [brat'+ik]</td>
</tr>
<tr>
<td>nos [nɔs] ‘nose’</td>
<td>– nos + e [nɔs'+e]</td>
<td>– nos + ik [nɔs'+ik]</td>
</tr>
<tr>
<td>dom [dɔm] ‘house’</td>
<td>– dom + e [dɔm'+e]</td>
<td>– dom + ik [dɔm'+ik]</td>
</tr>
</tbody>
</table>

Palatalization is a straightforward assimilatory change spreading [–back] from the vowel to the consonant.

(3) Palatalization

\[ C \rightarrow C / \quad i e \quad [–back] \]
A different assimilatory change occurs across word boundaries and affects the high front vowel /i/.

(4) Russian retraction

Ivan [ivan] ‘Ivan’ vs. stol Ivana [stɔl ˈivana] ‘Ivan’s table’
vagon Ivana [vəɡon ˈivana] ‘Ivan’s carriage’
brat Ivana [brat ˈivana] ‘Ivan’s brother’
nos Ivana [nɔs ˈivana] ‘Ivan’s nose’
dom Ivana [dɔm ˈivana] ‘Ivan’s house’

These data show that the vowel assimilates to the consonant in the sense that the feature [+back] from the velarized consonant is spread onto /i/, yielding the back unrounded vowel [ɨ], a process that I call Retraction.

(5) Retraction

\[ i \rightarrow ɨ / C — [+\text{back}] \]

Palatalization and Retraction compete with each other over inputs containing a consonant and /i/ since both rules are applicable to such strings. These rules are in a bleeding relationship in the sense that the application of one rule preempts the application of the other rule. This is evident from the derivation in (6), which looks at the diminutive stol+ik and the phrase stol Ivana.

(6) a. stɔl+ik stɔl ivana
stɔl’+ik stɔl’ ivana Palatalization
– – Retraction
b. stɔl+ik stɔl ivana
stɔl+ik stɔl ivana Retraction
– – Palatalization

We witness an ordering paradox: the order Palatalization before Retraction (6a) derives the correct form [stɔl’ik] but the wrong form *[stɔl ˈivana]; the reverse order, Retraction before Palatalization (6b) yields the correct [stɔl ˈivana] but the wrong *[stɔl+ik]. This ordering paradox is solved by Lexical Phonology. The point of interest is that the correct analysis is predicted by the principles of the theory, so the order of the rules need not be stipulated.

Building on the earlier work by Kiparsky (1973), Mascaró (1976), Halle (1978), Rubach (1981), and Mohanan (1982), Kiparsky’s (1982) groundbreaking paper ‘From Cyclic to Lexical Phonology’ proposes that phonological rules are of two kinds: lexical rules and postlexical rules. Lexical rules interact with WFRs and are placed in the lexicon, because, according to the lexicalist hypothesis (Chomsky 1970), word formation is placed in the lexicon. The consequence is that lexical rules are predictably limited to the domain of words as words and not sentences are derived in the
lexicon. In contrast, postlexical rules take the sentence as their domain, because they apply to strings derived by syntactic operations. These assumptions lead to the following model of relationships.

(7) Lexical Phonology model (preliminary version)

It follows from the model in (7) that lexical rules must apply before postlexical rules, that is, the ordering of a lexical rule before a postlexical rule need not be stipulated. A further prediction is that a rule that applies across word boundaries must be postlexical. This assertion follows from the fact that constituents larger than words are derived syntactically and that in (7) the syntactic component is placed after the lexicon and before the postlexical component.

Returning to the Russian rules of Retraction and Palatalization, the Lexical Phonology model predicts that Retraction must be a postlexical rule, because it applies across word boundaries. The status of Palatalization is unclear at this point. From the perspective of the model in (7), it could be a lexical or a postlexical rule. The latter option is open, because postlexical rules are not restricted to word edges. On the contrary, they are not restricted in any way, so they apply across the board, affecting structures not only at word edges but also inside words.

The status of Palatalization is established on the basis of a different principle than the constitution of the component parts of the Lexical Phonology model. The principle is that lexical but not postlexical rules can make reference to lexical information, that is, the information contained in the lexical entries. The lexical information in question is of three types: (i) lexical conditioning, that is, the specification of a morpheme as a
member of a vocabulary class, (ii) morphological conditioning, that is, the specification of a morpheme for its grammatical features, and (iii) exception features, that is, the information that a morpheme is an exception to a given rule.

Rules may be conditioned lexically in the sense that their application can be restricted to a certain class of morphemes. For instance, the English rule of Velar Softening, $k \rightarrow s$ before front vowels, is restricted to the Romance layer of the vocabulary; consequently, we see $[s]$ in romantic $[k]$ – romantic$+ism$ $[s]$ but not in monarch $[k]$ – monarch$+ism$ $[k]$.

There are rules that are conditioned morphologically. For example, the rule known as Second Velar Palatalization in Polish turns $//k g//$ into $[ts dz]$ before the dat./loc.sg. suffix $-e$, as in $rzek+a [k]$ ‘river’ (nom.sg.) – $rzec+e [ts]$ (dat.sg.) and $nog+a$ ‘leg’ (nom.sg.) – $nodz+e [dz]$ (dat.sg.). Elsewhere before $e$, $//k g//$ are turned into $[tS dZ]$, as I show in (19) in Section 3.

Finally, rules may have idiosyncratic exceptions, that is, their application can be blocked by exception features listed in the lexical representation of morphemes. This point is relevant to Russian Palatalization.

According to Avanesov (1968) and Halle (1959), Palatalization has a handful of exceptions. For instance, $otel$ ‘hotel’ and $šose$ ‘highway’ are pronounced with $[t]$ and $[s]$, respectively, in spite of the fact that the following vowel is $e$. Since palatalization has exceptions, it cannot be a postlexical rule. It must, therefore, be a lexical rule.

The ordering paradox in (6) is now resolved. The solution follows from the principles of Lexical Phonology, in particular, from the following tenets.

(8) a. If a rule applies across word boundaries, then it must be postlexical; hence Retraction is postlexical.
b. If a rule has exceptions, then it must be lexical; hence Palatalization is lexical.
c. If a rule is lexical, then it applies in the domain of the word; hence Palatalization applies inside words but not across word boundaries.
d. If a rule is lexical, then it applies before postlexical rules; hence Palatalization applies before Retraction.

The derivation of the conflicting inputs in (6), $stol^+ik$ ‘table’ (dimin.) and $stol$ Ivana ‘Ivan’s table’, proceeds as in (9). Square brackets denote morphological constituency, showing that $stol$ is a root, $ik$ is the diminutive suffix, $Ivan$ is a root, and $-a$ is the gen.sg. suffix. Internal brackets are erased at the end of the lexical component by the Bracket Erasure Convention.

(9) Lexical component

\[
\begin{align*}
\text{[[stol][ik]]} & \quad \text{[[stol]]} & \quad \text{[[ivan]a]} \\
\text{[[stol][ik]]} & \quad - & \quad - & \quad \text{Palatalization} \\
\text{[stol'ik]} & \quad - & \quad \text{[ivan]} & \quad \text{Bracket Erasure Convention}
\end{align*}
\]
The reason why Palatalization cannot apply to stol Ivana is that in the lexical component, in which Palatalization operates, stol and Ivana do not form a constituent yet, that is, they are processed as separate words. They become a phrase in the syntax and hence constitute an input to the phonological rules in the postlexical component. One of these rules is Retraction, which takes its toll and turns /i/ into [í] after a hard, that is, [+back], consonant /l/. Retraction does not affect /stól'ik/ because /l'/ is palatalized, that is, [–back], so the environment of the rule is not met. I conclude that Lexical Phonology solves the ordering paradox between Palatalization and Retraction in a principled way, yielding the correct results: the palatalized [l'] in stolik and the back vowel [í] in stol Ivana.

Sometimes the status of a rule as postlexical can be diagnosed without recourse to the empirical facts of whether a rule applies across word boundaries or only inside words. This is true if a rule is not structure-preserving. The Structure Preservation Constraint (Kiparsky 1985) is meant to capture the distinction between rules that produce contrastive and non-contrastive segments. A rule preserves structure if it derives sounds that are attested in the inventory of underlying segments. From this perspective, Palatalization and Retraction are both structure-preserving rules, because both palatalized consonants and //í// are underlying segments in Russian. In contrast, American English Flapping is not structure-preserving. The rule turns //t d// into a flap in intervocalic contexts. Schematically:

(10) Flapping
    t d → [c] / V — V

Flapping derives [c] in words such as city [stɹi], lady [leɹi] and editor [ɛdɪɹə]. Since the occurrence of [c] is fully predictable, the flap is not an underlying segment in American English. Therefore, Flapping is not a structure-preserving rule. Given the principle that non-structure-preserving rules must be postlexical, it is predicted that Flapping should be able to apply across word boundaries. This prediction is borne out because we find [c] in phrases, for example, in that is and about it.

2 Cyclic Rules

The derivation for stol’ik ‘table’ (dimin.) in (9) assumes that lexical rules apply to fully derived words. That is, (9) assumes that phonology follows
morphology in the sense that phonological rules apply after the relevant WFRs have completed their work. An alternative view and the one adopted by Lexical Phonology is to assume that WFRs and lexical phonological rules apply in tandem, which means that lexical rules reapply as a block after every step in the morphological derivation of a word. This mode of application is illustrated schematically in (11), where I represent phonological effects as prime signs.

(11) Cycle 1  
[Root]  
[Root]'  Lexical rule (1)  
[Root]''  Lexical rule (2)  

Cycle 2  
[[[Root]'' X]]  WFR: X Suffixation  
[[[Root]'' X]']  Lexical rule (1)  
[[[Root]'' X]'']  Lexical rule (2)  

Cycle 3  
[[[[Root]'' X]''] Y]  WFR: Y Suffixation  
[[[[Root]'' X]''] Y]'  Lexical rule (1)  
[[[[Root]'' X]''] Y]''  Lexical rule (2)  

The idea that the derivation may proceed in steps called cycles goes back to the work of Chomsky et al. (1956) and it was widely used in SPE. From the point of view of Lexical Phonology, the motivation for the cycle can be drawn from the interaction between morphology and phonology. Below I look at three examples: English al-Nominalization, the application of Vowel Reduction in compensation vs. condensation, and the Rhythmic Law in Slovak.

Siegel (1974) observes that deverbal al-Nominalization in English is sensitive to stress. Specifically, -al is attached to verbs whose final syllable is stressed, as in arríve – arrív+al and propóse – propós+al, where the accent marks stress. The rule is systematically blocked if the final syllable is unstressed, so *édit+al, from édit, is not a possible word. Siegel’s observation is readily accounted for if the derivation is cyclic. On cycle 1, the roots arríve, propóse and edit receive stress from the Main Stress Rule (SPE). Consequently, when the al-Nominalization applies on cycle 2, the stress on the root morphemes is visible, so the rule can make the correct choice of the base to which –al can be appended.

The celebrated SPE example compensation vs. condensation shows that phonological rules may be sensitive to the derivational history of the word. The point of interest is the fact that the vowel marked E in the second syllable of these words reduces in compEnsation but not in condEnsation, even though the phonological structure of these words is virtually identical. The difference is found in the root cycle (cycle 1). The noun compEnsation derives from compEnsate, where E is not stressed. In contrast, the noun condEnsation derives from condEnse, where E is stressed on the root cycle. Since vowel reduction applies to unstressed vowels, the E of compEnsation reduces to schwa but the E of condEnsation does not.

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Cyclic vs. non-cyclic application of phonological rules may have empirical consequences, a point that is illustrated by the Slovak Rhythmic Law (Kenstowicz and Rubach 1987; Rubach 1993). In Slovak, vowels are shortened after a long vowel. Schematically:

(12) Rhythmic Law

\[ V: \rightarrow V / V: C_0 \] —

The rule accounts for the alternations in (13), where the accent is the orthographic way of marking long vowels.

(13) a. adjectival masculine nom.sg. suffix //iː//

\[ \text{mal+ý [mal+i:] 'small' – čír+y [čí:r+i] 'clear'} \]

b. agentive //ni:k//

\[ \text{rol'+a 'field' – rol'+ník [rol'+nì:k] 'farmer'} \]

\[ \text{pút’ [pu:t’] ‘pilgrimage’ – pút+ník [pu:t+nìk] ‘pilgrim’} \]

The suffixes -ý //iː// and -ník //ni:k// can co-occur in the same word, as in the adjective rol’+níc+k+y ‘farmer’ (adj.), where -ý //iː// surfaces with a short -ý [i] in accordance with the Rhythmic Law (RL). The question is what happens when the suffixes are appended to a root with a long vowel, such as \[ \text{pút’} / /pu:t’/ /. \] The predictions made by a non-cyclic derivation (14a) and a cyclic derivation (14b) are different. In (14), I informally use the spelling in order to avoid the complications referring to the alternations of consonants. Recall that accents denote long vowels.

(14) a. [\[\text{pút}níc[k][ý]\] b. Cycle 1 [\[\text{pút’t}\] RL]

\[ \begin{array}{c|c|c}
\text{Cycle 2} & [\text{pút[ník]}] & \text{WFR: -ník} \\
& [\text{pút[ník]}] & \text{RL} \\
\text{Cycle 3} & [\text{pút[níc][k]}] & \text{WFR: -k} \\
& - & \text{RL} \\
\text{Cycle 4} & [\text{pút[níc][k][ý]}] & \text{WFR: -ý} \\
& - & \text{RL} \\
\end{array} \]

The non-cyclic derivation (14a) derives short vowels in both suffixes, which is incorrect. The attested surface form is pút+níc+k+y [pu:t+nts+k+i:] ‘pilgrim’ (adj.), where the vowel of the suffix //ni:k// has shortened by the Rhythmic Law. This result is obtained if the derivation is cyclic (14b), as then both the direction of application of RL and the fact that RL must iterate on successive steps in morphological derivation follow from the cycle itself. To put it differently, this mode of derivation is predicted by the model of Lexical Phonology.

To conclude, lexical phonological rules and WFRs apply in tandem. The derivation proceeds in cycles as dictated by morphological operations. Every cycle following the root cycle begins with a WFR adding an affix. The structure thus derived is subjected to the operation of lexical
rules. This mode of derivation continues until a complete word has been formed.

3 Derived Environments and the Strict Cyclicity Constraint

Polish has a fully productive rule of Coronal Palatalization (Rubach 1984), exemplified for the class of obstruents in (15).

(15) nom.sg.   loc.sg.    verb
donos [s] ‘report’ donosi+e [c+ɛ] donos+i+c [c+i] 
mróz [s] ‘frost’ mroz+i+e [z+ɛ] mroz+i+c [z+i] 
poś [t] ‘sweat’ pośi+e [ťc+ɛ] poċ+i+c [ťc+i] 
brud [t] ‘dirt’ brudzi+e [dź+ɛ] brudzi+i+c [dź+i]

The dentals /s t d/ turn into prepalatal fricatives and affricates before front vowels. Schematically:

(16) Coronal Palatalization
s t d → ć ẓ ęc dź / — i ɛ

Coronal Palatalization is a lexical rather than a postlexical rule, because it does not apply across word boundaries, for instance, we see [s] rather than [ć] in donos Ewy ‘Eve’s report’. The suggestion that Coronal Palatalization is a lexical rule appears to be supported by the words in (17), which defy the rule and hence seem to be exceptions. (Recall that lexical but not postlexical rules may have exceptions.)

    teraz [tɛrases] ‘now’, deszczy [dɛʃtʃi] ‘rain’
b. zez [zɛz] ‘squint’ – zezi+e [zɛɛz+ɛ] (loc.sg.)
    sepsi+a [sɛpsi+a] ‘sepsis’ – sepsi+e [sɛpɛɕ+ɛ] (loc.sg.)
    test [tɛst] ‘test’ – teści+e [tɛɕtɛɕ+ɛ] (loc.sg.)

It would appear that the words in (17a) should be analysed as exceptions to Coronal Palatalization. The problem with this analysis is that it misses a generalization: the exceptional strings of hard consonants followed by front vowels are limited to the morpheme-internal position. The words in (17b) confirm this generalization and, in addition, make it clear that the analysis in terms of exception features cannot be correct. The point is that sequences of the same consonants followed by ɛ defy Coronal Palatalization inside morphemes but not at morpheme boundaries, as shown by the comparison of the underlying and the surface representations in (18).

(18) zezi+e ‘squint’ (loc.sg.): / /zɛez+ɛ/ → [zɛɛz+ɛ]
    sepsi+e ‘sepsis’ (loc.sg.): / /sɛps+ɛ/ → [sɛpɛɕ+ɛ]
    teści+e ‘test’ (loc.sg.): / /tɛst+ɛ/ → [tɛɕtɛɕ+ɛ]

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If these morphemes were marked as exceptions to Coronal Palatalization, the rule would be blocked on all occurrences of consonants followed by */e/*, so */zez+e/* would surface as */*zez+e/*, without palatalization, and the attested surface form */zez+e/* could not be derived.

The correct analysis of Coronal Palatalization is different. The rule applies to strings that span a morpheme boundary and is blocked inside morphemes. Once this assumption is made, Coronal Palatalization becomes an exceptionless rule.

The restriction of rule application to strings spanning a morpheme boundary is Kiparsky’s (1973) discovery known as the Derived Environment Constraint. Mascaró (1976) proposed that lexical rules are restricted to derived environments by a general principle of strict cyclicity (see below). Lexical Phonology makes excellent sense of derived environments, because the derivation proceeds in cycles and each cycle after the root cycle begins with deriving a new structure by a WFR. Thus, */zezi+e/* ‘squint’ (loc.sg.) has */zez/* as the input to the first cycle. The structure is not derived because */zez/* is taken from the list of lexical entries. Consequently, Coronal Palatalization cannot apply on this cycle. On the second cycle, the loc.sg. ending */e/* is added by a WFR: */zez+e/*. The */z+e/* string is derived in the sense that it has not existed before and has now been created by a WFR. That is, */z+e/* is derived phonologically, which opens it to the operation of Coronal Palatalization: */z+e/* \(\rightarrow\) */zez+e/*.

Kiparsky’s (1973) principle of derived environments states that structures can be derived either morphologically, that is, by a WFR, as in */zez+e/*, or phonologically. In the latter case, a structure is the result of a phonological rule applying earlier in the derivation. The interaction between Velar Palatalization and Spirantization in Polish is a clear illustration of this situation (Rubach 1984).

Polish Velar Palatalization turns velars into postalveolar stridents, with stops becoming affricates. The rule applies before both */i/* and */e/*, but the examples in (19) show only the context of */e/*.

(19) a. krok [k] ‘step’ – kroc+ek [tʃ] (dimin.): */kro+ek/* \(\rightarrow\) [krɔtʃ+ek]

móżg [k] ‘brain’ – módz+ek [dʒ] (dimin.): */mużg+ek/* \(\rightarrow\) [muʒdʒ+ek]

dač [x] ‘roof’ – dasz+ek [ʃ] (dimin.): */dax+ek/* \(\rightarrow\) [daʃ+ek]

The */dʒ/* derived from */g/* by Velar Palatalization spirantizes to */ʒ/* after a sonorant (Rubach 1984).

(20) a. brzeg ‘shore’ – brzę+ek (dimin.): */bʐeɡ+ek/* \(\rightarrow\) [bʐɛɡ+ek]

drag ‘pole’ – draż+ek (dimin.): */dɾɔŋ+ek/* \(\rightarrow\) [dɾɔwʒ+ek]

b. Spirantization

\(dʒ \rightarrow ʒ / [+\text{sonor}]\)
Spirantization never applies to underlying //dʒ//, so brydż+a ‘bridge’ (gen.sg.)9 and kindżal ‘dagger’ surface with [dʒ] rather than with [ʒ]. The generalization is that Spirantization is governed by the Derived Environment Constraint in the phonological sense: the input to Spirantization must be derived by rule and cannot come directly from the underlying representation.

Following a suggestion by Mascaró (1976), the concept of derived environments is built into Lexical Phonology as part of the Strict Cyclicity Constraint (SCC), which governs the application of rules in a cycle. This is illustrated in (21), where I look at zezi+e //zɛz+ɛ// ‘squint’ (loc.sg.), brzeż+ek //bʐɛg+ɛk// ‘shore’ (dimin.) and brydż+a //brídʒ+a// ‘bridge’ (gen.sg.).

(21) Cycle 1 [zɛz] [bʐɛg] [brídʒ]
    blocked by SCC – – Coronal Pal.
    – – Velar Pal.
    – blocked by SCC Spirantization

    WFRs
    [[zɛz]ɛ] – – Coronal Pal. 10
    – [[bʐɛʒ]ɛk] – Spirantization

The SCC blocks the application of the cyclic rules on the first cycle. This is correct for (21) but not for the instances discussed in Section 2: the al-Nominalization in arriv+al and the absence of Vowel Reduction is condensation. For these instances it is crucial that the Main Stress Rule Applies on the first cycle to the roots arrive and condense. To accommodate such cases, the SCC is restricted to the structure-changing application rules, as in (21).11 The Main Stress Rule performs a structure-adding operation, because stress does not exist in the underlying representation.12 The consequence is that the Main Stress Rule is not within the purview of the SCC and can apply on the first cycle, the desired result.

To conclude, an important property of lexical rules is that they are cyclic and that their application is governed by the SCC.13

4 Postcyclic Rules

Booij and Rubach (1987) have argued that not all lexical rules can be cyclic. Rather, lexical rules are of two kinds: cyclic rules and postcyclic rules. The latter apply across the board to fully derived words and are not subject to the SCC. Since postcyclic rules are placed in the lexicon, their domain of application cannot be larger than the word. The Lexical Phonology model presented earlier in (7) is now modified to include the postcyclic component.
The evidence for postcyclic rules is of two types. First, there are rules that are not subject to the SCC and yet cannot be postlexical rules. Second, there are rules that must apply in a non-cyclic way and yet cannot be regarded as postlexical rules.

Russian Palatalization, discussed in Section 2, is a classic example of a lexical rule that is not subject to the SCC. On the one hand, the arguments adduced in Section 2 make it clear that Palatalization cannot be a postlexical rule: it has exceptions and does not apply across word boundaries. On the other hand, Palatalization cannot be subject to the SCC, because it is a structure-changing rule and yet applies morpheme internally in a fully productive way. This is documented by the fact that palatalization affects borrowings, applying to strings that do not span a morpheme boundary, for instance, we have palatalized consonants in technik+a [tʰɛxn'ik+a] ‘technology’, direktor [d'ir'ektɔr] ‘director’ and in names such as Nevad+a [n'ɛvad+a].

Dutch Syllable-final Devoicing is an example of a rule that can be neither cyclic nor postlexical, so it must be postcyclic (Booij and Rubach 1987). The rule is sensitive to syllable structure, which is assigned by syllabification, a set of operations that take effect after every step in a derivation. Syllabification is an algorithm that applies in a continuous way, so it cannot be ordered extrinsically vis-à-vis phonological rules (see, for instance, Rubach and Booij 1990). Since syllable structure does not exist in the underlying representation, Syllabification is structure-adding rather
than structure-changing. Therefore, it is not constrained by the SCC and can apply on the first cycle. Furthermore, since Syllabification designates codas, it provides a derived environment for Syllable-final Devoicing, which is therefore free to apply on the root cycle because the SCC is satisfied. With this clarification, I look at the derivation of \textit{held+in} [h\textepsilon ld+in] ‘heroine’ and assume that Syllable-final Devoicing is a cyclic rule.

\begin{equation}
\text{(23) Cycle 1} \quad \begin{array}{l}
\text{cycle 1} \\
\text{h\textepsilon ld} \\
(h\textepsilon ld)\sigma \\
(h\textepsilon lt)\sigma \\
\text{Cycle 2} \\
(h\textepsilon lt)\sigma \text{ in} \\
\ast(h\textepsilon l)\sigma (\text{tm})\sigma
\end{array}
\end{equation}

The result is incorrect because we have derived \ast[h\textepsilon ltin] for the actually attested [h\textepsilon ldim]. Evidently, Syllable-final Devoicing cannot be a cyclic rule. Could it be a postlexical rule then? The answer is negative.

Dutch resyllabifies consonants in clitic phrases, so the phrase \textit{vond ie} (literally ‘found he’) has the dental stop as the onset of the \textit{ie} syllable. The point is that the stop appears as [t] due to Syllable-final Devoicing, a fact that cannot be derived if the rule is postlexical, as the following incorrect derivation shows.

\begin{equation}
\text{(24) Postlexical component} \quad \begin{array}{l}
\text{v\textendash o\textendash nd} \sigma \text{ (i)}\sigma \\
(v\textendash o\textendash nd) \sigma \text{ (di)}\sigma \\
\text{–} \quad \text{Resyllabification} \\
\text{–} \quad \text{Syllable-final Devoicing}
\end{array}
\end{equation}

The difficulties in the derivation of \textit{held+in} ‘heroine’ and \textit{vond ie} ‘found he’ disappear if we recognize a class of postcyclic lexical rules that apply at the stage at which the words have been fully derived already but the syntactic rules have not operated yet, as envisaged by the model in (22). In (25), I look at the postcyclic and postlexical derivation of \textit{held+in} and \textit{vond ie}. The inputs to the postcyclic component are the outputs from the cyclic component: the syllabified words /(h\textepsilon l)\sigma (dm)\sigma/ ‘heroine’, /(v\textendash o\textendash nd)\sigma/ ‘found’ and /(i)\sigma/ ‘he’. They are subjected to the postcyclic rules, including Syllable-final Devoicing. Subsequently, they enter the syntactic component, where the phrase \textit{vond ie} is formed. The phrase is processed phonologically in the postlexical component.

\begin{equation}
\text{(25) Postcyclic component} \quad \begin{array}{l}
(h\textepsilon l)\sigma (dm)\sigma \\
\text{–} \\
\text{–} \\
\text{Postlexical component} \\
(v\textendash o\textendash nt)\sigma (i)\sigma \\
(v\textendash o\textendash n)\sigma (ti)\sigma
\end{array}\end{equation}
Booij and Rubach (1987) assume that every phonological rule is assigned to one of the three components: cyclic, postcyclic or postlexical. The advantage of this view is that the status of a rule (cyclic, postcyclic or postlexical) can, in most cases, be predicted from the independently existing ordering relationships into which a given rule enters. Specifically, a rule that is ordered before a cyclic rule must be cyclic; a rule that is ordered after a postlexical rule must be postlexical; and a rule that is ordered between postcyclic rules must be postcyclic. For instance, the derivation of the Polish word brzeżek ‘shore’ (dimin.) given earlier in (21) shows that Velar Palatalization is ordered before Spirantization, a feeding order. Since we know from the discussion in Section 3 that Spirantization is cyclic, we predict that Velar Palatalization must also be cyclic. As a cyclic rule, Velar Palatalization is limited by the SCC to derived environments, which means that it cannot apply morpheme-internally. These are exactly the attested empirical facts, for instance, we see [k] rather than [tʃ] before front vowels in kin+o ‘cinema’ and kelner ‘waiter’.

5 Level Ordering

Most researchers working in the framework of Lexical Phonology assumed the existence of levels, for example, Kiparsky (1982) proposed three lexical levels for English. In general, a level can be postulated if we can claim that it has some WFRs and some phonological rules that are specific to it. With multiple levels, it is predicted that affixes assigned at a later level must be peripheral to affixes assigned at an earlier level.

This view appears to be correct for English. For example, Kiparsky (1982) argues that -ian is a level 1 suffix because it causes stress shift, and the Main Stress Rule is located at level 1: Mongol – Mongol+ian, where an accent marks stress. In contrast, -ism is a level 2 suffix because it is stress neutral, that is, the stress does not change when -ism is appended: nášional – nášional+ism. The level ordering hypothesis predicts that -ism must always be peripheral to -ian. This is correct because words such as Mongol+ian+ism exist while words such as *Mongol+ism+ian are impossible. The latter is ill-formed because the level 2 suffix -ism has been added before the level 1 suffix -ian, an impossible configuration from the point of view of the level ordering hypothesis. However, there are counterexamples, showing ordering paradoxes.

The celebrated example of an ordering paradox is the word ungrammaticality. From the point of view of morphology, the prefix un- is added to the constituent grammatical and not to the constituent grammaticality because un- attaches to adjectives and not to nouns. Therefore, the nominalizing suffix -ity must attach to ungrammatical rather than to grammatical. This is an ordering paradox because -ity is a level 1 suffix while un- is a level 2 prefix; compare, for instance, the stress shift in nášional – nášional+ity and the absence of complete assimilation in words such as un+lawful and un+reasonable.
Level ordering is not an essential part of Lexical Phonology. First, in most languages level ordering cannot be motivated. Second, as argued by Fabb (1988) for English, the ordering of affixes is a matter of the selectional restrictions on the particular affixes rather than a matter of different levels.

6 Conclusions and Prospects

Lexical Phonology is a theory of rules and derivations, which are organized in the way shown by the model in (22). There are three classes of rules: cyclic, postcyclic and postlexical. Each class exhibits certain properties that are either specific to it or that it shares with the other classes of rules. These properties are summarized in (26).

(26) Properties of phonological rules

<table>
<thead>
<tr>
<th>Property</th>
<th>Cyclic</th>
<th>Postcyclic</th>
<th>Postlexical</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Interaction with WFRs</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>2. Cyclic application</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>3. Strict Cyclicity Constraint</td>
<td>yes</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>(derived environments)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Word level</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>5. Phrase level</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>6. Morphological conditioning</td>
<td>OK</td>
<td>OK</td>
<td>no</td>
</tr>
<tr>
<td>7. Lexical conditioning</td>
<td>OK</td>
<td>OK</td>
<td>no</td>
</tr>
<tr>
<td>8. Exceptions</td>
<td>OK</td>
<td>OK</td>
<td>no</td>
</tr>
</tbody>
</table>

Lexical Phonology as described in this article flourished as a theory in the 1980s and 1990s. Without doubt, it was the dominant paradigm in generative phonology, as documented by a large number of journal articles and book size monograph studies of various languages (Rubach 1984, 1993; Booij 1995; Odden 1996; Wiese 1996; Giegerich 1999; Kristoffersen 2000; Mateus and d’Andrade 2000; Siptár and Törkenczy 2000, and others). Today, Lexical Phonology continues to be an important source of insight in two streams of research: Distributed Morphology (DM) and Derivational Optimality Theory (DOT). Relevant here is the phonological rather than the morphological part of Lexical Phonology.

DM, which dates back to the seminal paper by Halle and Marantz (1993), continues, in its phonological part, most of the assumptions of Lexical Phonology with one significant exception: it totally rejects the lexicalist hypothesis that morphological operations take place in the lexicon. Rather, morphological operations are distributed in the sense that they are first performed on abstract morphemes and phonological exponents.
of morphemes are inserted only after syntax. The heart of Lexical Phonology – the lexicon – does not exist, so phonology is placed in the postsyntactic module. However, many other tenets of Lexical Phonology are upheld. Significantly, phonological processing is executed in terms of rules rather than constraints and rules are of two types: cyclic and postcyclic (see, for example, Vaux 1998 and Halle and Matushansky 2006). Cyclic rules apply stepwise, to each morphologically embedded constituent while postcyclic rules apply only once to fully derived structures, as in Lexical Phonology.

Optimality Theory [OT, henceforth; see McCarthy’s (2007) article in this journal] appears to be completely incompatible with Lexical Phonology, because OT rejects any form of derivation and it is derivation (cyclic, postcyclic and postlexical) that is at the heart of Lexical Phonology. This assertion is valid for standard OT (McCarthy and Prince 1995; Prince and Smolensky 2004) but not for LP-OT (Lexical Phonology–OT of Kiparsky 1997, 2000) or DOT (DOT of Rubach 1997, 2000a,b). DOT rejects the fundamental principle of standard OT that all evaluation must be performed in parallel (strict parallelism) and, consequently, no derivational steps are permitted. DOT intentionally recaptures the insight of Lexical Phonology that phonological operations are carried out at successive levels. Rubach (1997, 2000a) proposes that the divide between the lexical level (word domain) and the postlexical level (postsyntactic domain) is the default model in phonology. Kiparsky (2000) moves this assumption further and proposes that the theory should include three levels of evaluation: the stem level, the word level and the postlexical level, which parallel the Lexical Phonology distinction of the cyclic, the postcyclic and the postlexical components. Each level constitutes a miniphonology, with its own inputs and constraint ranking.

Phonological processing begins at the stem level, which takes the underlying representation as its input. The winner from the stem level is the input to the word level and, in the same line of logic, the winner from the word level is the input to the postlexical level. Constraints may be reranked between levels but reranking must be minimal and requires motivation (the Reranking Minimalism Principle of Rubach 2000a). I illustrate this modus operandi of DOT by reanalysing the Palatalization vs. Retraction example from Russian, which was analysed in terms of Lexical Phonology in Section 1 (see Rubach 2000b).

One of the important assumptions of OT, regardless of whether it is standard OT or DOT, is the tenet that all constraints are universal. This tenet throws new light on Russian Palatalization, which must now be viewed from a cross-linguistic perspective. That is, the process expressed in (3) in Section 1 can no longer be regarded as a process specific to Russian, because the constraint set is the same for all languages and languages can differ only in how they rank the universal constraints.
A broader view involving languages other than Russian shows that Palatalization may have different environments in different languages. For example, Ukrainian admits palatalization before \(i\) but not before \(e\), so rule (3) as an OT constraint (technicalities aside) is not possible (see Rubach 2005). In the case of Russian, the relevant constraints are PAL-\(i\) and PAL-\(e\). Crucially, only the former but not the latter is active in Ukrainian.

Focusing on PAL-\(i\), I adopt the following statement of the constraint from Rubach (2003a).

(27) PAL-\(i\): A consonant and a following high vowel must agree in backness.

PAL-\(i\) encompasses two operations stated as separate processes in Section 1: palatalization (albeit limited to the environment of \(i\)) and retraction, thereby expressing the generalization that both seek to eliminate a disagreement between [+back] (i.e. velarized) consonants and the [–back] vowel: \(Ci \rightarrow C'i\) (palatalization) and \(Ci \rightarrow C'i\) (retraction). Both of these changes equally satisfy PAL-\(i\), because the outputs exhibit agreement in [±back] between the consonant and the vowel. (Recall the \([i]\) is [+back]; see Section 1). In the case of palatalization, it is the consonant that adjusts to the vowel: the consonant loses its [+back] feature and becomes [–back]. In the case of retraction, the agreement is at the cost of the vowel, which changes from [–back] to [+back]. PAL-\(i\) does not distinguish between these two ways of achieving agreement in backness. The distinction is made by the faithfulness constraints in (28).

(28) a. IDENT-C[+back]: [+back] on a consonant in the input must be preserved in an output correspondent of that consonant.

b. IDENT-V[–back] [–back] on a vowel in the input must be preserved in an output correspondent of that vowel.

Whether the surface effect from the input \(Ci\) is palatalization or retraction is a matter of how the constraints in (28) are ranked at a given level.

The evaluation of \(stol'\text{ik } Ivana\) \([stol'\text{ik } ivana]\ ‘Ivan’s table’ (diminutive) proceeds as follows. At the word level, \(stol'\text{ik}\) and Ivana are evaluated separately, because they do not constitute a phrase yet. This mode of phonological processing is, in the relevant ways, an exact copy of the postcyclic derivation in Lexical Phonology. At the postlexical level, the input is the phrase \(stolik\ Ivana\), which mirrors the postlexical derivation in Lexical Phonology. Recall that \(stol'\text{ik}\) is a diminutive form of \(stol\) ‘table’, where /l/ is a velarized [+back] lateral. The pointer ✡ shows the winning candidate while the exclamation mark indicates that the candidate has been eliminated.
At the postlexical level, where *stolik* and *Ivana* constitute a phrase, the faithfulness constraints are reranked, so that IDENT-C[+back] dominates IDENT-V[–back].

Crucially, the input to the postlexical level is the winner from the word level, /stɔ́l'ik/, and not the underlying representation //stɔ́l+ik/>. Had the latter been the input, there would be no way to simultaneously derive the palatalization of /l/ and the retraction of /i/ in *stolik Ivana*. Since IDENT-C[+back] is ranked above IDENT-V[–back] at the postlexical level, /i/ would have affected not only *Ivana* but also the /i/ of *stolik*, leading to the wrong surface form *[stɔ́l'ik évana]*. It is therefore crucial that //stɔ́l+ik// is evaluated at the word level before the phrase *stolik Ivana* has been formed. The effect is that the input to the postlexical level is /stɔ́l'ik/, with a palatalized /l'/. The string [l'i] in [stɔ́l'ik] satisfies PAL-i as both [l'] and [i] are [–back]. In contrast, the string [k i] in candidate (30b), arising across a word boundary in *stolik Ivana*, violates PAL-i because [k] is [+back] and [i] is [–back]. The conflict is resolved in favour of changing the vowel from /i/ to *é*], as envisaged by the ranking of IDENT-C[+back] above IDENT-V[–back]. This ranking means that it is more important to be faithful to the [+back] feature on the consonant than to the [–back] feature on the vowel. The effect is retraction: *[stɔ́l'ik évana]*, the correct result.

The distinction between the word level and the postlexical level is well-motivated in languages other than Russian, which supports the claim that it belongs to the general DOT model and need not be stipulated for particular languages. This distinction has been shown to play a role in Arabic (Kiparsky 2000), Bulgarian (Rubach 2000a), Catalan (Beckman and Ringen 2007), Czech (Rubach 2000a), Dutch (Booij 1997), Polish (Rubach 2000a, 2003a,b, 2004), Slovak (Rubach 2000a), and Ukrainian (Rubach 2005).

To conclude, the insights of Lexical Phonology have not been lost.
On the contrary, they constitute a research agenda in current work on phonological theory, which strives to accommodate them in frameworks that depart from the architectural assumptions of Lexical Phonology.

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Short Biography

Jerzy Rubach holds an appointment as Professor of Linguistics at two universities: The University of Iowa in the United States and The University of Warsaw in Poland. He has been a Visiting Professor at several European and American universities, including The Free University of Amsterdam, The Ohio State University, The University of Illinois at Urbana-Champaigne, The University of Washington, and The University of California at San Diego. His area of specialization is phonology and historical linguistics. His expertise is primarily in Germanic and Slavic languages. He has published five books and over sixty articles. His work has appeared in all the top-tiered journals of linguistics, including *Linguistic Inquiry, Language, Phonology* and *Natural Language and Linguistic Theory*. Most of his publications deal with Slavic languages, especially with Polish, Slovak, Russian, and Ukrainian. His earlier work is in the framework of Lexical Phonology, in which he has published a number of articles and *The Lexical Phonology of Slovak* (1993), Oxford University Press. The later and current work assumes the framework of Optimality Theory and argues that this theory should be modified to include the basic insights of Lexical Phonology, especially the distinction between lexical and postlexical processes. He holds an MA and a PhD from The University of Warsaw.

Notes

* Correspondence address: Jerzy Rubach, Department of Linguistics, University of Iowa, Iowa City, IA 52242-1408, USA and Instytut Anglistyki, University of Warsaw, ul. Nowy Swiat 4, 00–497, Warsaw, Poland. E-mail: jerzy.rubach@uw.edu.pl (spring) and jerzy-rubach@uiowa.edu (autumn).

1 I use double slashes for underlying representations, single slashes for intermediate stages and square brackets for phonetic representations. The latter are also used to denote morphological constituency.

2 Here and below, I abstract away from vowel reduction in unstressed syllables in Russian.

3 Idiomatic phrases are also listed in the lexicon, which predicts that they may exhibit the phonology that is within the purview of lexical phonological rules. This prediction is well-illustrated and supported by the vowel – zero alternations in Polish analysed by Rubach (1985).
For a general reference, see Kaisse and Shaw (1985), as well as Hargus and Kaise (1993).

The fact that these words are borrowings from the etymological point of view is irrelevant, because Palatalization regularly affects borrowings, for example, *direktor* ‘director’ has both soft [d’] and soft [r’].

More specifically, the input stops must be ambisyllabic. In the domain of the word, consonants are ambisyllabic between vowels if the second vowel is unstressed. See Kahn (1976) for discussion.

As I explain in Section 4, this mode of interaction between phonology and morphology is assumed for a subclass of lexical rules called postcyclic rules. Russian Palatalization happens to be exactly this type of rule, so the derivation in (9) is correct.

The diminutive suffix -ek has an e that alternates with zero when not in the final syllable, a vowel that is called a yer. See Rubach (1984) and (1986) for an analysis.

I cite the gen.sg. form because the nom.sg. *brydż* undergoes Final Devoicing, so [dʒ] is not visible: [brieʃ].

The SCC blocks the application of Coronal Palatalization to the root-internal /z/, like it did on the first cycle. The general principle is that cyclic rules cannot return to cycles that have already been completed unless a feeding change is performed by a rule applying on the current cycle. See Rubach (1984) for the exemplification of this principle.

The idea that structure-changing operations apply in derived environments goes back to Ringen’s (1975) treatment of the Alternation Condition.

Other typical structure-adding rules are syllabification and various fill-in rules that provide the missing features to underspecified segments.

For a different understanding of how the SCC works, see Kiparsky (1993).

Since palatalization is predictable, it is not encoded in the underlying representation, a standard assumption.

An alternative view, espoused by Kiparsky (1985), Halle and Mohanan (1985), Mohanan (1987), and others, is that rules do not belong to components or levels (see the next section). Rather, a rule potentially applies in all the components and levels unless this is not permitted by the principles of the grammar such as the SCC and the Structure Preservation Constraint.

A formal distinction between postcyclic and postlexical rules does not exist because all phonology is done after syntax, so such a distinction would not follow from the architecture of the grammar, a contrast to Lexical Phonology.

McCarthy (1999) calls these versions of OT ‘Stratal Optimality Theory’.

Derivational levels in OT have been shown to play an important role in historical change (see Bermúdez-Otero 1999).
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