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ABSTRACT VOWELS IN THREE DIMENSIONAL PHONOLOGY: THE YERS

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Recent years have witnessed the growing interest of linguists in problems of phonological representation. The ground-breaking work by McCarthy (1979), Halle and Vergnaud (1980), Clements and Keyser (1983), and others has opened the way to the investigation of the structural properties of segments as opposed to their phonetic properties. Representations are three-dimensional since they involve three tiers: the segmental tier called the melody, the skeleton containing timing slots, and the syllabic tier. Given this view, the investigation of the phonetic properties of segments, which has been the concern of generative phonology for many years, provides no more than basic information. The actual phonetic realization of a segment is defined further by structural information. Thus, for instance, it is now clear that length should be expressed in terms of the number of slots in the skeleton to which the segment is associated. Consequently, with the added skeletal structure, the same feature matrix at the melody tier may represent a long vowel or a short vowel. The converse is also true: one slot in the skeleton may be associated with more than one matrix at the melody level. Thus, in the case of affricates we have two matrices (stop and fricative) which are linked to a single skeletal slot. Identity at the melodic and skeletal tiers does not yet imply identity in phonetic realization. The crucial difference may rest with the syllabic tier. It is there that segments such as the vowel /u/ versus the semivowel /w/ are distinguished: the former is joined to the nucleus while the latter is not.

The three different ways of utilizing nonlinear structure are now summarized in (1). Let us note that here, as well as below, we simplify the representation by using transcription symbols rather than distinctive feature matrices at the melodic tier:

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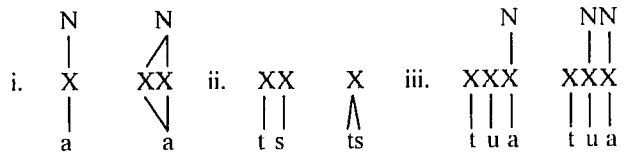
(1)



short/long sequence/affricate phonetic [twa] vs. [tua]

Given these representations, it is quite evident that some phonetic distinctive features of the classic generative phonology have now been eliminated. The examples in (1) show that [±long], [±del rel], and [±syllabic]' are now redundant. The relevant contrasts are expressed by the different structural properties.

Recently much interest has been taken in the relations that hold between the three tiers of phonological representation (for example, Levin 1985, Steriade and Schein 1986, and others). The present article joins the growing literature on this subject by investigating two aspects of structural representation: the independence of tiers and the relations between tiers and rules. We restrict the scope of this article to the theoretical problems that are raised by the so-called "yers", a pair of the well-known abstract vowels of Slavic. Their structural properties and phonological behavior are investigated in two closely related languages: Polish and Slovak. It turns out that there are rather intriguing differences in the ways in which these two languages make use of yers in their phonology.

This article is organized as follows. Section 1 provides the historical background and sets the scene for a theoretical debate. In section 2 we look at the consequences that follow from the view that the melodic tier is independent of the skeleton. In particular, we are trying to answer the question of how yers are manifested at the melodic tier and what implications for the system of rules emerge from these new manifestations. Section 3 is concerned with the relation between tiers and rules in both cyclic and postcyclic phonology. More specifically, we consider the question of how different rules focus on different tiers. The most important theoretical findings are summed up in section 4.

1. BACKGROUND

1.1. The SPE paradigm

Historically, Slavic is known to have had a pair of high lax (short) vowels which have been named "yers". They are usually represented as /ĭ ŭ/, where the diacritic above the vowel means [-tense], the feature that distinguishes them from /i u/. The yers underwent the so-called Havlík's Law, whereby even-numbered yers (counting from the right) lowered to merge with other vowels and odd-numbered yers deleted. It was Lightner's (1965) discovery that yers form part of the underlying structure of contemporary Slavic. They make a case for absolute neutralization since, due to the operation of the rule known as Lower, they never surface as high lax vowels. Lower vocalizes a yer before a yer in the next syllable. The yers that have not vocalized are deleted context-freely.

The surface effects of Lower are different in different Slavic languages. In (2) we give examples from Russian, which represents Eastern Slavic, from Slovak and Polish, which belong to Western Slavic, and from Serbo-Croatian, which is a member of the Southern Slavic subgroup. The examples are in the nom.sg. and the gen.sg.:

(2) a. *Russian*: ĭ ŭ → e o
koren' 'root' – korn'+a; ogon' 'fire' – ogn'+a

b. *Slovak*: ĭ ŭ → e o
pes 'dog' – ps+a; blazon 'fool' – blazn+a

c. *Polish*: ĭ ŭ → e
pies [p'jes] 'dog' – ps+a; bez 'lilac' – bz+u

d. *Serbo-Croatian*: ĭ ŭ → a
pas 'dog' – ps+a; zamak 'castle' – zamk+a

The words in (2) exhibit a pattern of vowel/zero alternations. Yers vocalize in the nom.sg. and delete in the gen.sg., where the ending is *-a* or *-u*. The nom.sg. induces yer vocalization since, as is generally assumed, its ending is a yer. Attention should be drawn to the fact that in Russian and Slovak the historical front/back distinction between the two yers is reflected in surface representations: yers change into mid vowels that are front and back, respectively. In Polish and Serbo-Croatian, yers merge into a single surface representation: [e] in the former and [a] in the latter. However, it should be noted that at least in Polish the front/back distinction encoded in the yers is carried over to the surface representation in terms of the palatalization of the preceding consonant: in *pies* 'dog' the *p* is 'soft' (which induces the insertion of [j]) while in *bez* 'lilac' the *b* is 'hard'.

Analysts of Slavic languages are always confronted with the problem of how to account for the modern reflexes of the historical yers. The facts of vowel/zero alternations are unquestionable and the pattern is productive with borrowings. The assimilation of borrowings has been discussed in Rubach (1984) and there is no need to repeat it here. Let us merely observe that there are many words such as *sweter* 'sweater', a borrowing from English into Polish, that have developed a "fleeting vowel"; compare the gen.sg. *swetr+a*.

Confronted with the facts of vowel/zero alternations, one can pursue two potential lines of reasoning:

(i) There are no underlying yers. Rather, surface representations are derived by a rule of epenthesis. Notice that this assumption is tantamount to claiming that a dramatic restructuring has taken place in the history of Slavic: the underlying high lax vowels have been lost and, simultaneously, a rule of epenthesis has been added.

(ii) The more conservative stance is to assume that yers are still present in the underlying representation and yer vocalization (lowering) is a synchronic rule of Slavic.

It is the second, more conservative stance that has prevailed and become standard in generative phonology: from the early days of Lightner's (1965) study of Russian, through the SPE type of analysis of Polish by Gussmann (1980), to the Polish Lexical Phonology in Rubach (1984).

A question may be asked what kind of evidence can be adduced against the vowel epenthesis analysis that does not recognize any underlying traces of the historical yers. Let us look at Polish, which is the best described Slavic language from the generative point of view. While the detailed analyses can be found in Gussmann (1980) and Rubach (1984), it will probably suffice to look at the evidence from the typological point of view.

Broadly speaking, there are four types of evidence that can be used to argue against vowel epenthesis and in favor of underlying yers.

(i) Admissible consonant clusters

Polish is renowned for its tolerance of a great variety of rather unusual consonant clusters. Thus, it is not surprising to discover all kinds of combinations of sonorants and obstruents in violation of the sonority hierarchy both word-initially and word-finally:

(3)

mdlić 'feel sea-sick'	rytm 'rhythm'
rtęć 'mercury'	Piotr 'Peter'
łkać 'sob'	wlókł 'he pulled'

More importantly, the same consonant sequences sometimes are and sometimes are not broken up by a "fleeting" *e* (the last example is due to Gussmann 1980:27):

(4)

oset 'thistle' – ost+u (gen.sg.)	*vs.* post 'fasting'
kuter 'cutter' – kutr+a (gen.sg.)	*vs.* łotr 'rascal'
wapień 'limestone' – wapn+ia (gen.sg.)	*vs.* wapń 'calcium'

On the interpretation that the fleeting *e* comes from epenthesis, *oset* 'thistle' derives from //ost//[2] and *e* breaks up the //st// cluster. However, the unanswered question is why the //st// of *post* 'fasting' remains intact.

(ii) Triggering effects

Yers, regardless of whether they have vocalized, trigger the application of phonological rules, notably, the rules of palatalization. Thus, for example, the //s// of *głos* 'voice' becomes a prepalatal [ś] before the adjectivizing morpheme spelled *-n* in *głos+n+y*.[3] Similarly, the //k// of *bok* 'side' changes into [č], spelled *cz*, in *bocz+n+y* (Adj.). The rules at work here are Coronal Palatalization and First Velar Palatalization (see Rubach 1984:31,33).

For the theory that does not recognize underlying yers, the palatalization effects present a mystery: why should *n* trigger palatalization rules? Given the yers, the explanation is straightforward. The ajectivizing *-n* must come from //ĭn//. The front yer triggers palatalization rules and then deletes, since the environment for yer lowering (vocalization) is not met: //ĭn// is followed by *-y* //i// and not by a yer. With this interpretation it is no accident that the adjectivizing *-n* is represented as phonetic [en] in words such as *win+a* 'guilt' – win+*ien* [v'ińen] 'guilty' (masc. nom.sg.). The nom.sg. ending is a yer. Consequently, //ĭn// lowers to [en].

(iii) Blocking effects

Unvocalized yers may perform exactly the opposite function from that described in (ii): they may block the application of phonological rules. For example, Polish has a well-known rule that deletes //j// before consonants (see Gussmann 1980, Rubach 1984, both derived from Jakobson 1948):

(5) *j-Deletion* $j \rightarrow \emptyset / \_\_C$

This rule never applies before the adjectivizing *-n*. We thus have surface [j] in both *urodzaj* 'crop' and *urodzaj+n+y* 'fertile'. If *-n* is //ĭn//, the explanation is straightforward: //j// is followed by a vowel and not by a consonant, hence (5) does not apply.

Observe that we have now discovered four independent pieces of evidence for postulating a yer in our diagnostic example: the application of Coronal Palatalization ($s \rightarrow ś$) as well as First Velar Palatalization ($k \rightarrow č$), the appearance of [e] in *win+ien* 'guilty', and now the nonapplication of *j*-Deletion in *urodzaj+n+y* 'fertile'. It is hardly an accident that all of these facts converge at a common point: they all indicate that yers play a role in the structure of Polish.

A very different instance of the blocking effects of the yers will be discussed in section 3. Nasal Assimilation systematically fails to apply in words such as *Iren+k+a* [-nk-] 'Irene' (dimin.), where the diminutive morpheme *-k* contains

a yer; compare *Iren+a* 'Irene' – *Iren+k+a* (dimin.) – *Iren+ek* (gen.pl.). Note that the gen.pl. ending of feminine and neuter nouns is a yer (see Gussmann 1980, Rubach 1984).

Finally, the typology of the blocking effects includes also cases where rules do not apply due to the feature composition of the yer. For instance, Coronal Palatalization (*t* → *ć*) is blocked in *kot+ek* 'cat' (dimin.) because the diminutive suffix has a back yer. Thus, we have two yers: front and back.

(iv) Alternations

Further credibility to underlying yers is given by the observation that vowel/zero alternations are not limited to the alternation of *e* and zero but extend to *i* and *y* in various allomorphs of the same morpheme. Thus, *zamek* 'lock' exhibits the following pattern of alternations: [-mek], just given, [-mk-] in the gen.sg. *zamk+a*, and [-mɨk-] in the derived imperfective form of the verb 'to lock' – *zamyk+a+ć*. This pattern of alternations is systematic and hence calls for a rule-governed explanation. While a rule turning one of the surface fleeting vowels into another can be postulated regardless of whether we have underlying yers, the existence of forms such as *zamk+a* (gen.pl.) and *zamyk+a+ć* 'to lock' (derived imperfective) presents a problem for the theory that intends to account for vowel/zero alternations by means of epenthesis. Observe that in the same context, that is, between *-m* and *-k+a*, we have no vowel in *zamk+a* and the vowel [ɨ] in *zamyk+a+ć*.

The argument from alternations is strengthened further by the interaction of the fleeting *e/i/y* with the so-called "nasal vowels" (see Rubach 1984:130 ff.). The pattern is clearly rule governed. Compare:

(6) a. ze+kln+ą 'they will rebuke': [ze-] – [-ln-]
b. s+klin+aj+ą 'they rebuke' (derived imperfective, D.I. hereafter): [s-] = /z-/ prior to devoicing – [-lin-]
c. s+klą+ć [s+kloń+ć], *-ą* is the "nasal vowel" letter, 'to rebuke': [s-] – [-loń]

These alternations can be easily accounted for on the assumption that the underlying source is a yer. The representation of the structure prefix + root is thus //zɨ̆+klɨ̆n-//, where //ɨ̆// and //ĭ// are yers, back and front, respectively. The yer of the prefix lowers to [e] if the root yer has not been vocalized and can therefore serve as an environment for the lowering of the prefix yer: *ze+kln+ą* 'they will rebuke' //zɨ̆+klɨ̆n+om// → /ze+klɨ̆n+om/ by Yer Lowering and further → /ze+kln+om/ by Yer Deletion (see rules (11) and (12) below). The word *s+klin+aj+ą* 'they rebuke' in (6b) demonstrates that the root must indeed have a yer: it surfaces as [i] here due to the application of Derived Imperfective Tensing, rule (10) below. The infinitive *s+klą+ć* 'to rebuke' in (6c) shows that the yer of the root has been vocalized as [o]. This happens if the yer is followed by two consonants of which the first is a nasal: //zɨ̆+klɨ̆n+ć//. In sum, we have a highly complex pattern of alternations: *e*/zero in the prefix and zero/*i*/*o* in the root (see Rubach 1984:130 ff. for a complete analysis). It is difficult to see how a theory involving epenthesis could account for this pattern in a satisfactory manner.

In Slovak the arguments for underlying yers are essentially the same as in Polish. However, there is one significant difference: additional support is drawn from surface manifestations of the yers. Recall that in Slovak, unlike in Polish, the reflexes of the yers have not merged (see (2b) in section 1.1).

Let us briefly review the arguments for the yers. We deliberately try to use the same examples as in Polish:

(i) Admissible consonant clusters

As shown by *pisk* 'scream' [sk] is an admissible cluster. Yet, we have a yer in *misk+a* 'bowl' – *misiek*[4] (gen.pl.).

(ii) Triggering effects

As in Polish, First Velar Palatalization (*k* → *č* before a front vowel) derives the [č] before the adjectivizing morpheme *-n*: *vek* 'century' – *več+n+ý* 'eternal'.

(iii) Blocking effects

The parallel to Polish is again exact. The *j*-Deletion rule of Slovak (*j* is deleted before consonants) does not apply to adjectivizations such as *pokoj+n+ý* 'quiet'. Needless to say, both the triggering effect and the blocking effect of the morpheme *-n* is clear if we assume that *-n* has a front yer.

(iv) Alternations

The parallelism with Polish goes so far that the same example can be used: *zámok* 'lock' (nom.sg.) – *zámk+a* (gen.sg.) – *zamyk+a+ť* 'to lock' (D.I.).

(v) Surface manifestations of the yers

This is a new and rather powerful argument. Unlike Polish, Slovak does not neutralize the distinction between the front yer and the back yer. The former appears as [e] and the latter as [o]. The distribution of the yers presents a serious problem to adherents of the epenthesis solution.[5] Both the fleeting *e* and the fleeting *o* can appear in exactly the same environment (see also (32) below):

(7) ker 'bush' – kr+a (gen.sg.) *vs.*
svokor 'father-in-law' – svokr+a (gen. sg.)

september 'September' – septembr+a (gen. sg.) *vs.*
bobor 'beaver' – bobr+a (gen.sg.)

Further, the distribution of *e* and *o* cannot be determined on the basis of whether the neighboring consonants are palatalized. This is clearly demonstrated by closely minimal pairs such as that in (8), where the *l* is a hard lateral, the *l'* is a prepalatal consonant, and *s* and *h* are not palatalized:

(8) priemysel 'industry' – priemysl+u (gen.sg.) *vs.*
uhol' 'coal' – uhl'+a (gen.sg.)

We conclude from this survey that the theory proposing vowel epenthesis in Polish and Slovak cannot be upheld. We are therefore left with the contrasting option: fleeting vowels are part of the underlying representation of morphemes and they are deleted in some contexts.

The recognition of the fact that vowel/zero alternations need to be accounted for by deletion rather than by epenthesis does not automatically mean that we have to recognize the abstract yers and the rules of absolute neutralization (Lower and Yer Deletion). We could simply posit the rules deleting *e* in Polish and *e/o* in Slovak. They would handle alternations such as those given in (2b) and (2c): Slovak *pes* 'dog' – *ps+a* (gen.sg.), Polish *pies* 'dog' – *ps+a* (gen.sg.), etc. However, such rules cannot be formulated since the deletion of the vowel is an unpredictable fact. Compare the data in (9a) for Polish and (9b) for Slovak:

(9) a. *Polish*:
kuter 'cutter' – kutr+y (nom.pl.) *vs.*
skuter 'scooter' – skuter+y (nom.pl.) *vs.*

pudel 'poodle' – pudl+e (nom.pl.) *vs.*
model 'model' – model+e (nom.pl.)

oset 'thistle' – ost+y (nom.pl.) *vs.*
kaset 'cassette' (gen.pl.) – kaset+a (nom.sg.)

mięsień [–śeń] 'muscle' – mięśn+i (gen.pl.) *vs.*
jesień 'autumn' – jesien+i (gen.pl.)

b. *Slovak*:
šev 'seam' – šv+u (gen.sg.) *vs.*
lev 'lion' – lev+a (gen.sg.)

kotol 'cauldron' – kotl+a (gen.sg.) *vs.*
atol 'atoll' – atol+u (gen.sg.)

Thus, the fleeting vowels must be differentiated from the nonfleeting vowels in the underlying representation. This conclusion coupled with the evidence from the triggering and the blocking effects has laid the foundation for the standard generative interpretation that contemporary Polish and Slovak have underlying yers. They are high vowels and they are distinct from //i u// by being [–tense]. In Polish the yers have been given the guise of //ĭ ŭ// rather than //ĭ ŭ// since, first, Polish has //ŭ// as a member of both its underlying and its phonetic inventories, and second, [ŭ] surfaces in derived imperfectives. Thus, if *zamek* 'lock' is //zamĭk// rather than //zamŭk//, the only change that needs to be effected in order to derive *zamyk+a+ć* 'lock' (D.I.) is the replacement of [–tense] by [+tense]. However, Slovak has no [ŭ], hence in the standard treatment the Slovak yers would most probably be represented as //ĭ ŭ//.

Within the classic generative paradigm, yers have been best investigated in Polish. All descriptions recognize that the appearance of [i ŭ] in derived imperfectives is due to the rule of Derived Imperfective Tensing (see Łaskowski 1975, Gussmann 1980, Rubach 1984). We formulate it schematically as follows:

(10) $$\textit{D.I. Tensing}\ \begin{bmatrix} \text{V} \\ +\text{high} \\ -\text{tense} \end{bmatrix} \rightarrow [+\text{tense}]\ /\ \text{—C}_0\ \text{aj}_{]\text{D.I.}}$$

That is, //ĭ ŭ// are turned into [i ŭ] if they stand before the derived imperfective morpheme *-aj*, as in *zamyk+aj+ą* 'they lock'. (Note that in the infinitive *zamyk+a+ć* the *j* is deleted before a consonant by rule 5).

The surfacing of //ĭ ŭ// as [e] is accounted for by postulating the rule known as Lower (Lightner's 1965 term). In the most recent treatment of this problem in Rubach (1984), it has been argued that Lower and Yer Deletion are two separate rules:

(11) $$\textit{Lower}\ \begin{bmatrix} \text{V} \\ +\text{high} \\ -\text{tense} \end{bmatrix} \rightarrow [-\text{high}]\ /\ \text{—C}_0 \begin{bmatrix} \text{V} \\ +\text{high} \\ -\text{tense} \end{bmatrix}$$

Yers are lowered to mid vowels if they are followed by a yer in the next syllable and they are deleted elsewhere:

(12) *Yer Deletion* $\begin{bmatrix} V \\ +\text{high} \\ -\text{tense} \end{bmatrix} \rightarrow \emptyset$

Arguments have been presented that Lower is cyclic. In fact, it is a rather classic example of a cyclic rule, since it participates in the so-called "ordering paradoxes" (see Rubach 1984:186). On the other hand, Yer Deletion cannot be cyclic, since it deletes underlying segments context-freely. Had it been cyclic, the Strict Cyclicity Constraint would have never allowed it to apply, as the environments are invariably "nonderived".

While the interpretation that Lower is cyclic and Yer Deletion postcyclic has been advanced only recently, it has been standard for many years to regard the so-called "zero endings" in Slavic as underlying yers: the nom.sg. and the gen.pl. (Lightner 1965, Gussmann 1980, Rubach 1984). These yers are seen at work in deeper layers of phonology, where they induce both triggering and blocking effects. In surface terms they have no phonetic representation since, being inflectional endings, they are never followed by a yer that could trigger Lower (11). Consequently, they delete postcyclically by rule (12).

We sum up our discussion by deriving the various allomorphs of the Polish morpheme 'lock'. The examples are the nom.sg. *zamek* (the yer ending), the gen.sg. *zamk+a* (the *-a* ending), and the derived imperfective form *zamyk+aj+ą* 'they lock' (in (13) we omit *-ą*):

(13)	zamɨk	zamɨk	zamɨk	
Cycle 2	zamɨk+ɨ	zamɨk+a	zamɨk+aj	WFRs (respectively)
	–	–	zamik+aj	D.I. Tensing (10)
	zamɤk+ɨ	–	–	Lower (11)
Postcyclic	zamɤk	zamk+a	–	Yer Deletion (12)
	zamek	–	–	Vowel Spell-out

The last rule in (13) is Vowel Spell-out, which can be schematically formulated as follows:

(14) *Vowel Spell-out* $\text{ɤ} \rightarrow \begin{cases} \text{o} \;/\; \text{—CC} \\ \\ \text{e} \end{cases}$

This rule has been postulated in Rubach (1984) to account for the alternations of "nasal vowels". It is motivated also from other sources. Notably, it permits us to postulate //ɤ// in order to express the fact that some *e*'s in Polish are nonpalatalizing. These *e*'s appear in the contexts

in which they could not be derived by Lower, hence they cannot be interpreted as underlying back yers.

1.2. Three-dimensional phonology

Given the fact that yers must be made underlyingly distinct from other vowels, the linear framework is forced into the claim that the difference is expressed in terms of phonetic features.[6] Thus, yers are the only high vowels which are lax. Further, the inventory of underlying segments is complicated by including yers as its members. On the other hand, nonlinear three-dimensional phonology offers several other options. With respect to the interpretation of the yers, this was first noticed by Spencer (1986).

Spencer, revising the analysis of Polish by Gussmann (1980) and Rubach (1984), has proposed that the traditional yers should be represented as empty syllabic slots. The actual phonetic segment [e] would be supplied by a default rule. While Spencer's theory can easily overcome the type of difficulty outlined in (i) in 1.1, that is "admissible clusters", it cannot deal with the requirements of the remaining types of motivation: triggering effects, blocking effects, and alternations.

Thus, using the examples that we quoted earlier, we have palatalization in *głoś+n+y* 'loud', the adjective from the noun *głos* 'voice': *s* → *ś*. If yers are skeletal slots with no representation in the melodic tier, the adjectivizing morpheme *-n* is //n// in terms of the melody and it cannot trigger palatalization. Neither can we account for the fact that //j// is not deleted in *urodzaj+n+y* 'fertile': the glide stands before a consonant and hence should be deleted by *j*-Deletion (5). The correct blocking effect can only be obtained if the adjectivizing *-n* is in fact //ĩn//, that is, it has a vowel – consonant representation in the melodic tier. We can further associate the *-n* of *głoś+n+y* 'loud' and *urodzaj+n+y* 'fertile' with the [en] of *win+ien* [v'iń+en] 'guilty'. We can also account for the alternations between [e] and [i/i] as in *zamek* 'lock' – *zamyk+aj+ą* 'they lock' (D.I.); recall rule (10) above.

Farina (1985), who has studied Russian, makes a different suggestion. In her view yers are represented as a [–back] melody feature which is connected to the X slot but not to the N, that is, it is nonsyllabic. However, this is too strong, at least for Polish and Slovak. It obliterates the distinction between yers and glides. As we shall see in section 2.1, both languages have the yer *i*. Given that glides (here *j*) have X slots, the only way to draw the relevant distinction is to assume that yers have no representation in the skeletal tier at all. In other words, they are floating matrices. Precisely this assumption has been made by Kenstowicz and Rubach (1987) in their study of Slovak.

Kenstowicz and Rubach's evidence derives primarily from the observation

that unvocalized yers are systematically ignored by rules of vowel lengthening and shortening. If yers have no X slots, then they are automatically invisible to quantitatively oriented rules, since all quantitative operations consist in adding or deleting a slot in the skeleton (recall (1a): length is represented in terms of X slots).

In this article I shall develop the suggestion of Kenstowicz and Rubach (1987) that yers are floating matrices and use the new concept of the yers to explore various ideas and theoretical mechanisms of three-dimensional phonology. More specifically, I shall consider two problems: the independence of tiers and the relations between tiers and rules.

2. THE INDEPENDENCE OF TIERS

The suggestion that yers are represented solely at the melodic level, that is, that they are floating matrices, is acceptable in three-dimensional phonology due to the assumption that tiers are independent of each other. In other words, there need not be a one-to-one correspondence between elements on adjacent tiers. The concept of the yer is now defined in terms of structural features: a floating matrix. As observed originally in Kenstowicz and Rubach (1987), the transfer of the properties defining the yer to nonsegmental layers of representation opens the possibility that any vowel, not just high vowels, can now be given the status of yer. This follows from the fact that yers are now in no way connected to the phonetic make-up of elements at the melodic tier.

In this section we look at the consequences of divorcing the yers from their segmental content and spell out the full details for the phonology of Polish and Slovak. These consequences are found in two areas: underlying representations and phonological rules.

2.1. Representations

Let us exploit the full range of possibilities created by the new concept of the yer and assume that indeed all fleeting vowels are yers. We begin with Polish.

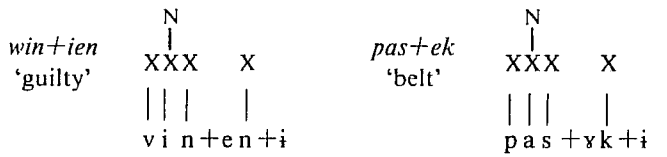
In a linear account of Rubach (1984), the underlying inventory of Polish includes nine vowels:

(15)

i	i̞	u
ĭ	ɤ̆	
e	ɤ	o
	a	

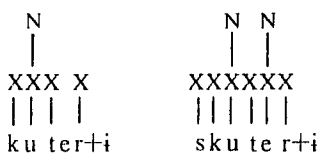
The high lax vowels //ĭ ɤ̆//, that is, the traditional yers, are now eliminated, since their function can be taken over by //e ɤ// acting in their capacity of yers. In (16) we give the underlying representation of the adjectivizing morpheme *-(e)n* of *win+a* 'guilt' – *win+ien* [v'iń+en] 'guilty' (masc. nom.sg.) – *win+n+a* (fem. nom.sg.) and the diminutive suffix *-(e)k* of *pas* 'belt' – *pas+ek* (dimin. nom.sg.) – *pas+k+a* (gen.sg.). The former is palatalizing while the latter is not. We follow the traditional description by assuming that the inflectional yers are represented as //i̞// but now crucially without the syllabic slot.[7]

(16)



The distinction between "yer" *e* and "full" vowel *e* is now made at the skeletal level. We thus avoid the problem that could potentially be created by examples such as those in (9). Recall that *kuter* 'cutter' has a yer while *skuter* 'scooter' does not; compare the gen.sg. *kutr+a* and *skuter+a*. The representations in the nom.sg. are as follows:

(17)



As is evident from (16) and (17), the rule of Lower is now different: it seems to merely assign the structural property N over X (syllabic slot) rather than lower the vowels. We shall return to the formulation of Lower in the next section.

Derived imperfectives provide further instances of fleeting vowels. Thus, we have //i// and //i̞// which surface when followed by the imperfective morpheme *-aj* and delete elsewhere. These //i i̞// do not alternate with any other vowels:

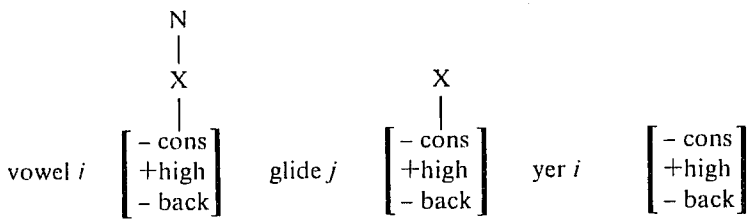
(18) zapomn+ą 'they will forget' – zapom*i*n+aj+ą 'they forget'
wyrw+ą 'they will pull out' – wyr*y*w+aj+ą 'they pull out'

These alternations can be easily accounted for by assuming that the surface [i] and [i̞] are yers in the underlying representation. That is, the fleeting //i i̞// do not carry X slots while the nonfleeting //i i̞// do. The examples

in (18) thus contrast with words such as *błys+n+ą* 'they will glitter' – *błysk+aj+ą* 'they glitter'. Again, it seems that Derived Imperfective Tensing (10) needs to be modified along the same lines as Lower (11): it should assign syllabic X slots to the fleeting //i i//.

Observe that now we have arrived at a three-way structural distinction in the class of high segments which are represented by the same feature matrix at the melodic level:

(19)



Finally, the new concept of the yer gains further support from the treatment of exceptions. Notice that allomorphs of the same morpheme can now be related even if one of them shows an aberrant behavior with respect to the pattern of vowel/zero alternations.

Examples are not difficult to find. One such case is the morpheme *dotk/dotyk* 'touch'. As a verb, it follows the rules as expected. The yer sufaces as [i] in the derived imperfective *dotyk+aj+ą* 'they touch' and it deletes elsewhere: *dotk+n+ą* 'they will touch'. However, when used as a noun, the morpheme is irregular. The yer //i// does not turn into [e] before the yer of the nom.sg. It thus is an exception to Lower (11), which in itself is not particularly unusual, as Lower does have a number of exceptions. The truly irregular nature of the noun comes to light when we realize that it sufaces with [i] and the [i] is not a fleeting vowel in this noun: *dotyk* (nom.sg.) – *dotyk+u* (gen.sg.).

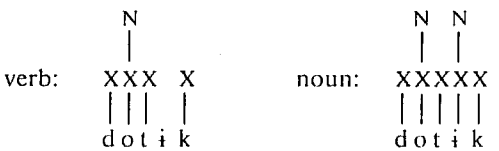
In the linear framework there is no way in which the verb could be related to the noun other than by deriving one form from the other by means of some special minor rule. For example, one might try to derive the noun from the imperfective form of the verb:

(20) dotĭk
dotĭk+aj WFR: Imperfective Formation
dotik+aj D.I. Tensing (10)
dotik *aj*-Truncation (it applies to lexically specified items)

This synchronic recapitulation of an irregular historical development is not a particularly enlightening solution and, to my knowledge, has never been seriously proposed. The linear framework would thus list both //dotĭk// and //dotik// without any possibility of relating them phonologically as allomorphs.

With the nonlinear interpretations of the yers, the difficulties just outlined do not arise. The verb and the noun are related at the segmental level but remain distinct at the higher levels of representation:

(21)



There is no need to propose morphological derivations such as that in (20). Also, we can uphold Kiparsky's (1982) assumption that synchronic truncation is not permitted in Lexical Phonology.

Similar simplifications in accounting for irregularities can be made with respect to Lower. In four words the fleeting *e* appears on the surface in the context where it should have been deleted. Compare the regular forms on the left with the irregular ones on the right. The last two examples are due to Gorecka (personal communication):

(22)

nom.sg.	*gen.sg.*		
magister 'M.A. holder'	magistr+a	*vs.*	magister+ium 'M.A. degree'
minister 'minister'	ministr+a	*vs.*	minister+ial+n+y 'ministerial'
Luter 'Luther'	Lutr+a	*vs.*	luter+an+izm 'Lutheranism'
błazen 'fool'	błazn+a	*vs.*	błazen+ad+a 'buffoonery'

With respect to the first three words, we may speculate that in diachronic terms the forms on the left and the corresponding more complex forms on the right were borrowed independently. Consequently, it was possible for one form to develop a yer, that is, to lose the X slot, and for the other to remain unaffected. Yet, synchronically the relatedness of these forms should be stated.

The case is parallel to the *dotk/dotyk* 'touch' allomorphy that we discussed

earlier. In a linear framework there is no representation that the allomorphs have in common. The underlying forms are different. Thus, *błazen* 'fool' has the yer //ɤ// for the surface *e* while *błazen+ad+a* 'buffoonery' has an underlying //e//. In a nonlinear framework both forms have //e// at the melodic tier. (They differ in the skeleton: the //e// in *błazen* has no corresponding X slot while the //e//in *błazen+ad+a* does.) The relatedness is captured by the fact that the two forms have a level of representation in common: they are identical at the melodic tier.

In sum, Polish has four segmental representations of the yers //e ɤ i ɨ//. We shall now look at Slovak. The parallelism of the arguments is rather close, with one significant exception: fleeting *a*. However, the actual segmental representations of the yers are largely different.

The inventory of Slovak has six vowels:

(23)

i	u
e	o
ä	a

Four or five of them play the double role of "full" vowels and yers. The direct descendants of the historical yers are the mid vowels [e o] as in (24a). The yers in derived imperfectives are represented only by [i]; compare (24b):

(24)

a. oheň 'fire' – ohň+a (gen.sg.)
ovos 'oats' – ovs+a (gen.sg.)

b. zapn+ú 'they will button up' – zapin+aj+ú 'they button up'
načn+ú 'they will begin' – začin+aj+ú 'they begin'

As in Polish, the structural representation of the yers makes it easier to relate exceptional forms. Thus, the variation of *-ik* and *-k* in *syn+ač+ik* 'son' (dimin. nom.sg.): *syn+ač+ik+a* (gen. sg.) ~ syn+*ač+k+a* is expressed at the X slot tier. The segmental relatedness of the variants remains intact.

The interest of the Slovak data consists in the fact that in addition to the direct descendants of the yers [e o] and [i], Slovak has developed a fourth regular representation: the low back vowel *a*. In some words fleeting *a* is the only possible segment, while in some other words it is in variation with the mid yer vowel:

(25)

	nom.sg.	*gen.pl.*
a.	jedl+o 'food'	jedál
	tehl+a 'brick'	tehál
b.	handr+a 'rag'	handier ~ handár
	dosk+a 'board'	dosiek ~ dosák
	kart+a 'card'	kariet ~ karát

Note that the gen.pl. ending is a back yer (perhaps the traditional *-u*). Also, in the gen.pl. all stem-final vowels are lengthened and mid vowels are diphthongized (see Kenstowicz and Rubach 1987).

The historical explanation for the rise of the yer //a// seems to be clear: this value of the yer must have been "borrowed" from Serbo-Croatian, where all yers surface as [a] (see (2d)). The intriguing question is how such a change may have come about. In a linear account this is a rather curious development. In terms of the grammar it means that Slovak has added a "minor rule" which turns some reflexes of Lower into [a].

The nonlinear hypothesis is much simpler. Given that being a yer is a structural and not a segmental property, changes at the melody level have no effect on the system of rules. From the point of view of Lower (that is, Yer Vocalization) nothing has changed: the melody representation for *-a* is just as much a floating matrix as it is for *-e*. The fact that a language may borrow words with such "abstract vowels" lends credibility to the claim that the balance of what constitutes the defining property of the yer has been changed from the segmental features to the structural features. Thus, the phonetic screws have been loosened and hence the phonological system of the yers has been opened to all kinds of historically unmotivated developments at the melodic tier.

Let us summarize. We have isolated five yers in Slovak: //e o a i u//. The fifth yer *-u* (or some other back vowel) is the ending of the nom.sg. and the gen.pl. In the next section we shall look at the rules which derive the yers. In particular, the question is what consequences for the form of these rules follow from the new concept of the yer.

2.2. The rules

2.2.1. Lower and Derived Imperfective Tensing

In our review of the new segmental representations of the yers we have ignored the small but systematic class of morphemes which exhibit a three-way alternation in Polish and Slovak: mid vowel/zero/high vowel. We begin with the Polish examples:

(26) zam*e*k 'lock' – zamk+a (gen.sg.) – zam*y*k+aj+ą 'they lock'
pos*e*ł 'envoy' – pos*ł*+a (gen.sg.) – pos*y*ł+aj+ą 'they send'
o+s*e*s+ek 'suckling' – wy+ss+ą 'they will suck out' – wy+s*y*s+aj+ą 'they suck out'
prze+kl*e*ń+stw+o 'swear-word' – prze+kln+ą 'they will swear' – prze+kl*i*n+aj+ą 'they swear'

The vowel/zero alternation is not a problem. It can be handled by manipulating the skeleton: vowels vocalize if they have received a syllabic X slot which is inserted by Lower or by D.I. Tensing. However, the data in (26) take us further afield. Apart from the alternation with zero, we also have pairs of alternating melodic segments: [e]/[ɨ] and [e]/[i]. This does not mean that we have to revive the traditional yers //i ɨ// and thereby complicate the inventory. There is a simpler solution: one of the alternating vowels is underlying. This gives us two options:

(i) Mid vowels are in the underlying representation. Thus, *zamek* 'lock' has the back yer //ɤ// and *prze+kleń+stw+o* 'swear-word' has the front yer //e//. In this interpretation Lower is a rule that assigns the syllabic slot while D.I. Tensing does two things: it assigns the slot and it effects the raising of //ɤ e// to [ɨ i], as indeed found in *zamyk+aj+ą* 'they lock' and *prze+klin+aj+ą* 'they swear'.

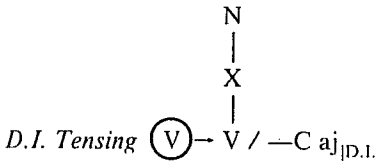
(ii) High vowels are in the underlying representation. Now D.I. Tensing merely assigns the syllabic slot while Lower must do both: assign the slot and change //i ɨ// into /e ɤ/. The /ɤ/ is later turned into [e] by Vowel Spell-out (14), which is an independently motivated rule of Polish phonology.

It seems that the choice of one alternative or the other cannot be made in a principled way, as (i) and (ii) are exact mirror images of each other. Fortunately, evidence can be found to guide us in the selection of the correct theory. The decisive argument will be given in section 2.2.2 (*r*-Lowering). For the moment, let us merely observe that there are words which would find an easier interpretation if the second alternative were accepted.

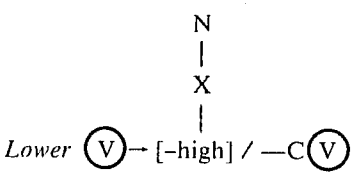
The word *przy+lg+n+ą* [-lg-] 'they will stick to' – *przy+leg+aj+ą* [-leg-] 'they stick to' (D.I.) is one such case. If D.I. Tensing merely assigns the syllabic X slot, then *e* can function as the yer here and the derivation is entirely regular. If, however, we assume that D.I. Tensing raises mid vowels in addition to assigning the slot (the first alternative), then *przy+leg+aj+ą* cannot be handled. It must undergo D.I. Tensing in order to receive a slot, yet the yer *e* should not be raised to *i*.

In sum, we propose that alternative (ii) be accepted. D.I. Tensing (which we now call D.I. Vocalization) and Lower are now formulated as follows:

(27)



(28)

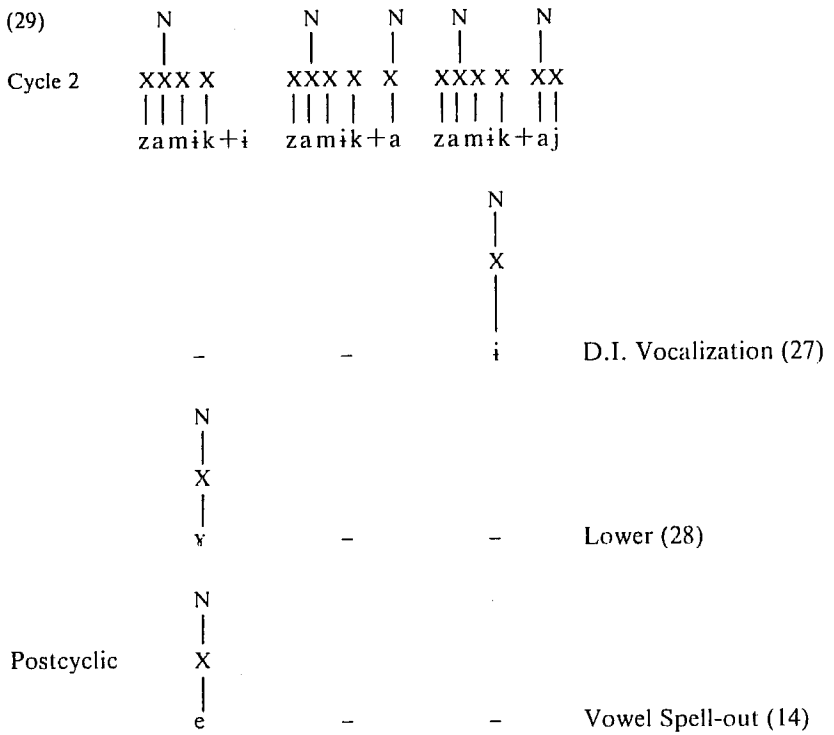


By convention, the circled segment is interpreted as having no X slot.[8]

Let us emphasize that the formulation of Lower in (28) does not mean that all yers are high vowels in the underlying representation. It is only the yers in the morphemes that show a three-way alternation (*e* – zero – *i/ɨ*) that must be interpreted as //i ɨ//. In all the remaining cases of *e*/zero alternations (the overwhelming majority) the yers are represented as mid vowels. Rule (28) assigns the syllabic slot and the lowering is vacuous.[9]

We sum up our discussion by looking at the sample derivation of *zamek* 'lock' (nom.sg., the back yer ending), *zamk+a* (gen.sg.), and *zamyk+aj+ą* 'they lock' (D.I.). We omit the inflectional ending cycle on the verb since it is irrelevant:

(29)



The question that remains is what happens to the yers that have not vocalized. Do they undergo Yer Deletion or do they remain as floating matrices? We shall consider this problem in section 3.

As regards Slovak, the facts are strikingly similar. However, there are some differences, and it is these differences that call for a solution that is exactly the opposite of the one just given for Polish.

Like Polish, Slovak has a class of morphemes which show a three-way alternation: mid vowel/zero/[i]:

(30)

nom.sg.	*gen.sg.*	*D.I.: 3rd p.pl.*
prí+jem 'receipt'	prí+jm+u	pri+jím+aj+ú
zámok 'lock'	zámk+a	zamyk+aj+ú
názov 'name'	názv+u	nazýv+aj+ú

We face the same problem as in Polish: one vowel must be derived from the other. Depending on which vowel we assume as underlying, either D.I. Tensing or Lower will have to effect feature changes in addition to assigning the syllabic slot structure.

The interesting fact about Slovak is that it has lost the distinction between [i] and [ɨ] while preserving the surface distinction between the reflexes of the front and the back yer. Schematically, the difference between Polish and Slovak can be presented as follows:

(31)

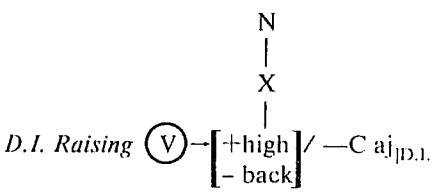
	Polish	Slovak
D.I. Tensing/Vocalization:	i ɨ	i
Lower/Yer Vocalization:	e	e o

It is now clear that the solution suggested for Polish cannot be directly adopted for Slovak. Had we assumed that the underlying segments must be selected from the high vowel series, as was the case in Polish, we would not have been able to predict where the putative //i// should be lowered to [e] and where to [o], since both can appear in exactly the same context:

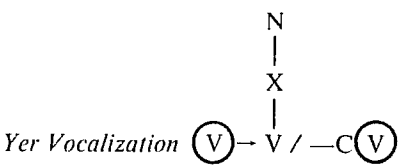
(32) *prí+jem* 'receipt' – prí+jm+u (gen.sg.) – *pri+jím+aj+ú* 'they receive'
ná+jom 'hiring' – ná+jm+u (gen.sg.) – *na+jím+aj+ú* 'they hire'

Thus, underlying the vowel/zero/[i] alternation are the mid vowels //e o// which act in their capacity of yers. The solution for Slovak is the mirror image of that for Polish. D.I. Tensing is a rule of raising (in addition to slot assignment), while Lower adds syllabic structure without effecting any changes in feature matrices. To match these new roles more closely, we relabel the rules as Derived Imperfective Raising and Yer Vocalization, respectively:

(33)

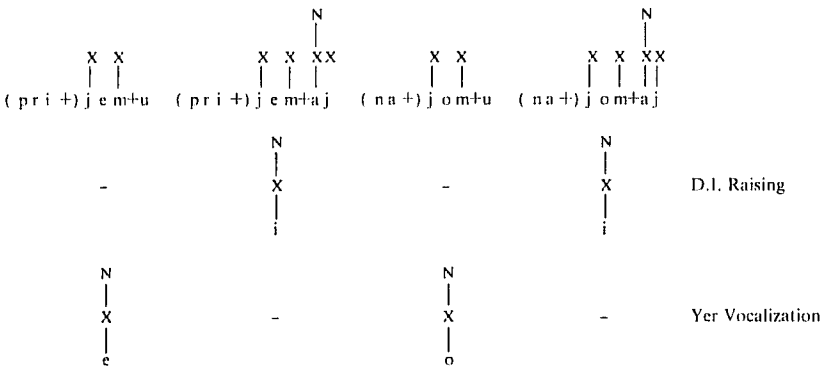


(34)



Partial derivations of *prí+jem* 'receipt' – *pri+jím+aj+ú* 'they receive' and *ná+jom* 'hiring' – *na+jím+aj+ú* 'they hire' are given in (35). Note that the yer //u// is the nom.sg. ending:

(35)



In the next section we look at one further consequence of the new representation of the yers. Again, in spite of the obvious similarities in the data as well as in the form of the rules, Polish and Slovak end up following quite distinct paths.

2.2.2. r-*Lowering*

As is well known, the yers that have been turned into tense high vowels by D.I. Tensing (10) lower to [e] if they stand before /r/. We quote the rule from Gussmann (1980):

(36) r-*Lowering* $\begin{bmatrix} +\text{syll} \\ +\text{high} \\ +\text{tense} \\ -\text{round} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{high} \\ -\text{back} \end{bmatrix} \quad / \_\_ \text{r}$

As shown by Rubach (1984:56), *r*-Lowering is cyclic. D.I. Tensing in conjunction with rule (36) accounts for the alternations of zero and [e] in words such as the following:

(37) umr+ą 'they will die' – umier+aj+ą 'they die'
popr+ą 'they will support' – popier+aj+ą 'they support'
wywr+ą 'they will impress' – wywier+aj+ą 'they impress'

With the new concept of the yer, *r*-Lowering becomes entirely superfluous as a rule. The yer in (37) is simply the vowel //e//. Below we compare the earlier derivation of Rubach (1984) with the one that we have proposed now. They are given in (38a) and (38b), respectively:

(38)

a. umĭr+aj
umir+aj Tensing (10)
umer+aj *r*-Lowering (36)

b. u m e r + a j
D.I. Vocaliz. (27)

Further rules derive the phonetic [um'jeraj+ow̃] in *umierają* 'they die'.

The Slovak *r*-Lowering has a broader context since it applies also before *l*:

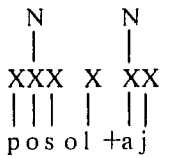
(39) umr+ú 'they will die' – umier+aj+ú 'they die'
zavr+ú 'they will close' – zavier+aj+ú 'they close'
posl+ú 'they will send' – posiel+aj+ú 'they send'

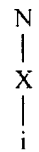
The rule is stated as follows (I use the traditional paradigm):

(40) *Liquid Lowering* $\begin{bmatrix} \text{V} \\ -\text{back} \end{bmatrix} \rightarrow [-\text{high}] \,/\, \_\_ \begin{bmatrix} +\text{cons} \\ +\text{sonor} \\ -\text{nas} \end{bmatrix}$

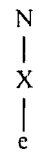
The parallel with Polish is very close. Even the status of the rule is the same. Liquid Lowering is cyclic since it systematically fails to apply in nonderived environments, for example, *sirot+a* 'orphan', *cirkev* 'Orthodox church', *syr* 'cheese'. Yet, unlike Polish, Slovak retains the rule, even with the new representation of the yers. The derivation of *posiel+aj+ú* 'they send' in (41) makes this clear. Note that the underlying yer is //o//, as shown by the fact that we have a phonetic zero in *posl+ú* 'they will send' and [o] in the nom.sg. of the noun *posol* 'envoy'. (We omit the last cycle.)

(41)

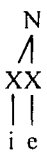




D.I. Raising (33)



Liquid Lowering (40)



other rules (lengthening and diphthongization)

In sum, the new representation of the yers can claim yet one more piece of evidence in its favor: the grammar of Polish (but not of Slovak) is made simpler by eliminating one phonological rule. More generally, we conclude that the consequences of the principle that tiers are independent are advantageous. It is this principle that has opened the way to the new representation of the yers, which has led to a more adequate description of Polish and Slovak than could be achieved in the SPE paradigm.

3. TIERS AND RULES

In this section we shall be concerned with the ways in which the relations between tiers and rules are affected by the new concept of the yer. While looking at the problem we shall be exploring various descriptive mechanisms that have been uncovered by three-dimensional phonology. The data are drawn from Polish. Our examples are: the lowering in derived imperfectives, the comparative degree of adjectives, and the assimilation of nasal consonants.

The derived imperfective suffix *-aj* induces the well-known process of vowel lowering, whereby /o/ changes to [a]:

(42) po+dw*o*j+ą 'they will double' – po+dw*a*j+aj+ą 'they double'
za+gr*o*dz+ą 'they will block' – za+gr*a*dz+aj+ą 'they block'
wy+g*o*n+ią 'they will expel' – wy+g*a*n+iaj+ą 'they expel'

We state this rule informally as follows:[10]

(43) *D.I. Lowering*

Consonants cannot block this rule but vowels can; for instance, *wy+prowadz+ą* 'they will lead out' – *wy+prowadz+aj+ą* 'they lead out' (no change of *o* to *a*). The correct result is achieved by making D.I. Lowering sensitive to the N node, since it is at the syllabic tier that vowels are adjacent. The rule can now apply across all segments that carry no N node. Given the new representation of the yers as floating matrices, a prediction is made that yers should not be able to block the application of the rule. This prediction is borne out:

(44) a. na+w*o*d+n+ią [na+vod+ń+oṽ] 'they will water'
na+w*a*d+n+iaj+ą [na+vad+ń+aj+oṽ] 'they water',
where *-n* is the familiar adjectivizing morpheme; compare *wod+a* 'water' – *wod+n+y* (Adj.). Recall that the adjectivizing morpheme has a yer: it is the *e* as in *win+a* 'guilt' – *win+ien* [v' iń+en] 'guilty' (see section 1.1).

b. s+kr*o*pl+ą 'they will precipitate'
s+kr*a*pl+aj+ą 'they precipitate',
where *kropl* is underlying //kropel// with the yer *e*, as shown by the alternation in the noun *kropl+a* 'drop' – *kropel* (gen.pl.).

The question may be asked why we do not delete the yers prior to the application of D.I. Lowering. Such a possibility does not exist in Lexical Phonology. As noted earlier, Yer Deletion (12) is a postcyclic rule, while D.I. Lowering is cyclic (it applies before the specified morpheme *-aj*). Since all cyclic rules precede postcyclic rules (see Booij and Rubach 1987), the yers are there when D.I. Lowering applies. The examples in (44) thus have the intermediate structure /na+vod+Eń+aj-/ and /z+kropEl+aj-/, where *E* denotes the yer. The prediction about the invisibility of yers to D.I. Lowering is thereby upheld.

The nature of the yers as well as the role of the tiers in the statement of rules can be fruitfully explored by considering the formation of the comparative degree of adjectives:

(45) a. mił+y 'nice' (masc.) – mil+sz+y [mil+š+i]
dług+a 'long' (fem.) – dłuż+sz+a [dwuš+š+a]

b. szczupł+y 'slim' – szczupl+ejsz+y [ščupl+ejš+i]
mądr+y 'wise' – mądrz+ejsz+y [mondž+ejš+i]

c. skąp+y [skomp+i] 'mean' – skąp+sz+y [skomp+š+i]
tward+y 'hard' – tward+sz+y [tfart+š+i]

As established by Wójcicki (1983), the comparative morpheme is //ĭš//, that is, it has a front yer[11] which now, given the new interpretation of the yers, would be represented as unlinked *i* or *e*. The yer makes it clear why we have surface reflexes of palatalization before [š] in (45a): *t* → *l* by Coronal Palatalization and *g* → ž by First Velar Palatalization (see Rubach 1984: 31,33).

The data in (45b) indicate that the comparative degree has an allomorph with *-ej* as an extension. As observed in traditional grammars (for example, Szober 1959:129), *-ej* is inserted if the adjective ends in a consonant cluster. The comparison of the data in (45b) and (45c) demonstrates that the second member of the cluster must be a sonorant.

Let us first analyze the data in terms of the standard theory. The rule is stated as follows:

(46) *Comparative Allomorphy* $\emptyset \rightarrow$ ej / C $\begin{matrix} C \\ [+sonor] \end{matrix}$ — ĭš

The overall picture is quite complex. Comparative Allomorphy applies regularly also in the case of adjectives whose final consonant cluster is broken up by a yer at deeper stages of derivation:

(47) głos 'voice' – głoś+n+y 'loud' – głoś+n+iejsz+y [gwoś+ń+ejš+i] 'louder', where the adjectivizing *-n* contains a yer, as explained in (44a)

ciepł+o 'warmth' – ciepeł+k+o (dimin.): zero/*e* alternation, hence an underlying yer;
ciepł+y 'warm' – ciepl+ejsz+y [ćepl+ejš+i] 'warmer'

The linear framework of Lexical Phonology cannot account for *ej* insertion in (47). To see this, consider the derivation of *głoś+n+iejsz+y* 'louder'. For the moment, we represent the yers in the traditional way as high lax vowels:

(48)	głos	
Cycle 2	głos+ĭn	WFR: Adjectivization
	głoś+ĭn	Coronal Palatalization (*s* → *ś* before front vowels, see Rubach 1984:31)
	–	Comparative Allomorphy (46)
	–	Lower (11)
Cycle 3	głośĭn+ĭš	WFR: Comparative Degree
	głośĭń+ĭš	Coronal Palatalization
	głośĭń+ejĭš	* Comparative Allomorphy (assume that it can apply)
	–	Lower
Cycle 4	głośĭńejĭš+i	WFR: nom. sg.
	no rule applies	
Postcyclic	głośńejši	Yer Deletion (12)

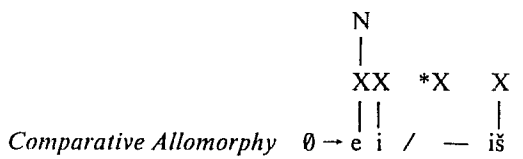
The asterisk on the application of Comparative Allomorphy in cycle 3 marks the place where we run into difficulty. The environment of Comparative Allomorphy is not met, but the derivation requires that the rule should apply. The conclusion is obvious: the yer of //ĭn// must be deleted in cycle 2. This will create the desirable consonant cluster and Comparative Allomorphy will be able to correctly apply in cycle 3. Unfortunately, this proposal is unacceptable in Lexical Phonology. With Yer Deletion as a postcyclic rule, yers may be deleted only in postcyclic phonology. At the same time *ej* must be inserted in the cycle and not postcyclically. Notice that it is the *ej* that blocks the application of Lower in cycle 3. The order is thus extrinsic: Comparative Allomorphy precedes Lower. The latter is cyclic (see Rubach 1984:186), hence the former must also be cyclic. However, in the cyclic component the application of Comparative Allomorphy is incorrectly blocked by an intervening yer. The validity of Lexical Phonology as a descriptively adequate framework has been challenged.

With the nonlinear approach and the new representation of the yers the problem just outlined does not arise. Observe that Comparative Allomorphy is motivated by facts of syllabification. Had the rule not applied, *szczupl+ejsz+y* [ščupl+ejš+i] 'slimmer' and *głoś+n+iejsz+y* [gwoś+ń+ejš+i] 'louder' would have had to surface as *[ščupl+š+i] and

*[gwoś+ń+š+i] with a clear violation of the sonority hierarchy. While Polish permits such violations word-initially and word-finally, it clearly follows the sonority hierarchy in word-internal syllabification.[12] Also, Gorecka (personal communication) has established that Polish has a constraint against two sonorants in a coda. Gorecka's observation is confirmed by our data. Words such as *pokor+n+y* 'humble' take the extension *ej* in the comparative degree: *pokor+n+iejsz+y* [pokor +ń+ejš+i]. The *ej* permits the /n/ to resyllabify as an onset and we thereby avoid the coda [-rn-], which is inadmissible due to the sonorant constraint. (Note that the principle of the sonority hierarchy cannot exclude such codas.)

In sum, the insertion of *ej* is clearly connected to the fact that the second consonant of the cluster is a sonorant and cannot syllabify. Rule (46) is now replaced by (49), where the asterisk on the X slot means that this slot is not integrated on the N tier, that is, it is extrasyllabic:

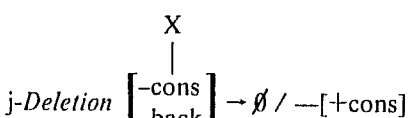
(49)



As shown by Rubach (1984), Syllabification is cyclic, hence it can feed cyclic Comparative Allomorphy.

In order for this solution to work, it is necessary that yers should be invisible to Syllabification. Notice that the function of syllabification rules is to organize X slots into syllables. Yers escape these rules since they carry no X slots. Syllabification isolates the sonorant consonant as extrasyllabic, which provides the environment to Comparative Allomorphy.

The data in (45b) reveal yet another interesting fact. Notice that in defiance of *j*-Deletion (5), the *j* of *ej* is not deleted before a consonant. This is hardly surprising given that the morpheme of the comparative degree has a yer: //iš//. The generalization is straightforward and covers the whole of Polish phonology, not only the comparative suffix: yers block *j*-Deletion. Unlike the previous rules, *j*-Deletion looks exclusively at the melody tier as an environment, since it is there that the yers are visible and form a "natural class" with other vowels:

(50) 

It is essential for the rule not to specify that [+cons] is linked to an X slot. Had this been done, the adjacency of the *j* and the consonant would have been achieved at the skeletal tier and the rule could apply across the yers.

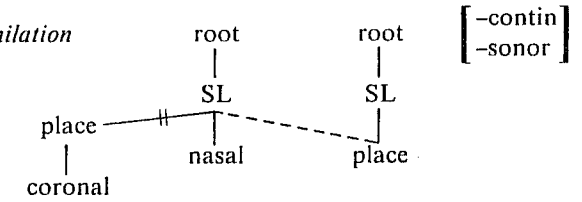
An even clearer example of how tiers determine adjacency, and hence the application of the rules, is the rule of Nasal Assimilation to which we now turn.

Consider the following examples:

(51) trąb+a [tromb+a] 'trunk', tęp+y [temp+i] 'blunt'
kolęd+a [kolend+a] 'carol', wstręt [fstrent] 'repulsion'
sądz+i+ć [soɲʒ+i+ć] 'to judge', kręc+i+ć [kreńć+i+ć] 'to turn'
ciąg+ną+ć [ćoŋg+noń+ć] 'to pull', sęk [seŋk] 'knot'

Evidently, Polish has a rule of Nasal Assimilation which spreads the place features of the stop or affricate to the preceding nasal. We state the rule using the formalism developed in Clements (1985), Halle (1986), and Steriade and Schein (1986). Phonetic features are grouped under nodes. Below we omit the nodes that are not relevant. Note: SL means "supralaryngeal".

(52) *Nasal Assimilation*



Nasal Assimilation as a rule holds for all dialects of Polish. However, there is one significant difference which distinguishes educated north-eastern Polish (the so-called Warsaw dialect) from south-western Polish (the so-called Cracow dialect). In the Warsaw dialect there is no assimilation if the cluster of the nasal and the stop is broken up by a yer in the underlying representation. We thus have the opposition: [nk] vs. [ŋk] in words such as the following:

(53) Iren+k+a [iren+k+a] 'Irene' (dimin.), where the suffix contains the yer; compare the zero/*e* alternation *Iren+ka* (nom.sg.) – *Iren+ek* (gen.pl.); *vs.*
rękˌ+a [reŋk+a] 'hand': no yer, hence Nasal Assimilation can apply.

gank+u [gank+u] 'porch' (gen.sg.), an underlying yer between *n* and *k* since we have *e* in *ganek* (nom.sg.) *vs.*
bank [baŋk] 'bank'.

trunk+u [trunk+u] 'drink' (gen.sg.), an underlying yer, compare *trunek* (nom.sg.) *vs.*
punkt [puŋkt] 'point'

The traditional explanation is that the two dialects differ in rule ordering. In Warsaw the order is Nasal Assimilation before Yer Deletion, while in Cracow it is just the opposite. The derivation of *Iren+k+a* 'Irene' (dimin.) and *rękˌ+a* 'hand' is hence as follows. The non-palatalizing mid vowel //ɤ// is the back yer of the diminutive morpheme.

(54) a. Warsaw:

iren+ɤk+a	renk+a	
–	reŋk+a	Nasal Assimilation
iren+k+a	–	Yer Deletion

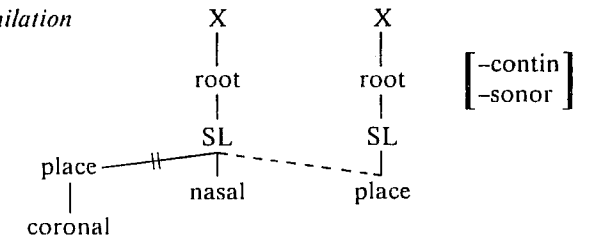
b. Cracow:

iren+ɤk+a	renk+a	
iren+k+a	–	Yer Deletion
ireŋ+k+a	reŋk+a	Nasal Assimilation

As is clear from the morpheme-internal application in (54), Nasal Assimilation is a postcyclic rule. Consequently, we are no longer under the pressure of the fact that the yer cannot be deleted, since Yer Deletion is postcyclic. In other words, the rule-ordering solution in (54) is acceptable from the point of view of Lexical Phonology. However, it may be questioned whether yers should be deleted at all. If we take seriously the assumption of three-dimensional phonology that X slots are timing units, then it follows that a matrix that is not connected to a slot cannot be realized phonetically. Yet, there may be descriptive or theoretical arguments in favor of deleting the unvocalized yers (by rule or by convention).

One potential argument is precisely the operation of Nasal Assimilation in the two dialects of Polish. However, at closer inspection this argument can be turned around and used in favor of not deleting the yers. Notice that the difference between the two dialects reduces to the difference in the relationship between the melody and the skeleton. In Warsaw, Nasal Assimilation is rule (52). It operates solely on the melody tier and hence it is blocked by yers. On the other hand, in Cracow, Nasal Assimilation is rule (52) with the added information that the nasal and the stop are linked to X slots:

(55) *Nasal Assimilation* (Cracow)



Since yers carry no X slots, the adjacency of the nasal and the stop is established at the skeletal tier and the rule applies across the yers, as required. There is an unexpected advantage to this way of viewing the difference between the dialects: the extrinsic ordering demonstrated in (54) is eliminated.

4. CONCLUSION

Revisiting the Slavic yers has given us an occasion to explore the various theoretical mechanisms made available by three-dimensional phonology. The enrichment of phonological representations in terms of tiers has opened the way to transferring properties from the segmental-feature level to the levels of organizational structure: the skeleton and the syllable. To the well-known facts, for example, that length is a property of the skeleton and not of the distinctive feature matrix, a new option has been added: structural features may take over some of the functions of absolute neutralization. The yers are an instance of such a theoretical development.

The transfer of the defining property of yers from the phonetic feature composition to the structural configuration "a floating matrix" has advantageous consequences. These can be seen in two areas: segmental representations and phonological rules.

In the area of representation, a considerable simplification is made in the inventory of underlying segments, since the yers have been eliminated. At the same time the concept of the yer as a type of representation has been broadened: any vowel can be a yer. This is a desirable result. Our inspection of the facts of Slovak shows that not only the traditional reflexes of the yers but also some other vowels follow the same pattern of behavior. Thus, in diachronic terms, a change has taken place. The yer has been defined solely in terms of structural properties, and it has been divorced from its phonetic content.

In the area of phonological rules there are a number of significant changes. Rules may assign structure or change features or do both. In fact, closely related languages which have virtually the same rules may differ in precisely

the type of operation that the rules perform. In Polish the traditional Derived Imperfective Tensing now assigns structure only, while the traditional Yer Lowering does both: it assigns structure and changes features. Slovak has the same two rules, but the types of operation are reversed: Derived Imperfective Tensing assigns structure and changes features, while Yer Lowering assigns structure only.

With the new definition of the types of rule-governed operations and the new concept of representation, some traditional rules may be entirely eliminated. This is the fate of *r*-Lowering in Polish (but not in Slovak).

Three-dimensional phonology offers new possibilities of establishing adjacency and hence of determining whether a rule can apply. In fact, all the three possibilities are used: adjacency at the syllabic tier, adjacency at the skeletal tier, and adjacency at the melodic tier (see Derived Imperfective Lowering, Syllabification and Comparative Allomorphy, and *j*-Deletion, respectively: all in section 3). Interestingly, two dialects of the same language may establish adjacency in different ways. In Warsaw Polish, Nasal Assimilation requires adjacency at the melodic tier, while in Cracow Polish, the adjacency at the skeleton is sufficient. As these two dialects demonstrate, the possibility of establishing adjacency in a nonlinear fashion may lead to the elimination of extrinsic ordering, which simplifies the grammar.

NOTES

1. The suggestion that [±syllabic] should be eliminated as a feature has been elaborated in Levin (1985). Levin's proposal is to use the structural representation: nucleus, as shown in (1iii). I also follow Levin (1985) in representing the skeleton as a sequence of X slots rather than CV slots.
2. I shall use double slashes for underlying representation, single slashes for intermediate stages, and the traditional square brackets for phonetic representation.
3. I use a simplified transcription. The following symbols require clarification:

   [c ʒ] – alveolar affricates (Polish and Slovak)
   [č ǯ] – postalveolar affricates (Polish and Slovak)
   [š ž] – postalveolar fricatives (Polish and Slovak)
   [ć ʒ́] – prepalatal affricates (Polish)
   [ś ź] – prepalatal fricatives (Polish)
   [t' d'] – alveolo-palatal stops (Slovak)
   [ń] – prepalatal nasal (Polish), alveolo-palatal nasal (Slovak)

   Note also: (1) *y* stands for [i] in Polish and contrasts with *i* [i]; however, in Slovak *y* and *i* are two alternative spellings of the same sound [i]; (2) accent over the vowel in Slovak denotes length.

4. Note that the surface reflex of the yer here is the diphthong [ie]. This is due to three rules: Lower, which derives the vowel /e/ before the yer of the gen.pl., Vowel Lengthening, which produces /e:/, and Diphthongization, wich turns long mid vowels into diphthongs. For details, see Kenstowicz and Rubach (1987).
5. The argument becomes even stronger when we realize that *a* is also a fleeting vowel in Slovak. We address this problem in section 2.1.
6. Gussmann (1980) has shown that the diacritic solution is not tenable.
7. As a matter of fact, the inflectional ending could be any back vowel. The problem cannot be resolved in any unambiguous way since inflectional yers never surface phonetically.
8. To be more precise: the environment for Lower should contain a second optional C.
9. This may be, but does not have to be, the case. As has been pointed out to me by one of the anonymous reviewers, there is nothing in the theory that would ban underlying forms with high vowels as yers. Thus, *kuter* 'cutter' (compare the forms in (9) above) could have a high vowel yer for the alternating *e*, and Lower (28) would derive the correct form. With examples of this type the analysis proposed in this article leads to non-uniqueness that would not arise in alternative analyses, such as that of Spencer (1986).
10. Gussmann (1980) has collapsed *o* → *a* with Derived Imperfective Tensing (10). This is a mistake. As observed originally in Rubach (1984) and developed further in Rubach (1987), Derived Imperfective Tensing and Derived Imperfective Lowering (*o* → *a*) are ordered at different points in the grammar. The former must apply before Vowel Deletion (V → ∅ / —V) while the latter applies crucially after it. My revision of Derived Imperfective Tensing as rule (27) makes this point even stronger, since the rule assigns structure and does not change features. See Rubach (1987) for a formalized statement of Derived Imperfective Lowering and for the arguments leading to its ordering with respect to Vowel Deletion and Derived Imperfective Tensing.
11. Wójcicki (1983) points out further that there is a subsidiary allomorph which has a back yer.
12. This hierarchy is clearly the governing principle when syllabifying clusters of obstruents and sonorants or sonorants and obstruents. For example, *Tatry* 'the Tatra mountains' has two alternative syllabifications: *Ta-try* (more likely) and *Tat-ry* (less likely); however, words such as *karty* 'cards' have only one: *kar-ty*.

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