Representing the laryngeal system of Ukrainian

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Abstract

The Ukrainian laryngeal system is unique among Slavic languages and constitutes a typological puzzle in phonological theory. Like other Slavic languages, it contrasts fully voiced obstruents with voiceless unaspirated ones. However, unlike most of them, it does not devoice word-final obstruents and exhibits asymmetrical regressive voicing assimilation which, in clusters of two obstruents, turns a voiceless one into voiced, but not the other way round. The paper reviews how binary and privative approaches to laryngeal phonology may deal with the Ukrainian data, focusing mainly on the relation between the choice of phonological representation of the contrast and the kind of computation it must entail given the assumptions of autosegmental phonology. The focus on representation determines the types of frameworks taken into consideration which do not include the currently most popular Optimality Theory. It appears that the closest to achieving some degree of explanatory adequacy are two quite disparate representational proposals which share the view that phonetic grounding in the phonological representation must be relaxed and partly replaced with phonetic interpretation playing the role of the interface. One of these proposals is based on a binary feature [±tense], while the other employes the privative feature [voice]. On the other hand, phonetic interpretation, if left unrestricted, may lead to a situation where neither the type of phonological representation of the laryngeal contrasts, nor the phonological computation are of any consequence in laryngeal phonology.

Key words: Ukrainian phonology, voice assimilation, distinctive features, binarity, privativity, phonetic interpretation

1. Introduction

The Ukrainian laryngeal system is unique in many respects. It poses both general typological and specific theoretical questions. The standard variety of Ukrainian (Zilyns'kyj 1932/1979; Andersen 1986; Bethin 1987; Danylenko and Vakulenko 1995), contrasts fully voiced obstruents with voiceless unaspirated ones (D/T) like other Slavic languages, e.g. *dym* 'smoke' vs. *tym* 'that one, instr.'. However, unlike most Slavic languages, it does not exhibit word-final obstruent devoicing, maintaining the laryngeal distinction in this position like Serbo-Croatian (D/T#), e.g. *plid* [plid] 'fruit' vs. *plit* [plit] 'fence', *hryb* [hryb] 'mushroom' vs. *hryp* [hryp] 'flu, gen.pl.'. Additionally, unlike all the other Slavic languages, Ukrainian has unique asymmetrical regressive voicing assimilation in which a voiceless obstruent assimilates to the following voiced one (TD → DD), e.g. *borot'ba* [borod'ba] 'fight', *brat gazdyni* [d-g] 'housewife's brother', but not the voiced obstruent

to the following voiceless one (*DT → TT), e.g. *ridko* [ridko] 'rarely', *vid tyx* [d-t] 'from those'.[1]

Final obstruent devoicing (FOD) seems to be related to the presence or absence of regressive voicing assimilation (RVA). In Polish, which has FOD, e.g. *grzyb* [gʒɨp] 'mushroom', symmetrical RVA occurs both word-internally, e.g. *kózka* [kuska] 'goat, dim.', *prośba* [proʑba] 'request', and across a word boundary, e.g. *brat Gosi* [d-g] 'Gosia's brother', *sad Kasi* [t-k] 'Kasia's orchard'. On the other hand, Serbo-Croatian, which has no FOD, exhibits regular assimilation internally, e.g. *slàdak* [sladak] 'sweet' / *slàtka* [slatka] 'sweet, fem.', which is also reflected in the spelling, but not across word boundaries, e.g. *pet dinara* [t-d] 'five dinars', *sred škole* [d-ʃ] 'middle of school' (e.g. Pianka and Tokarz 2000). Thus, Ukrainian, appears to pattern with languages like Polish in having RVA medially and across the word boundary, but it restricts it to assimilation of voiceless obstruents to voiced ones. The relation between FOD and RVA in this language is therefore partial. On the other hand, Ukrainian patterns with Serbo-Croatian with respect to FOD, but only partially with respect to RVA.

In trying to account for laryngeal patterns such as those in Ukrainian, phonological theory typically concentrates on the representation of the linguistically meaningful distinctions and on the necessary computation which is responsible for the observed phenomena such as devoicing, assimilation, or their absence. Neither representation nor computation is self-evident. Both are strictly dependent on specific theoretical assumptions of a given framework. They are, however, not independent of each other. The representation and computation are strictly related as they determine the necessary modifications of the targets of devoicing and assimilation and point to possible triggers.

Another theoretical question of paramount importance is the assumed nature of the interaction between phonology and phonetics. How the observed phonetic properties of segments are represented in the phonology? Which surface phenomena are in fact phonological? What is the nature of the output of phonological derivation? These are just some of the questions theoretical phonology must grapple with.

In this brief article, in Section 2, we first look at two distinct analyses of Ukrainian, using binary features [±voice] (e.g. Wetzels and Mascaró 2001) and [±tense] (Bethin 1987). These will allow us to identify the crucial theoretical questions concerning the targets and triggers in the Ukrainian laryngeal system. A modification of Bethin's analysis is also provided, in which the binary features are replaced with privative, albeit equipollent ones. Section 3 discusses two alternative privative analyses, one based on the feature [voice] (e.g. Cho 1990; Lombardi 1995) and one based on [fortis] (e.g. van der Hulst 2015), which will be shown to require a more pronounced model of interaction between phonology and phonetics than the binary systems. It will be concluded that the choice of representation is not without influence on the general design of sound systems with respect to the relation between phonology and phonetics, and not only on the nature of phonological computation. The representational choices are therefore not equal. While phonetically grounded models are perfectly capable of achieving descriptive adequacy, they may be viewed as circular and require unduly complex computation. On the other

[1] Some exceptions to this pattern exist and involve particular segment types or particular structure of words or prefixes. See, e.g. Bethin (1987) for discussion of the variation in words involving [h~x], e.g. *nihti* [nih'ti~nix'ti] 'nails'.

hand, an unrestricted role of phonetic interpretation, that is, the interface between phonology and phonetics may lead to a surprising result of making both representation and computation redundant.

2. Binary features and Ukrainian voicing

In this section, we first consider two different analyses of Ukrainian which use binary features. We focus on two issues. Firstly, it will be demonstrated that the choice of binary features has specific consequences regarding the nature of phonological computation that has to go with it, which follows from general assumptions of autosegmental representation. Secondly, it will be shown that a binary system does not directly imply a close relationship between phonology and phonetics. Such systems are adequate descriptively and serve as good illustration of the theoretical problems that arise regarding Ukrainian and its place in a more general typology of laryngeal systems. This section contains a privative reanalysis of the Ukrainian data using the insights of the binary proposal in Bethin (1987).

2.1. [±voice] in Wetzels and Mascaró (2001)

Wetzels and Mascaró (2001) argue for a universal binary representation of [voice] by pointing to some inconsistencies of privative proposals, and by providing typologically based empirical evidence for the activity of both [+voice] and [-voice] across languages. The latter argument rests firmly on the assumption that surface voice assimilation to the following obstruent is always phonological and involves *delinking* of the lexically present feature [+voice] or [-voice] from the target obstruent under specific conditions and *spreading* of the relevant feature [+voice] or [-voice] from the following obstruent. In this paper, we ignore the question of the actual cause or trigger of laryngeal delinking, that is, whether it is caused by particular position within the syllable (e.g. Bethin 1987, 1992; Gussmann 1992), a simple linear adjacency between two obstruents (e.g. Rubach 1996), or by some other type of constraint on the distribution of the laryngeal features (e.g. Lombardi 1995).

What is in focus here is the relation between the processes of delinking and spreading, which is generally close and implicational in autosegmental frameworks with binary [±voice]. The two mechanisms are interrelated in the sense that spreading is possible only if the target obstruent has undergone delinking. Thus, delinking feeds assimilation by spreading, and the absence of delinking prevents it. However, delinking and spreading may be subject to separate parameterization in that delinking, when it is active, need not be followed by spreading (Wetzels and Mascaró 2001: 208). In such cases, delinking is followed by another mechanism, namely, the universal *default* providing [-voice] to an unmarked obstruent which then surfaces as voiceless. The default filling occurs at the end of the derivation. This follows from another quite widespread assumption concerning phonological computation in which the output of the derivation, the surface representation, is fully specified.

The relation between delinking, spreading and default filling in Ukrainian is illustrated in (1). For simplicity, we first look only at obstruent clusters with opposite lexical marking, that is, $D^{+v}T^{-v}$ and $T^{-v}D^{+v}$. As mentioned above, regardless of their morpho-syntactic arrangement, that is, whether they are word-internal, or arise across morpheme

or word boundary, they surface as DT and DD respectively. Surface *TD seems to be missing in this language. Given the interdependence between delinking, spreading and default filling described above, and the fact that delinking and spreading can be parameterized separately, the two correct surface outcomes, that is, DD in (1a) and DT in (1f) can be understood only if delinking can exclusively target the [-voice] feature, which is followed by obligatory spreading of [+voice] to the target, thus, bleeding the default filling. The wrong surface outcome *TD is shown in (1b) and (1c). The former involves delinking of [-voice] which is not followed by spreading of [+voice], while the latter shows no delinking, which precludes both remaining mechanisms. (1d) and (1e) show the potentially incorrect effect of [+voice] delinking. Here, the unmarked D^o would have to be filled with [-voiced] either by spreading from the following obstruent or by default.[2] The correct result in (1f) is guaranteed only if there is no [+voice] delinking. Thus, not only can the processes be parameterized but they can also manipulate both, neither, or either value of [±voice] separately.

(1) Derivational variants for lexical TD vs. DT sequences in Ukrainian[3]

	lexical	*delinking*	*spreading*	*default*	*surface*
a.	**T^{-v} D^{+v}**	**T^o D^{+v}**	**T^{+v} D^{+v}**	**-**	**DD**
b.	T^{-v} D^{+v}	T^o D^{+v}	-	T^{-v} D^{+v}	*TD
c.	T^{-v} D^{+v}	-	-	-	*TD
d.	D^{+v} T^{-v}	D^o T^{-v}	D^{-v} T^{-v}	-	*TT
e.	D^{+v} T^{-v}	D^o T^{-v}	-	D^{-v} T^{-v}	*TT
f.	**D^{+v} T^{-v}**	**-**	**-**	**-**	**DT**

Thus, while [-voice] must delete but not spread in Ukrainian, [+voice] does not delete but must spread in this system. The lexical sequences $D^{+v}D^{+v}$ and $T^{-v}T^{-v}$, which are not shown in (1), surface as DD and TT without any observable modification. Given what we have established about the behaviour of [±voice] in Ukrainian, we can assume that in the lexical sequences of the type $D^{+v}D^{+v}$ nothing happens because there is no [+voice] delinking, while in $T^{-v}T^{-v}$, [-voice] is first delinked ($T^{-v}T^{-v} \rightarrow T^oT^{-v}$). At this point we cannot really determine whether it is the spreading from the following obstruent (cf. 1d) or the default filling (cf. 1e) that eventually provides its surface specification ($T^oT^{-v} \rightarrow T^{-v}T^{-v}$). Independent evidence is only available for default filling concerning the word-final pre-pausal context, as shown in (2b) below.

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[2] Throughout this paper, the neutral or neutralized obstruents are represented with 'o', following the tradition of laryngeal realism (e.g. Honeybone 2002).

[3] The traditional derivational presentation of the mechanisms involved has been chosen over the currently more popular Optimality Theoretic one for simplicity (see, e.g. Prince and Smolensky 1993/2004).

The derivations in (2) combine the word-final and pre-obstruent contexts in this language into one system.

(2) Deriving the Ukrainian pattern with binary [±voice]

	a. _#	b. _#	c. _C	d. _C
	/h r y b^{+v}/	/h r y p^{-v}/	/b o r o t'$^{-v}$-b^{+v} a/	/r i d^{+v}-k^{-v} o/
delinking	-	p^{o}	t'^{o}-b^{+v}	-
spreading	-	-	t'$^{+v}$-b^{+v}	-
default filling	-	p^{-v}	-	-
	[h r y b]	[h r y p]	[b o r o d' - b a]	[r i d - k o]

In *hryb* (2a), the lexical form with a voiced obstruent goes through the derivation unchanged. In *hryp* (2b), we must assume that the final /p/ is first delaryngealized, and then receives its voiceless specification by default (p^{-v}→p^{o}→p^{-v}). This analysis, with an intermediate unmarked obstruent, allows us to account for the assimilation to a following voiced obstruent across a word boundary in, e.g. *brat gazdyni* [d-g] 'housewife's brother' and internally, e.g. *borot'ba* [borod'ba] 'fight' (2c), in which the first obstruent loses its feature [-voice] (p^{-v}→p^{o}) and becomes a target of obligatory spreading of [+voice]. Otherwise, it would have received [-voice] by default and yielded an illicit form *[borot'ba]. Finally, in [ridko] (2d), the feature [+voice] is not delinked and makes it to the surface, just like the final /b/ in [hryb] (2a).

Descriptively, the above analysis is accurate. One may wonder, however, about the asymmetrical behaviour of the active features [-voice] and [+voice]. The former must delink, and need not spread, while the latter must spread and cannot delink. Rules or constraints that single out particular features in this way are possible in binary and computationally robust systems such as derivational autosegmental and non-derivational constraint-based frameworks like Optimality Theory (Prince and Smolensky 1993/2004; Grijzenhout 2001). Typologically speaking, such asymmetry in target and trigger behaviour entails the possibility that a system with reversed behaviour should also be possible. It will be recalled that in Slavic languages the regressive voicing assimilation and final devoicing are typically viewed as symmetrical laryngeal delinking of [±voice] and symmetrical spreading of [±voice] from the following obstruent (see e.g. Rubach 1996 for Polish). Such systems exhibit a direct relation if not implication between delinking and spreading. The former feeds and entails the latter.

Systems such as Ukrainian seem to provide evidence for a separate treatment of delinking and spreading mechanisms (e.g. Wetzels and Mascaró 2001), as well as separate setting thereof for [+voice] and [-voice]. This implies that, indeed, an opposite featural behaviour is predicted to exist. The hypothetical system in which it is [+voice] now that must delink but cannot spread, while [-voice] must spread and cannot delink is predicted to have final devoicing (D# → T) and regressive assimilation to a voiceless obstruent (DT → TT), disallowing surface *D#, *DT, but also *DD. It seems that Modern German is the closest example of such a system. It disallows precisely the three configurations: *D#, *DT, and *DD, which are possible in Ukrainian. Like in Ukrainian, though, the status of [-voice] spreading is unclear, as the same effect can be derived from default filling, as shown in (3a) and (3b).

(3) Hypothetical reversed system with [+v]-delinking and [-v]-spreading (German)

	lexical	[+voice] *delinking*	[-voice] *spreading*	$C^o \rightarrow C^{-v}$ *default*	*surface*
a.	$*D^{+v}\ T^{-v}$	$D^o\ T^{-v}$	$D^{-v}\ T^{-v}$	-	TT
b.	$*D^{+v}\ T^{-v}$	$D^o\ T^{-v}$	-	$D^{-v}\ T^{-v}$	TT
c.	$*D^{+v}\ D^{+v}$	$D^o\ D^{+v}$	-	$D^{-v}\ D^{+v}$	TD
d.	$T^{-v}\ D^{+v}$	-	-	-	TD
e.	$T^{-v}\ T^{-v}$	-	-	-	TT
f.	T^{-v} #	-	-	-	T
g.	$*D^{+v}$ #	D^o	-	D^{-v}	T

In German, lexically voiced obstruents (D^{+v}) devoice word-finally (3g), e.g. *bewei*[z]*en* 'to prove' vs. *Bewei*[s] 'proof', and syllable finally, e.g. *bewei*[z]*en* 'to prove' *bewei*[s.b]*ar* 'provable' (3c). This looks like the exact opposite of the Ukrainian pattern, which follows from the opposite way in which the different values of [±voice] are singled out by the delinking and spreading mechanisms. The absence of *DD in German follows from the fact that [+voice] delinks in the relevant context – syllable final – but does not spread, and the outcome TD ($D^{+v}D^{+v} \rightarrow D^oD^{+v} \rightarrow D^{-v}D^{+v}$ = TD) is due to default filling (3c).

The asymmetrical treatment of [±voice] in the computational systems of German and Ukrainian gives credence to the binary system because it demonstrates that both values of the feature [voice] can be active, and therefore, they are needed. The model predicts that delinking and spreading may select both, neither, or either value. An example of a language in which both [-voice] and [+voice] delink and spread is Polish (Rubach 1996). On the other hand, Serbo-Croatian seems to be an example of a system in which both mechanisms are switched-off for either value. But this happens only across the word boundary. In the word-final C# and in clusters of the type C#C no delinking and therefore also no spreading is possible, thus precluding assimilation. Interestingly, word-medially, the settings are the same as in Polish – delinking and spreading manipulate both values of [±voice] – yielding voicing agreement in internal obstruent clusters.

Ukrainian and German, then, appear to fill the predicted typology in a binary system in targeting the voicing values separately and in a different, reversed, configuration. This is indeed true with respect to the feature [+voice]. Ukrainian disallows delinking of this feature and makes its spreading mandatory, while German has the opposite settings: mandatory delinking and disallowed spreading of [+voice]. The same mirrored settings cannot be determined for the feature [-voice], though. While in Ukrainian this feature must delink, in German, it cannot be ascertained which setting is in force. It is compatible with both options, that is, obligatory delinking and forbidden delinking. Given that three contexts are relevant here, that is, lexical T#, TT, and TD, the first setting, with obligatory delinking, is vacuous. The lexical T^{-v} will surface as T anyway because it will receive

[-voice] in T# and in TD by default, while in TT it may receive it by default or by spreading from the following obstruent. The setting forbidding delinking leads to the same result, albeit differently. The absence of delinking precludes the operation of the other mechanisms, and the lexical form makes it to the surface representation.

Similar ambiguities concern spreading of [-voice]. In Ukrainian, the only context in which it can be evoked concerns TT clusters, in which the first obstruent must lose [-voice]. However, given the independently established activity of default filling, the status of spreading in this vacuous derivation is undermined. The same concerns German, in which spreading of [-voice] can be postulated in the case of lexical DT and TT. In both cases, active spreading is uncertain because the neutralized first obstruent can obtain [-voice] from default as well. Obviously, if there is no delinking of [-voice] in German, then both spreading and default filling are precluded. Thus, the two values of [±voice] are not treated in an equal way in Ukrainian and German.

More importantly, the German facts illustrated in (3) can be obtained with a simple setting for the mechanisms of delinking and spreading in which both voicing values would be symmetrically involved. It is enough to say that in German [±voice] must delink, but must not spread. Then, all the ambiguity concerning spreading and default filling disappears.

(4) German delinks but does not spread

	lexical	*delink* [±voice]	*spread* [±voice]	$C^o \rightarrow C^{-v}$ *default*	*surface*
a.	$*D^{+v}\ T^{-v}$	$D^o\ T^{-v}$	-	$D^{-v}\ T^{-v}$	TT
b.	$*D^{+v}\ D^{+v}$	$D^o\ D^{+v}$	-	$D^{-v}\ D^{+v}$	TD
c.	$T^{-v}\ D^{+v}$	$T^o\ D^{+v}$	-	$T^{-v}\ D^{+v}$	TD
d.	$T^{-v}\ T^{-v}$	$T^o\ T^{-v}$	-	$T^{-v}\ T^{-v}$	TT
e.	T^{-v} #	T^o	-	T^{-v}	T
f.	$*D^{+v}$ #	D^o	-	D^{-v}	T

This simpler analysis of German assimilation – it is simpler because it involves fewer mechanisms and no specific targeting of individual values of [±voice] – demonstrates that phonetically observable assimilation to a voiceless obstruent need not be viewed as phonological spreading of [-voice]. What is more, the analysis can in fact be further simplified by assuming that default filling is not a phonological mechanism, but an instance of post-phonological universal phonetic interpretation of the laryngeally neutral obstruent. The privative models, which we look at in Section 3, take this situation even one step further. Since the default is not phonological, there is no reason to refer to [-voice] in German phonology at all, also in the lexical representation. The only mechanism that needs to be referred to is delinking of [+voice], which can now be viewed as a privative feature [voice].

As for Ukrainian, we will look at a similar privative analysis in Section 3.1, which makes Ukrainian different from German in two respects: the feature [voice] is not delinked, but it seems to spread. Thus, the question of the theoretical status of spreading still stands. Though, it is hoped that the story so far suggests that direct analysis of assimilation as phonological spreading should be treated with caution. Below, we look at an alternative binary analysis of Ukrainian, which does not seem to require spreading of [+voice].

2.2. [±tense] in Bethin (1987)

A slightly different binary analysis of Ukrainian is provided in Bethin (1987). It aims to explain rather than just describe the reasons for the asymmetrical assimilation in Ukrainian, that is, *borot'ba* [borod'ba] 'fight' as opposed to *ridko* [ridko] 'rarely' by assuming a different phonological representation of the laryngeal distinctions in Ukrainian. In contrast to the common [±voice] approaches, Bethin assumes that the contrast is based on the feature [±tense]. The difference between [±voice] and [±tense] systems becomes apparent when we consider what these systems say about markedness (e.g. Trubetzkoy 1939/1969). The binary values suggest symmetrical activity of features. However, it has long been assumed (e.g. Jakobson *et al.* 1952) that the positive value, for example, [+voice] is the marked one, and the negative value, e.g. [-voice], is treated as unmarked. This idea later lead to underspecification in phonological theory in which the positive value is present in the lexical representation, while the unmarked value is provided in the process of derivation (e.g. Mascaró 1987). In this respect, the analysis of Ukrainian based on [±voice], which was illustrated in the previous section, goes against the normal markedness practice because it singles out [-voice] as marked and therefore positionally restricted, and not [+voice].

Bethin's proposal repairs this situation in that the [±tense] representation renders voiceless obstruents in Ukrainian marked, that is, [+tense], thus achieving a direct relation between markedness and phonological computation. In her analysis voicing is concomitant with tenseness. It is not contrastive, and it is not subject to phonological computation. This point is very important because to some extent the analysis breaks with the generally assumed phonetic basis of phonological features – Ukrainian, like other Slavic languages, contrasts fully voiced and voiceless unaspirated obstruents. The use of [±tense] divorces the phonological representation and computation from phonetic grounding and the laryngeal phenomena to do with voicing are now expressed indirectly. Additional consequences of this analysis will be mentioned below.

Generally, in Bethin (1987), the phonemic distinction of tenseness and laxness is realized phonetically as one of voicing, but the feature [±voice] still seems to be needed. The asymmetrical process of the so-called regressive voicing assimilation to a voiced obstruent receives a novel interpretation. Ukrainian has a rule of syllable final laxing which changes the [+tense] value in the relevant obstruent to [-tense] (5).

(5) Syllable Final Laxing

$$[+\text{obstruent}] \rightarrow [-\text{tense}] \,/\, \_\_\_ \left\{ \begin{matrix} \# \\ C \end{matrix} \right\}$$

The rule in (5) is not a voicing rule. If it were, then word-final voiceless obstruents would become voiced as a result, e.g. *snip* *[snib] 'sheaf', instead of [snip], because the final obstruent is laxed. The same would be expected of the voiceless obstruents followed by other voiceless obstruents, e.g. *xlopčyk* *[xlobčyk] 'little boy', instead of [xlopčyk].[4] The rule simply undermines the status of tense obstruents in syllable final position in which they become targets of voicing assimilation. The latter takes place before a lexically lax obstruent bearing additional [+voice], which, however, is not phonologically spread to the target consonant, although it technically could. These two elements of the analysis – that voicing assimilation, which is observed on the surface, need not be a result of phonological spreading, and that the output of phonological derivation leaves certain aspects of the representation non-specified, are quite revolutionary and herald the advent of privativity in laryngeal phonology discussed in the following section (Mester and Itô 1989; Cho 1990; Lombardi 1995).

In the derivations below, spreading and default filling are left in the picture for comparative reasons to show their inert status. Another decision we make in this illustration concerns the feature [±voice]. While Bethin (1987) is couched in a binary system, and the feature [+voice] is crucial for the analysis, she does not refer to [-voice] even once. As will become evident in (6) below, the lexical representation of the voiceless obstruents as [+tense, -voice] would significantly complicate the analysis. For this reason, we mark the lexically voiceless obstruents as [+tense] only, and provide a modified analysis of Bethin (1987) in the following subsection.

(6) Deriving the Ukrainian pattern with binary [±tense] (Bethin 1987)

	a. _#	b. _#	c. _C		d. _C
	/h r y $b^{-t,+v}$/	/h r y p^{+t}/	/b o r o	t'^{+t}-$b^{-t,+v}$ a/	/r i $d^{-t,+v}$-k^{+t} o/
laxing	-	p^{-t}		t'^{-t}-$b^{-t,+v}$	-
**spreading*	-	-		-	-
**default filling*	-	-		-	-
phonetic int.	b	p		d' - b	d - k
	[h r y b]	[h r y p]	[b o r o	d' - b a]	[r i d - k o]

Recall that the analysis claims that Ukrainian has a rule of laxing, which manipulates the feature [±tense] and no corresponding rules affecting [±voice]. It requires that a lexical [-tense] obstruent is marked for [+voice], as in *hryb* (6a) and *ridko* (6d), while the lexical [+tense] obstruents – it is our understanding – do not carry [-voice], whose presence would be not only superfluous but it would complicate the above elegant derivations in *hryp* (6b) and *borot'ba* (6c). In the forms, *hryb* (6a) and *ridko* (6d), the relevant syllable final lax obstruent is phonetically interpreted as voiced due to the lexical presence of [+voice], either in the segment itself (6a), or in the following obstruent (6c). The feature [-tense] alone does not produce a voiced obstruent as is evident from the derivation of

[4] Bethin in fact assumes that in *xlopčyk* there is no laxing of /p/ because the cluster is tautosyllabic, and so the context for the rule is not met. It seems that this syllable-based assumption is superfluous. It follows from her analysis that the laxed /p/ would still be pronounced as voiceless because voicing would require the following voiced obstruent.

hryp (6b). Thus, the minimally expressed difference between *hryb* and *hryp* lies in the presence of [+voice] in the former. If [+voice] were a mere derivative, or a phonetic interpretation of [-tense] alone, we would expect word-final voicing, which does not take place. The voiceless phonetic interpretation of the final /p/ in *hryp* can also be guaranteed by [-voice] in the lexical representation, but, as mentioned above, this would complicate the derivation of *borot'ba* (6c). The syllable final /t'/ would have to be not only laxed but also somehow lose [-voice] to be assimilated to the following voiced obstruent. This would require a change of analysis to one in which not only [±tense] but also [±voice] is manipulated by the phonology of Ukrainian. On the other hand, the permanent underspecification of the voiceless obstruents for [-voice], which we assume was Bethin's unexpressed intention, renders them amenable to phonetic assimilation without further derivation, once they are laxed. This concerns not only *borot'ba* but also *brat gazdyni* [d-g] 'housewife's brother', that is, the word-final context. The obstruent in this position is phonetically assimilated only in the presence of the following voiced obstruent. Under this analysis, the voicing assimilation in *borot'ba* is obtained either by means of spreading, or by virtue of phonetic interpretation of the target, which is phonologically neutral with respect to voicing. It is the latter that Bethin assumes to be the case. The Ukrainian assimilation to a voiced obstruent does not involve [+voice] spreading, even in a binary system. Thus, not only [-voice] spreading in German, but also [+voice] spreading in Ukrainian might turn out to be an illusion.

Assimilation, then, is a good term to describe a surface phenomenon, but its phonological status may be much more complicated. It can be an instance of spreading, or follow from the phonetic interpretation. In both cases, it seems, the target must be neutral or neutralized. This suggests, that to some extent assimilation is always phonologically conditioned. Below, we focus especially on the requirement that the target of assimilation be neutral or neutralized.

2.3. A privative reanalysis of Bethin (1987)

Bethin's proposal appears to be innovative and has interesting consequences for phonological theory. Firstly, it incorporates the theory of markedness directly into the representation of the obstruents in the right way, which has consequences on the computation. Phonology only laxes tense objects syllable finally. The voiceless obstruents are marked with [+tense] and are therefore viable targets of lenition in prosodically weak position. This is different from the [±voice] analysis presented in 2.1., in which the voiceless obstruents are technically unmarked because they bear [-voice], and their delaryngealization is therefore theoretically unexpected, or at least more arbitrary in nature. Secondly, her analysis introduces notions like phonetic interpretation and phonetic assimilation, which change the nature of the relation between phonology and phonetics – not everything is phonological. The nature of an observed phenomenon is determined by the analysis, not by an a priori assumption like in the case of binary [±voice]. Thirdly, Bethin's analysis points to the necessity of using two features [±tense] and [±voice] to understand the working of the Ukrainian system.

There are, however, some glitches concerning the way the binary features are used here. Firstly, the laxing rule involves a change in value, which suggests that a more theoretically elegant way to express the phenomenon would be to refer to a privative feature [tense]. Secondly, the use of [±voice] predicts that [-voice] should play some role in the

system. All it does, however, is getting in the way of the analysis, suggesting again that a privative use of [voice] might be more consistent with the analysis of Ukrainian.

A privative version of Bethin's analysis can be readily provided. It seems clear that the representation of the laryngeal contrast in Ukrainian may be now translated into an equipollent one with two privative features [voice] and [tense] (D^{voice} vs. T^{tense}). Under this view, syllable final laxing is not a feature changing rule [+tense] → [-tense] as in Bethin (1987), but a delaryngealization or delinking process, that is, [tense]-delinking, producing a neutral obstruent ($T^{tense} \rightarrow T^{o}$), where the latter is subject to phonetic interpretation depending on the phonetic or phonological context involving [voice] (/borot'^{t}b^{v}a/ → /borot'^{o}b^{v}a/ = [borod'ba]). Thus, Bethin's analysis can be reformulated as utilizing a three-way distinction in Ukrainian, where only the neutral one can phonetically assimilate to the following voiced obstruent. In the absence of such context, it will be phonetically interpreted as voiceless. This conforms with the general idea discussed above that the target of assimilation must first lose its lexical identity (be neutralized). The equipollent use of the privative features seems to be still required because the voiced obstruent in this language is not just neutral (C^{o}), it is neutral before another, phonologically voiced obstruent ($C^{o}D^{voice}$), or it is a lexically voiced one (D^{voice}). We need to stipulate, though, that there is no [voice]-delinking in Ukrainian (/rid^{v}k^{t}o/ = [ridko]). This is parallel to the mechanisms targeting specific features in Wetzels and Mascaró (2001).

One apparent drawback of this analysis is that two laryngeal categories are proposed for a two-way contrast system. This goes against the theory of markedness and privativity (e.g. Trubetzkoy 1939/1969), but such proposals are not uncommon in the recent literature (e.g. Helgason and Ringen 2008). The debate between privative monovalent and equipollent approaches is not likely to be resolved soon.

Concluding the discussion of binary models, it should be said that they allow for and indeed entail robust systems of computation in which each operation can single out one feature value or both. We have observed that delinking of the laryngeal property in the target obstruent is probably the most important mechanism in laryngeal phonology. Its absence precludes the remaining mechanisms such as spreading and default filling, which are required only because of the general assumption that the output of phonological computation is fully specified. The analysis of Ukrainian voicing in Bethin (1987) is unique among binary approaches, in that it captures the choice of the manipulated category [+tense] in a more restrictive way that the [±voice] models, and eliminates the need for spreading or default filling, replacing them with a mechanism of phonetic interpretation at the interface between phonology and phonetics. This is consistent with most current privative approaches. As shown above, Bethin's binary analysis of Ukrainian voicing can be translated into a simpler privative, though equipollent system. Below, we turn to privative monovalent analyses of Ukrainian.

3. Privative accounts

Privative, especially monovalent approaches, may be viewed as theoretically more desirable than binary, or privative equipollent ones for a number of reasons. Firstly, they directly follow the Trubetzkoyan idea of markedness – one phonological category for a two-way contrast. Secondly, they simplify the phonological computation by restricting possible mechanisms. Thirdly, they enforce a different view on the relation between phonology and phonetics. The representation is less phonetically grounded, the output of

phonology can involve non-specification, and phonetic interpretation comes to the fore in laryngeal systems emphasizing the fact that phonology and phonetics are separate and represent different levels of linguistic explanation. The first privative accounts of voicing phenomena follow the approaches based on [±voice] in assuming that the relevant privative feature in languages like Ukrainian is [voice], which marks the voiced series (D^{voi}), whereas the voiceless obstruents are non-specified (Mester and Itô 1989; Cho 1990; Lombardi 1995). This idea has been further developed in the recent approach to representation called laryngeal realism (Harris 1994; Iverson and Salmons 1995; Honeybone 2002; Beckman *et al.* 2013).

3.1. Privative [voice] (Cho 1990, Lombardi 1995)

The Ukrainian voicing facts seem to be attractive for privative analyses based on [voice] because such systems are inherently asymmetrical. Again, we focus on the relation between the representation, possible delaryngealization and spreading, not on the actual formulation of the delaryngealization context. Both Cho (1990) and Lombardi (1995) argue for a privative analysis of Ukrainian. To simplify the matters a little, it is proposed that in this language, the voiced obstruents are represented with the feature [voice] (D^{voi}), while the voiceless obstruents have no laryngeal representation, and, as such, they are phonetically realized as voiceless unaspirated (T^{o}). The absence of final devoicing and assimilation of voiced obstruents to voiceless ones is explained single-handedly by assuming that this language does not possess laryngeal delinking. This protects the voicing of the obstruents in the final and pre-obstruent context as illustrated in (7) and predicts that the only type of regressive assimilation can be that to a voiced obstruent because the property can spread to the preceding unmarked object.

(7) Deriving the Ukrainian pattern with privative [voice]

	a. _#	b. _#	c. _C	d. _C
	/h r y b^{v}/	/h r y p^{o}/	/b o r o t'^{o}-b^{v} a/	/r i d^{v}-k^{o} o/
delinking	-	-	-	-
spreading	-	-	t'^{v}-b^{v}	-
**default filling*	-	-	-	-
phonetic int.	b	p	d' - b	d - k
	[h r y b]	[h r y p]	[b o r o d' - b a]	[r i d - k o]

In this analysis, phonetic interpretation takes over the function of default filling. Despite the fact that there is no laryngeal delinking in Ukrainian (7a,d), the neutral object is a viable target of spreading (7c). This was impossible in binary analyses which first required delinking of [-voice]. Thus, Ukrainian can be described in a rather simple and explanatory way. There is no final devoicing because the feature [voice] is licensed in all positions. This accounts also for the absence of regressive assimilation to a voiceless obstruent, which would also require [voice] delinking. Additionally, [voice] is the only feature that can spread because it is the only feature available (7c).

Typologically, however, when we take into account the relation between delinking and assimilation, even without determining whether the assimilation is due to phonological spreading or phonetic interpretation, the analysis of Ukrainian based on privative [voice] presents a problem. It concerns assimilation in a system with no delaryngealisation. It will be recalled, that this problem does not exist in binary models in which the target of assimilation is lexically specified and in order to assimilate to the following obstruent it must first lose its identity. The neutral obstruent in a privative model does not seem to have identity. However, as mentioned earlier, in Serbo-Croatian, which, like Ukrainian, does not have word final devoicing, that is, delinking of [voice], there is no assimilation. Whatever our understanding of assimilation – whether it is a case of spreading or phonetic interpretation – it seems to be blocked across the word boundary in Serbo-Croatian. At the same time, assimilation is possible word-internally and it resembles Polish. These facts suggest that the absence of delinking should perhaps be viewed as a way of protecting not only the marked segment, but also the unmarked one. The word-final neutral C^{o} is protected against assimilation in Serbo-Croatian. On the other hand, in Ukrainian it is not.

The problem of having or not having an assimilation in the context $T^{o}D^{voi}$ remains regardless of whether we want to derive assimilation by spreading or by phonetic interpretation. The neutral obstruent is protected – its phonetic interpretation is faithful – in some systems and not in others. This problem requires further study and Ukrainian data are bound to contribute to this theoretical debate because of its typological import.

3.2. Privative [fortis]

If privative [voice] can be viewed as a descendant of [±voice], an opposite approach to marking two-way contrasts in 'voice' languages such as Slavic, which is based on [fortis], could be said to continue the [±tense] story discussed above. One of the representational approaches that universally marks the voiceless series in two-way systems is called new laryngeal realism (van der Hulst 2015; Schwartz 2016).[5] Either for model internal reasons – no delaryngealization universally – as in van der Hulst (2015), or for typological ones – the absence of final devoicing follows from absence of neutralization – as in Schwartz (2016), the laryngeal category [fortis] remains in the lexical representation. Ukrainian has not been analysed within new laryngeal realism. Therefore, the discussion below merely looks at what the approach will have to say about the familiar four items in (8).

(8) Deriving the Ukrainian pattern with privative [fortis]

	a. _#	b. _#	c. _C	d. _C
	/h r y b^{o}/	/h r y p^{F}/	/b o r o t'^{F}-b^{o} a/	/r i d^{o}-k^{F} o/
**delinking*	-	-	-	-
**spreading*	-	-	-	-
**default filling*	-	-	-	-
phonetic int.	→ b	→ p	→ d' - b	→ d - k
	[h r y b]	[h r y p]	[b o r o d' - b a]	[r i d - k o]

[5] The voiceless series can be marked in laryngeal relativism as well (Cyran 2014, 2024). This, however, is a systemic rather than a universal choice.

It appears that, in the absence of any phonological activity in terms of delinking or spreading, the phonetic forms have to be arrived at solely through the mechanisms of phonetic implementation. For example, the general spell-out rules $C^{o} \rightarrow$ [voiced] and $C^{F} \rightarrow$ [voiceless] cover most cases in Ukrainian, except for the assimilation in *borot'ba* (8c), which would require an additional statement: $C^{F} \rightarrow$ [voiced] / _C^{o}. Such statements are not impossible, but one of the unexpected consequences of their employment in sound systems is that the phonological representation of the laryngeal distinctions becomes irrelevant, it does not contribute to a better understanding of the facts at hand, thus, defeating the purpose of proposing the specific privative representation based on the feature [fortis]. The same effects can be obtained with [±voice], [±tense], and privative [voice] discussed in the previous sections. Needless to say, the burden of accounting for typological variation, like the one concerning German, Polish or Serbo-Croatian mentioned above, would rest solely on the language specific implementational statements (cf. Keating 1984).

4. Conclusions

While we can clearly see how some of the approaches discussed in this paper fare better with Ukrainian and its place in a broader typological picture, the theoretical debate about laryngeal systems needs to be continued. What is needed perhaps is a change of philosophy concerning phonology and its place in the workings of sound systems. This concerns the relation between phonology and phonetics, the role of the phonological representation, the explanatory limits of all three aspects of sound systems, that is, phonology, phonetics and the interface, as well as the more fundamental questions about the nature of linguistic evidence in phonetic patterns. For example, when confronted with phonetic voicing and voicelessness, devoicing, and assimilation are we dealing with linguistically real items and mechanisms, or with their mere externalization that is related to the mental linguistic aspects via arbitrary associations established during acquisition? We have seen how privativity simplifies the phonological component by stressing the role of phonetic interpretation. However, the problem with the latter is that, when left unconstrained, it leads to a robust interface between phonology and phonetics which obviates the need for particular phonological repesentations and indeed computation.

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