Polish Voice Assimilation in Optimality Theory *

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Polish Voice Assimilation has been a subject of much debate in the recent literature. This includes Booij and Rubach (1987), Cho (1990a, 1990b)[1], Rubach and Booij (1990a), Lombardi (1991, 1995), Bethin (1992), Gussmann (1992) and Rubach (1996). A unifying characteristic of all these analyses is the fact that they are carried out in a framework that precedes Optimality Theory (Prince and Smolensky 1993, McCarthy and Prince 1993a, McCarthy and Prince 1993b and others). As is usually the case, the introduction of a new framework poses the question of whether the generalizations expressed in the earlier frameworks can be maintained. A further question is whether the new framework can provide new insights. The goal of this paper is to address both of these questions with regard to voice assimilation in Polish.

The structure of the presentation is as follows. Section 1 introduces the range of data to be analyzed. This provides an occasion to state basic generalizations. Section 2 develops an OT vocabulary for the analysis of voice assimilation by proposing a set of output constraints. It is demonstrated how these constraints account for the data exemplified in section 1. We then look at various typologies in section 3 to see whether the constraints developed for Polish can find support in other languages. Section 4 addresses Progressive Devoicing. One further constraint is added and the generalization that progressive assimilation is limited to the domain of morphemes is discussed in detail. The most significant results of this paper are summarized in section 5.

1. Data and basic generalizations

Polish exhibits alternations of voiced and voiceless obstruents in several clearly defined contexts. We begin with instances of Final Devoicing.

(1) *chleb+y*[2] [b] 'bread' (masc. nom.pl.) - *chleb* [p] (nom.sg.)
ud+o [d] 'thigh' (neuter nom.sg.) - *ud* [t] (gen.pl.)
traw+a [v] 'grass' (fem. nom.sg.) - *traw* [f] (gen.pl.)

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Obstruents, but not sonorants, are subject to Final Devoicing. We are looking here at a process of neutralization since Polish has voiced and voiceless obstruents but not voiced and voiceless sonorants.

(2) *kod+y* 'codes' (masc. nom.pl.) - *kod* [t] (nom.sg.)
kot+y 'cats' (masc. nom.pl.) - *kot* [t] (nom.sg.)
dom (masc. nom.sg.) - *dom+y* (nom.pl.): voiced [m] in both cases

Similarly, obstruents, but not sonorants, are affected by Voice Assimilation. Thus, the [r] and the [l] as well as [m] in *karta* 'card' and *klamka* 'handle' are fully voiced. Voice Assimilation is an obstruent-to-obstruent process and applies regressively (but see section 4). Alternations arise as a result of suffixation or vowel deletion (Yer Deletion, see below). The cluster is then uniformly voiceless or voiced, depending on the voicing of the obstruent on the right.

(3) a. Devoicing
ud+o [ud+o] 'thigh' - *ud+k+o* [ut+k+o] (diminutive, dimin. hereafter)
grub+y [grub+i̯] 'fat' - *grub+sz+y* [grup+š+i̯] 'fatter'
wesz [veš] 'louse' - *wsz+y* [fš+i̯] 'lice'
dech [dex] 'breath' - *tch+u* [tx+u] (gen.sg.)
łyżek [wi̯żek] 'spoon' (gen.pl.) - *łyżk+a* [wi̯šk+a] (nom.sg.)

b. Voicing
kos+i+ć [ɕ] 'to mow' - *koś+b+a* [ʒ+b] 'mowing'
licz+y+ć [ʧ] 'count' - *licz+b+a* [ʤ+b] 'number'
wieszcz+y+ć [šʧ] 'prophesize' - *wieszcz+b+a* [žʤ+b] 'prophesy'

At word juncture, where Final Devoicing and Voice Assimilation are in competition, it is Voice Assimilation that wins. The opposition between the underlyingly voiceless and voiced obstruents is neutralized in favour of voiced obstruents in (4a) and in favour of voiceless obstruents in (4b).The examples in (4b) could be derived from either of the two generalizations: Final Devoicing or Voice Assimilation.

(4) a. Voicing
los+y [s] 'fates' - *los banku* [z##b] 'the fate of the bank'
sklep+y [p] 'stores' - *sklep warzywny* [b##v] 'greengrocer's'
rozkaz+y [z] 'orders' - *rozkaz bojowy* [z##b] 'war order'
trud+y [d] 'efforts' - *trud budowy* [d##b] 'the effort of building'

b. Devoicing
mord+y [d] 'killings' - *mord kobiety* [t##k] 'the killing of a woman'
staw+y [v] 'ponds' - *staw publiczny* [f##p] 'public pond'
czas+y [s] 'times' - *czas powrotu* [s##p] 'return time'
lot+y [t] 'flights' - *lot samolotu* [t##s] 'the flight of the aircraft'

In instances of final obstruent clusters, both Final Devoicing and Voice Assimilation seem to play a role, with the former feeding the latter in (5a) where each of the obstruents is voiced at the underlying level. There are also clusters of two underlyingly voiceless obstruents in (5b) where Final Devoicing and Voice Assimilation apply vacuously.

(5) a. *wróż+y+ć* [ž] 'predict' - *wróż+b+a* [ž+b] 'prediction' - *wróż+b* [š+p] (gen.pl.)
groz+i+ć [ʒ] 'threaten' - *groź+b+a* [ʒ+b] 'threat' - *gróź+b* [ɕ+p] (gen.pl.)

b. *nios+ą* [s] 'they carry' - *nieś+ć* [ɕ+tɕ] 'to carry'
plot+ą [t] 'they weave' - *pleś+ć* [ɕ+tɕ] 'to weave'

A different situation is presented in (6). In (6a) the configuration in the underlying representation is a voiceless obstruent followed by a voiced one while in (6b) it is exactly the opposite. The result is the same: the surface representations with voiceless clusters are derived by Final Devoicing and Voice Assimilation in (6a) and by Voice Assimilation alone in (6b).

(6) a. *pros+i+ć* [ɕ] 'ask' - *proś+b+a* [ʒ+b] 'request' - *próś+b* [ɕ+p] (gen.pl.)

b. *wiez+ie* [ʒ] 'he transports' - *wieź+ć* [ɕ+tɕ] 'to transport'

To summarize, we have four different configurations with regard to underlying voicing in final clusters:
– two voiced obstruents;
– two voiceless obstruents;
– voiceless obstruent followed by a voiced obstruent;
– voiced obstruent followed by a voiceless obstruent.
These configurations arise by virtue of suffixation, and the different underlying values for voicing are motivated by alternations. The argument from alternations does not fully extend to the data in (7).

(7) a. *gwiazd+a* [zd] 'star' - *gwiazd* [st] (gen.pl.) - *gwiazd+k+a* [st+k] (dimin.)
past+a [st] 'paste' - *past* [st] (gen.pl.)
b. *bzdur+a* [bzd] 'nonsense', *pstr+y* [pst] 'gaudy'

The clusters occur internally in a morpheme and the obstruents always act together: they are either all voiced or all voiceless. This generalization also applies to clusters which permit an alternation (7a) and to clusters that never alternate because they are always prevocalic (7b). A standard practice ever since Trubetzkoy (1939) is to posit archiphonemes in nonalternating clusters:

(8) *gwiazd+a* /Zd/ 'star', *past+a* /St/ 'paste'
bzdur+a /BZd/ 'nonsense', *pstr+y* /PSt/ 'gaudy'

Voice Assimilation is then a process of filling in unspecified values by spreading. In sum, Voice Assimilation can be either a feature filling (7) or a feature changing operation (3-6).

A complication for the analysis of both Final Devoicing and Voice Assimilation derives from the observation that sonorants (liquids and nasals) act as transparent segments. That is, the devoicing and voicing of obstruents operates as if these sonorants were absent. Consider the operation of Final Devoicing in (9).

(9) *bobr+y* [b] 'beaver' (masc. nom.pl.) - *bóbr*[3] [pr] (nom.sg.)
bieg+ł+a [g+w] 'she ran' - *bieg+ł* [k+w] 'he ran'
trucizn+a [zn] 'poison' (fem. nom.sg.) - *truc+izn* [sn] (gen.pl.)
romantyzm+u [zm] 'Romanticism' (masc. gen.sg.) - *romantyzm* [sm] (nom.sg.)

Like Final Devoicing, Voice Assimilation is also insensitive to the presence of sonorants.[4]

(10) a. Devoicing
Jędrek [dr] 'Andy' - *Jędrk+a* [trk] (gen.sg.)
uleg+ł +a [g+w] 'she succombed' - *uleg+ł+szy* [k+w+š] 'having succumbed'
pragmatyzm+u [zm] 'pragmatism' (gen.sg.) - *pragmatyzm społeczny* [sm##s]
b. Voicing
filtr+y [tr] 'filter' (nom.pl.) - *filtr wodny* [dr##v] 'water filter'
nios+ł+a+by [s+w] 'she would carry' - *niós+ł+by* [z+w+b] 'he would carry'
czasopism+o [sm] 'journal' - *czasopism zagranicznych* [zm##z] 'foreign journals' (gen.pl.)

Could one conclude that sonorants are simply unspecified for [voice] and, consequently, that the laryngeal nodes of obstruents are adjacent? It would then be natural for sonorants to be transparent to Voice Assimilation since they would be invisible at the relevant tier (that is, the laryngeal tier). This hypothesis is incorrect, albeit it does contain a grain of truth.

There are two reasons why the conjecture that sonorants are unspecified for [voice] cannot be maintained. First, in some situations sonorants act as blockers of Voice Assimilation. We address this problem directly below. Second, there is positive evidence that sonorants may also act as triggers of Voice Assimilation, a process that we discuss later under the heading of Cracow Voicing.

If all sonorants were always transparent to Voice Assimilation, then we would expect that voice contrasts in obstruents could only be found in strings that contain one obstruent in a word or phrase, since then Voice Assimilation, being an obstruent-to-obstruent spread, could not take effect, for example, *raz+y* 'blows' - *ras+y* 'races'. But this is not the case. Obstruents also contrast in words which contain more than one obstruent, and the obstruents may, but need not, agree in voicing.

(11) a. *pas+y* 'belts' - *bas+y* 'low voices'
plus+y 'pluses' - *blus+y* 'blues'
frak 'tails' - *wrak* [vr] 'wreck'
b. *god+y* 'wedding' - *kod+y* 'codes'
braw+o [brav+o] 'applause' - *praw+o* [prav+o] 'law'.

If Voice Assimilation were permitted to treat all sonorants as transparent, then the contrasts in (11) should not exist: the [b] of *basy* 'low voices' would devoice to [p] and the [k] of *kody* 'codes' would voice to [g]. The question therefore is what distinguishes the nontransparent sonorants in (11) from the transparent sonorants in (10).

Closer examination of the data shows that a common property of transparent sonorants is their inability to syllabify. Thus, for instance, the [r] in [jendrka] could not be put either in the onset or in the coda, because sonority violations would ensue. In contrast, the sonorants in (11) can be fully syllabified and are therefore nontranspa-

rent. We shall capitalize on these observations in the statement of Sonorant Default in section 2.

The hypothesis that all sonorants are unspecified for [voice] is incorrect for yet another reason. Polish has two prestigious dialects known as Warsaw Polish and Cracow Polish. One of the few distinguishing traits of these dialects is the operation of Voice Assimilation (see, for example, Wierzchowska 1971). In particular, Cracow Polish voices obstruents before sonorants while Warsaw Polish devoices them in the same position. (All the other generalizations hold in equal measure for both dialects.) This process known as Cracow Voicing is illustrated in (12).

			Warsaw Polish		Cracow Polish	
(12)	a.	*kod Ali* 'Alice's code'	t	a	d	a
		kod Janka 'Janek's code'	t	j	d	j
		kod Ludwika 'Ludwik's code'	t	l	d	l
		kod Romana 'Roman's code'	t	r	d	r
		kod nasz 'our code'	t	n	d	n
	b.	*kot Ali* 'Alice's cat'	t	a	d	a
		kot Janka 'Janek's cat' t	j	d	j	
		kot Ludwika 'Ludwik's cat'	t	l	d	l
		kot Romana 'Roman's cat'	t	r	d	r
		kot nasz 'our cat'	t	n	d	n

The presence of a word boundary is a condition for Cracow Voicing. Inside words, voice contrast before sonorants is maintained in all dialects of Polish. Unsyllabified sonorants do not count, as was the case previously. Thus, (13b) is parallel to (13a).

(13) a. *brudny* [dn] 'dirty', *zabawny* [vn] 'funny', *żyzny* [zn] 'fertile'
vs. *butny* [tn] 'rebellious', *ufny* [fn] 'trusting', *ciasny* [sn] 'narrow'

b. *srebrny* [brn] 'silver' (Adj.), *jędrny* [drn] 'firm'
versus *świetlny* [tln] 'light' (Adj.), *pomyślny* [ɕln] 'successful'

It is a challenge to explain why Cracow Voicing is limited to consonants that occur across word boundaries. We propose a solution to this dilemma in section 2.

Finally, let us look at the facts of Progressive Devoicing. The words in (14) show that assimilation works from left to right rather than from right to left, as has been the case so far.

(14) a. *tratw+a* [tratfa] 'raft' - *tratew+ek* [tratevek] (dimin. gen.pl.)
poszw+a [pošfa]'pillow case' - *poszew+ek* [poševek] (dimin. gen.pl.)
pochw+a [poxfa] 'sheath' - *pochew+ek* [poxevek] (dimin. gen.pl.)
bitw+a [bitfa] 'battle' - *bitew+n+y* [bitevn ɨ] 'warlike'

b. *kuter* [kuter] 'cutter' - *kutrz+e* [kutše] (loc.sg.)
koper [koper] 'dill' - *koprz+e* [kopše] (loc.sg.)
wicher [vixer] 'wind' - *wichrz+e* [vixše] (loc.sg.)
Piotr [pjotr] 'Peter' - *Piotrz+e* [pjotše] (loc.sg.)

The words in (14a) are straightforward. The forms on the right have a surface voiced fricative and, since Polish has no intervocalic voicing, it must be this fricative rather than [f] that is an underlying segment.[5]

The data in (14b) are more complex than those in (14a), because the surface obstruent [š] has /r/ as its underlying source. This is a standard analysis and is well supported (see, for example, Rubach 1984 and Bethin 1992). Briefly, an independent palatalization process takes /r/ to [ž] before front vowels.

(15) *biur+o* 'office' - *biurz+e* [ž+e] (loc.sg.)
biodr+o 'hip' - *biodrz+e* [ž+e] (loc.sg.)

In (14b) the added complication is a further change from [ž] to [š] but this is not surprising, because the preceding consonant is invariably voiceless. The situation is then the same as in (14a): a voiced obstruent devoices after a voiceless obstruent.

In the examples that we have seen so far, Progressive Devoicing is motivated by alternations but a similar pattern is found in words that do not exhibit alternations.

(16) a. *tward+y* [tfardɨ] 'hard', *kwadrat* [kfadrat] 'square', *chwast* [xfast] 'weed'

b. *dwa* [dva] 'two', *gwar+a* [gvara] 'dialect', *żwaw+y* [žvavɨ] 'lively'

c. *trzod+a* [tšoda] 'pigs', *pszenic+a* [pšɛnitsa] 'wheat', *chrzan* [xšan] 'horseradish'

d. *drzew+o* [dževo] 'tree', *grzywn+a* [gžɨvna] 'penalty', *wrzask* [vžask] 'scream'

These words do not reveal anything new as /f v š ž/ are independently motivated as underlying segments in Polish, compare *fal+a* 'wave', *wy* 'you', *szaf+a* [š] 'wardrobe', *rzek+a* [ž] 'river'. By Trubetzkoy's (1939) principle that [voice] is not distinctive in clusters, the clusters in (16) are all instances of archiphonemic representations. That is, the left obstruent in each cluster is unspecified for [voice]. Taking the first word in each group as an example, we arrive at the following representations of the clusters.

(17) *tward+y* 'hard': /Tf/
dwa 'two': /Dv/
trzod+a 'pigs': /Tš/
drzew+o 'tree' /Dž/

The words with archiphonemes are in all the relevant ways the same as the words exhibiting alternations. Whatever set of generalizations is going to account for the latter should also be able to account for the former.

Most alternations motivating Progressive Devoicing arise as a result of vowel deletion. It is the same deletion as found earlier in the discussion of Voice Assimilation (the *dech - tch+u* pattern in (3a)). Below we address this issue briefly and only inasmuch as it is relevant to the discussion of Voice Assimilation.

The alternating vowels are known as yers and they have been a subject of much study in generative phonology ever since Lightner's (1965) original discovery that they play a role in the phonology of modern Slavic languages.[6] The pattern of alternation can roughly be described as follows. As shown in (14), yers are vocalized (that is, appear phonetically) if they are followed by a yer later in the word or by a word boundary (intervening consonants do not count); otherwise they are not sounded. Thus, *tratew+ek* 'raft' (gen.pl.), which comes from the underlying /tratEv+Ek/ where capital /E/ stands for a yer, has both of its yers vocalized, because the environment for vocalization is met. However, the nom.sg. form /tratEv+Ek+a/ has only one vocalized yer: *tratew+k+a*. The second yer is not vocalized because it is before *-a* rather than before a yer or a word boundary. By the same token, the yer in the nondiminutive form /tratEv+a/ cannot vocalize and is therefore not realized phonetically.

There have been a number of interpretations of the yers in the literature. The recent widely accepted view due to Kenstowicz and Rubach (1987) is to assume that yers are floating segments. That is, they are defective from the point of view of syllabification. The

underlying representation of the yer lacks an X-slot or a mora. Vocalization is a process of inserting the missing X-slot or mora. Once this is done, yers are available to syllabification and surface as vowels in their function of syllable nuclei. Unvocalized yers are floating and therefore cannot be realized phonetically (Stray Erasure). In sum, they are not present in the output form.[7]

2. *OT proposal*

In this section we address the question of how the generalizations expressed earlier as Voice Assimilation, Final Devoicing and Cracow Voicing can be expressed in Optimality Theory. (Progressive Devoicing is discussed in section 4). We develop a set of constraints, some of which are standard and some of which are proposed in this paper for the first time. We then show how these constraints interact and how they are ranked. We begin with the standard constraints whose status is not controversial.

Any version of OT recognizes a class of Faithfulness constraints. The task of these constraints is to make sure that the output representation does not diverge from the underlying representation. This is achieved by prohibiting the addition of any new material as well as prohibiting the deletion of the existing structure (the Fill and the Parse constraint families, respectively). For the purposes of this paper, two Faithfulness constraints play a prominent role:[8]

(18) $\text{Parse}_{[\text{-voice}]}$ (Parse-v): [-voice] must be parsed

(19) $\text{Parse}_{[\text{+voice}]}$ (Parse+v): [+voice] must be parsed

These are separate constraints and, as we will show, it is essential to recognize this fact. The effect of (18) and (19) is to force the underlying [-voice] and [+voice] to appear in the output representation. Consequently, these constraints militate against Voice Assimilation and Final Devoicing. It therefore follows that in order for the latter two generalizations to have any effect at all, there must be some other constraints that outrank (18) and (19). We will look at them shortly, but first let us consider Voice Default and other standardly assumed constraints.

The literature of the past decade has made it clear that one way to recognize the unmarked status of voicelessness in obstruents is to assume that [-voice] is supplied by default (Kiparsky 1982,

Archangeli 1984 and others). This mode of reasoning can be accommodated into OT. Prince and Smolensky (1993) as well as McCarthy and Prince (1993a) assume that the output representation that is subject to OT evaluation is not necessarily equivalent to the phonetic representation of the classic generative phonology. In particular, default properties may be spelled out in the phonetic interpretation component. We will make use of this possibility and assume that Voice Default takes effect in the phonetic interpretation component. It is therefore not necessary for all instances of devoicing to be understood as the addition of [-voice] at the OT output level. The same result is obtained by leaving an obstruent unspecified for [voice], because [-voice] will automatically be provided by Voice Default in the phonetic interpretation.

While some default properties may be provided in the phonetic interpretation component, all other information must be present in the output representation in order not to escape evaluation. That is, underspecification in the output representation is possible only under pressure from some highly ranked constraints. It is therefore not controversial that OT must include SPEC (for Specify).[9]

(20) SPEC: output segments must be fully specified

One obvious consequence of SPEC is that words containing underlying archiphonemes in (7) will have optimal outputs with fully specified segments. This preempts the possibility that the archiphonemes are spelled out incorrectly as voiceless obstruents by Voice Default in the phonetic interpretation. In (21) we look at *bzdur+a* 'nonsense'. In the underlying representation, *b* and *z* are archiphonemes; that is, they are unspecified for voicing. We consider the cluster only.[10]

(21) underlying representation /b z d/

L

+v

	SPEC	PARSE-voice	PARSE+voice
1. b z d ← L L L +v			
2. b z d L +v	**!		
3. b z d L	***!		*

Note: in (21) and below I adopt the convention of putting the optimal candidate first; it is marked with an arrow and printed bold; also, I omit unparsed features.[11]

In more general terms, the beneficial consequence of SPEC is its ability to induce spreading. In this sense its role is far greater than that of filling in the missing values on underlyingly unspecified segments.

The fact that SPEC is a constraint does not mean that all optimal output representations must be fully specified. In some instances underspecified segments should be valued more highly than fully specified segments. The case in point is the operation of Sonorant Default.

As is well known, sonorants are typically voiced. The past literature expresses this generalization by assuming that sonorants are unspecified for [voice] in the underlying representation and that [+voice] is added by Sonorant Default (Kiparsky 1982, Archangeli 1984, Itô and Mester 1986, Steriade 1987 and others). This view is

compatible with OT in which Sonorant Default is a constraint that rewards the candidate with voiced sonorants. However, the exact statement of Sonorant Default requires further scrutiny.

Recall that not all sonorants behave in the same way in Polish. In particular, some sonorants block Voice Assimilation while others do not. This distinction can be seen to follow naturally from Sonorant Default if the nontransparent segments are specified for voicing and the transparent segments are not (see below). Recall further that the distinction between blockers and nonblockers is correlated to syllabification. The former are syllabified while the latter are not, because they violate sonority. In sum, Sonorant Default is sensitive to syllable structure.

(22) Sonorant Default (SonDef): all and only syllabified sonorants are specified for voicing.[12]

It is to be expected that the tier of representation that is relevant to Voice Assimilation is the laryngeal tier. While in the case of most segments the adjacency at the root tier is equivalent to adjacency at the laryngeal tier, in the case of unsyllabified sonorants there is an asymmetry. These sonorants have no representation at the laryngeal tier, as mandated by (22). They are therefore invisible to Voice Assimilation. Consider the representation of *Jędrk+a* 'Andy' (gen.sg.).

(23)

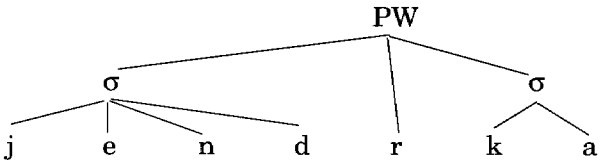
j	e	n	d	r	k	a
|	|	|	|		|	|
L	L	L	L		L	L
|	|	|	|		|	|
+v	+v	+v	+v	-v	+v	

For the purposes of Voice Assimilation, /d/ and /k/ are adjacent since their laryngeal nodes are adjacent. The same constraints that account for the straightforward cases such as *ud+k+o* 'thigh' (dimin.) will account for the devoicing of /d/ to [t] in (23). Note, however, that [voice] must be regarded as a binary rather than a privative feature since it is only then that the adjacency of the /d/ and the /k/ in (23) can be defined at the laryngeal tier. This is not a problem. As argued by Rubach (1996), the assumption that [voice] is binary is well supported in Polish, a fact that we will note later in connection with Cracow Voicing and Progressive Devoicing.

There are two outstanding problems: first, the prosodic status of

unsyllabified sonorants and, second, their specification for voicing in the phonetic representation. If sonorants violating sonority remain unsyllabified, then how is it possible for them to be pronounced? The point is that the /r/ in (23) is not deleted. A solution to this dilemma was proposed by Rubach and Booij (1990a), who argue that these sonorants are adjoined directly to the phonological word node (PW). This interpretation is additionally supported by the fact that native speakers are unable to decide whether the [r] in words such as /jendrka/ belongs to the first or to the second syllable. The syllabification judgements as well as the transparency effects are readily accounted for by representing these sonorants as belonging to neither syllable.[13]

(24)



The treatment of word-final transparency shown in (9) in section 1 is an exact parallel to the treatment of word-internal transparency in (23-24). Unsyllabified sonorants have no representation at the laryngeal tier, for instance, the /r/ of *bóbr* /bubr/ 'beaver'. Consequently, the laryngeal node of the presonorant obstruent (here: *b*) is final in the word in the same sense as the laryngeal node of *d* is final in *kod* 'code'. We predict that the /b/ and the /d/ in *bóbr* and *kod* should behave in the same way with regard to Final Devoicing, which is correct.

The second outstanding question refers to the phonetic specification for voicing in unsyllabified sonorants. This is a complex and poorly understood problem.

Amongst liquids, [r] is typically voiceless in voiceless contexts. In the case of [l] this may but need not be true. The nasals, on the other hand, are more often voiced than voiceless in devoicing environments (Wierzchowska 1971, Rubach and Booij 1990a). This variation depends to some extent on the tempo and style of speech and is difficult to capture in any phonological analysis, regardless of the framework. The recent literature claims that the issue is not phonological in nature and is best viewed as belonging to the sphere of phonetic implementation (Lombardi 1991, Bethin 1992).

A combined effect of Sonorant Default and the parsing constraints in (18-19) is the occurrence of voice contrasts in obstruents before sonorants: *buty* 'shoes' - *budy* 'sheds'. But how do we account

for alternations of voiced and voiceless obstruents? It is this central question that we turn to now.

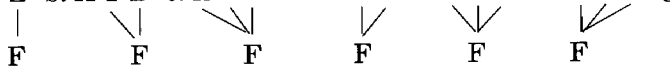
Our analysis of Voice Assimilation presupposes the concept of licensing (Itô 1986, Goldsmith 1990, Lombardi 1991, Itô, Mester and Padgett 1993, Zoll 1995 and others). This concept requires clarification in order to avoid confusion in the evaluation of various candidates submitted by GEN.

I will assume that [voice] is licensed on all segments unless otherwise mandated by a constraint. I will further assume that features can be licensed parasitically (Lombardi 1991, Itô and Mester 1993). Parasitic licensing plays a role in instances where a feature is multiply linked. Specifically, not all segments to which such a feature is linked need to be licensers; it is sufficient if one of them is. Parasitic licensing follows from the general principle in (25).

(25) A feature is licensed if it is linked to a licenser.

To look at an example, assume that some constraints make the licensing of the feature F illegal on X and Y in the string XYZ, but no constraint militates against the licensing of F on Z. Then, (26a-g) are well-formed while (26h-k) are ill-formed.

(26) a. X Y Z b. X Y Z c. X Y Z d. X Y Z e. X Y Z f. X Y Z g. X Y Z



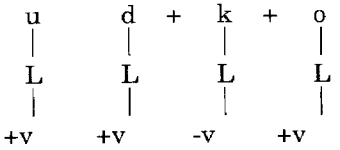
h. *X Y Z i. *X Y Z j. *X Y Z k. *X Y Z l. *X Y Z

Parasitic licensing occurs in (26b-f). The feature F is licensed on Y or on X and Y because it is linked not only to these segments but also to Z which is a legal licenser. It does not matter whether F is an underlying feature of Z (26b-c), Y (26d-e) or X (26f). With this clarification of licensing, we are now ready to look at the specific facts of Polish Voice Assimilation.

Recall that the attested alternations exhibit all kinds of configurations: two voiced obstruents, two voiceless obstruents, a voiced obstruent followed by a voiceless one; and the opposite, a voiceless obstruent followed by a voiced obstruent (see (5-7) in section 1). The desired output is one in which the cluster takes on the voicing of the rightmost obstruent. To use Trubetzkoy's (1939) concept, the opposi-

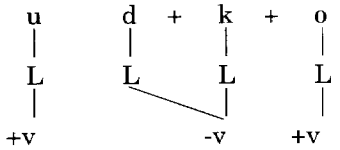
tion of voicing is neutralized before obstruents. In terms of licensing, this means that [voice] is not licensed on obstruents before obstruents. Consequently, [voice] is not permitted on *d* in (27). Our example is *ud+k+o* [ut+k+o] 'thigh' (dimin.) which comes from underlying /ud+k+o/, see the alternations in (3a).

(27)



While (27) is ill-formed, (28) is not.

(28)



The second obstruent, *k*, is a legal licenser of [voice] because it is before a sonorant rather than before an obstruent. Under parasitic licensing, [-voice] is also licensed on *d*. In sum, we need a constraint that outlaws the output in (27) but not in (28).

(29) Obstruent License (ObstrLic): [voice] on obstruents before an obstruent may only be licensed parasitically.[14]

In other words, when obstruents appear in a cluster XZ, then [voice] is not licensed if it is linked only to X. As we will see later, not all parasitic licensing can be regarded as licit.

For further clarification, it should be added that the adjacency relevant to Voice Assimilation constraints such as (29) is that of the laryngeal nodes (recall the discussion of [jendrka]). That is, (29) should be understood to say that [voice] is not licensed on the laryngeal node of an obstruent before the laryngeal node of another obstruent.

Obstruent License has its predecessors in the recent literature. More directly, it relates to the delinking rules of Cho (1990a). Less directly, it goes back to Lombardi (1991) and Bethin (1992). These latter authors have proposed that [voice], a privative feature in their analysis, is licensed before sonorants in an onset. They have thus

linked the licensing of voicing to syllable structure in a direct way. Rubach (1996) critiques this view and points out that in Polish, obstruents contrast not only in onsets but also in codas, for example, *sreb.(r).ny* 'silver' (Adj.) - *świet.(l).ny* 'light' (Adj.): [b] and [t] are in the coda; the liquids are unsyllabified as in /jendrka/ in (23).

On a more general level, Obstruent License expresses the well known observation that the salience of an obstruent is severely hindered before another obstruent due to diminished ability of sustaining contrast in a cluster of articulatorily similar sounds. It is therefore not surprising that an obstruent before an obstruent cannot act as licenser for [voice]. Consequently, its [voice] must be parasitic, that is, it must come from another segment.

The effect of Obstruent License is to permit the parsing of [voice] in the obstruents in (30a) but not in the left obstruents in the clusters in (30b).

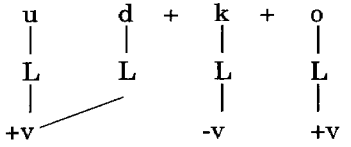
(30) a. *to* 'this', *do* 'to', *smok* 'dragon', *zmor+a* 'nightmare', *krat+a* 'bar', *groz+a* 'threat', *but+ny* 'rebellious', *trud+ny* 'difficult', *koch+liv+y* 'amorous'

b. *grub+sz+y* [p+š] 'fatter', *wsz+y* [fš] 'lice', *licz+b+a* [dʒ +b] 'number', *wieszcz+b+a* [ždʒ+b] 'prophesy', *past+a* [st] 'paste', *gwiazd+a* [zd] 'star'.

The underlined obstruents are legal licensers for [voice], because their laryngeal nodes are adjacent to laryngeal nodes of sonorants on the right rather than to laryngeal nodes of obstruents. (The sonorants have their [voice] in consequence of Sonorant Default.) By the same token, *k* is a licenser in /jendrka/ but *d* is not. The laryngeal node of *k* is adjacent to the laryngeal node of a sonorant while the laryngeal node of *d* is not (see (23) above). On the contrary, the laryngeal node of *d* is adjacent to the laryngeal node of *k*. This follows from the fact that *r*, being unsyllabified, cannot carry any voicing, a prohibition that is contained in Sonorant Default. The conclusion is that [voice] is not licensed on *d*. Likewise, the [voice] specification on *b* in *srebrny* 'silver' (Adj.) is licensed, because the laryngeal node of *b* is adjacent (across *r*) to the laryngeal node of *n*, which is a sonorant rather than an obstruent.

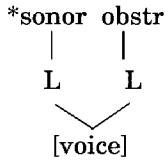
Returning to our example, *ud+k+o* [ut+k+o] 'thigh' (dimin.), consider the candidate in (31).

(31)



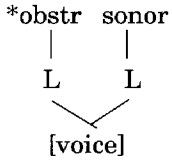
Obstruent License is not violated, because *d* is licensed parasitically by *u*. However, the result is incorrect: *[ud+k+o]. The parasitic licensing in (31) cannot be permitted. We need a new constraint.

(32) Sonorant Left (Son-L):



Sonorant Left outlaws candidates in which voicing is shared by a sonorant and an obstruent. The configuration as given, [sonorant] [obstruent], is essential. It could not be generalized to ban all types of multiple association of [voice] between sonorants and obstruents. The reason is that the sharing of voicing between obstruents and sonorants (in this order) is attested to. Recall that Cracow Voicing is such a case. The obstruent assumes the voicing from the following sonorant in *kot Ali* [d] 'Alice's cat'and *kot nasz* [d] 'our cat' (see (12) in section 1). This type of voicing is not permitted in Warsaw Polish, a fact that calls for Sonorant Right as a constraint.

(33) Sonorant Right (Son-R)



While Sonorant Left is unviolable in all dialects of Polish,[15] Sonorant Right is violable in the Cracow dialect. Before we address this particular problem, we need to explain how our constraints work and look at Final Devoicing.

In table (34) we evaluate a reasonably large number of candidates for *ud+k+o* [ut+k+o] 'thigh' (dimin.). The ranking is marked by a double line. Note also the abbreviations: Son-L = Sonorant Left, ObstrLic = Obstruent License, SonDef = Sonorant Default, Son-R = Sonorant Right, SPEC = Specify, Parse-v = $\text{Parse}_{[\text{-voice}]}$, Parse+v = $\text{Parse}_{[\text{+voice}]}$.

(34) /u d + k+o/[16]

	Son-L	ObstrLic	SonDef	Son-R	SPEC	Parse-v	Parse+v
1. u d+k+o L L L L← +v -v+v							*
2. u d + k + o L L L L +v +v +v						*!	
3. u d + k + o L L L L +v+v -v +v		*!					
4. u d + k + o L L L L +v -v +v	*!						*
5. u d + k + o L L L L +v +v				*!	*	*	*
6. u d + k + o L L L L +v +v +v				*		*	
7. u d + k + o L L L L +v -v +v		*!			*!		*
8. u d + k + o L L L L +v +v +v					*	*	
9. u d + k + o L L L L +v +v		*!			**!	*	*
10. u d + k + o L L L -v +v			*!		*		*

Let us clarify how the evaluation proceeds. Sonorant Left is violated in candidate (4) because the sonorant and the obstruent share [voice]. Obstruent License is violated by [d] in candidates (3), (6) and (8) since *d* carries [voice] and its laryngeal node is next to that of an obstruent. (It does not matter that in candidate (8) this node has no specification for voicing.) Candidate (4), on the other hand, does not violate Obstruent License because [+voice] on the *d* comes from the vowel, which is a legal licenser by virtue of Sonorant Default. There is also no violation of Obstruent License in candidate (2). The feature [+voice] is linked not only to *d*, which is not a licenser, but also to *k*, which is a licenser because its laryngeal node is before the laryngeal node of a sonorant and not that of an obstruent. Consequently, [+voice] on *d* is licensed parasitically via *k*. Sonorant Default is violated by candidate (10) because *u* is syllabified and yet does not have any specification for voicing. In candidates (5) and (6) [voice] is shared by an obstruent and a sonorant, therefore we see violations of Sonorant Right. All instances in which the feature [voice] does not appear in the output representation on some segment incur violations of SPEC; these are candidates (5) and (7-10). (The violations are multiple if more than one segment is unspecified.) The operation of the parsing constraints is self-evident, but two points might be noted. First, candidate (10) violates $\text{Parse}_{[+\text{voice}]}$ because the underlying [+voice] of *d* does not appear in the output form. However, this constraint is not violated by *u* since sonorants are not specified for voicing in the underlying representation. Second, it is debatable whether candidate (4), in which *d* is actually [+voice] in the output, violates $\text{Parse}_{[+\text{voice}]}$. Technically it does, because its [+voice] comes from the vowel and not from its own underlying [+voice]. Luckily, nowhere in our analysis is it essential to rely on violations of this type in the selection of the optimal candidate.[17]

Table (34) provides motivation for postulating Sonorant Left, Obstruent License and SPEC as constraints in addition to the standard $\text{Parse}_{[+\text{voice}]}$. Without these constraints, candidate (1) could not be selected as optimal vis-a-vis candidates (4) and (3) and (7), respectively. Furthermore, Obstruent License must be ranked higher than $\text{Parse}_{[+\text{voice}]}$. The ranking of this latter constraint is discussed in detail in section 4.[18]

Now we turn to Final Devoicing. Trubetzkoy (1939) observes that word-finally the opposition of voiced and voiceless obstruents can be neutralized. In terms of the current theory the relevant constraint is (35).

(35) Final Devoicing ($\text{FinDev}_{\text{PW}}$): [voice] on an obstruent[19] at the end of the phonological word may only be licensed parasitically.[20]

This constraint builds on the well known observation (Trubetzkoy's 1939 insight) that word-final position is perceptually weak and facilitates the loss of contrast. It is therefore not unexpected that final obstruents cannot act as [voice] licensers.

The operation of Final Devoicing is illustrated in (36).

(36) /k o d/

L L L

-v +v

	Son-L	FinDev	ObstrLic	SonDef	Son-R	SPEC	Parse-v	Parse+v
1. k o d ← (L L L; -v +v)						*		*
2. k o d (L L L; -v +v +v)		*!						
3. k o d (L L L; -v +v)	*!							*
4. k o d (L L L; +v)					*!	*	*	*
5. k o d (L L; -v)				*!		**		*

The optimal output in (1) receives [-voice] by Voice Default in the phonetic interpretation component. This candidate, unlike candidate (2), satisfies Final Devoicing by circumventing the licensing requirement: the final laryngeal node is not linked to [voice]. In candidate (3), Final Devoicing is also satisfied since [voice] on *d* is licensed parasitically from *o*. However, (3) fails by virtue of Sonorant Left. Table (36) motivates Final Devoicing which must be ranked higher than both SPEC and $\text{Parse}_{[+\text{voice}]}$. Also Sonorant Left is motivated; it must outrank SPEC in order to make sure that candidate (1) wins over (3).

Examples containing final clusters work very much the same way as *kod*, regardless of the configuration of the obstruents: voiced plus voiced, voiceless plus voiceless, voiced plus voiceless, or voiceless plus voiced. The sole difference is that not only Final Devoicing but also Obstruent License may play a role. In (37) we look at *wróż+b* [vruš+p] 'prophesies' (gen.pl.). The underlying representation has a cluster of voiced obstruents /vruž+b/; compare the verb *wróż+y+ć* 'prophesize' (see (5) in section 1). We look at the last three segments only.

(37) /u ž + b#/

L L

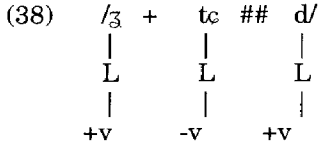
+v +v

	Son-L	FinDev	ObstrLic	SonDef	Son-R	SPEC	Parse-v	Parse+v
1. u ž +b# ← (L L L; +v)						**		**
2. u ž +b# (L L L; +v +v +v)		*!	*					
3. u ž +b# (L L L; +v +v)		*!	*					*
4. u ž +b# (L L L; +v +v)			*!			*		*
5. u ž +b# (L L L; +v +v)		*!				*		*
6. u ž +b# (L L L; +v)	*!					*		**
7. u ž +b# (L L)				*!		***		**

The optimal candidate in (1) is spelled out with a voiceless cluster by Voice Default in the phonetic interpretation (Warsaw Polish). Further motivation is provided for the constraints that we have developed so far. Final Devoicing is crucial for rejecting candidate (5). Sonorant Left excludes candidate (6) and Obstruent License bans candidate (4). Candidate (3) violates both Final Devoicing and Obstruent License since neither *ž* nor *b* are licensers. Furthermore, constraint interaction reveals that SPEC is ranked below Final Devoicing, Sonorant Left and Obstruent License.

The effects subsumed under Voice Assimilation follow from our system of constraints in a straightforward manner. Our example is the phrase *wieź+ć dary* [ʒ+dʒ##d] 'carry gifts' (see (6) in section 1). In (38) we look at the relevant cluster only.

(38)



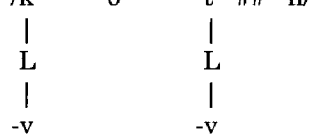
	Son-L	FinDev	ObstrLic	SonDef	Son-R	SPEC	Parse-v	Parse+v
1. ʒ+tɕ##d ←							*	*
2. ʒ+tɕ##d		*!	**					
3. ʒ+tɕ##d			*!			*	*	
4. ʒ+tɕ##d		*!	*			*		*
5. ʒ+tɕ##d						**!	*	*
6. ʒ+tɕ##d		*!	*					*

The constraints and their ranking established earlier are confirmed. For example, it is crucial that Obstruent License is ranked higher than the parsing constraints.[21]

Now we turn to the assimilation known as Cracow Voicing. As we will see, Final Devoicing plays a crucial role in this assimilation, albeit in an indirect way.

Recall that in Cracow Polish obstruents are voiced before sonorants (consonants and vowels alike) but only across word boundaries (see the data in (12-13) in section 1). Thus, *kot+n+y* [t+n] 'pregnant' (about a cat) contrasts with *kot nasz* [d##n] 'our cat'. This difference falls out from our system of constraints. Consider the evaluation of *kot nasz* /kot##naš/ 'our cat'.

(39)



	Son-L	FinDev	ObstrLic	SonDef	SPEC	Son-R	Parse-v	Parse+v
1. k o t##n ←						*	*	
2. k o t##n					*!		*	
3. k o t##n				*!	**		*	
4. k o t##n		*!						
5. k o t##n	*!						*	
6. k o t##n						**!	**	

In order for (1) to be the optimal candidate, the ranking of constraints must be as in (39). This is different from the earlier ranking, because SPEC now outranks Sonorant Right.[22] With this change, we obtain the correct output [kod##naš] for both *kot nasz* 'our cat' and *kod nasz* 'our code' in Cracow Polish. In Warsaw Polish the facts are exactly the opposite and it is [kot##naš] that is the desired output. Thus, candidate (2) in (39) must be optimal (likewise in *kod nasz*). The difference between Cracow Polish and Warsaw Polish is therefore a matter of constraint ranking: SPEC >> Sonorant Right in Cracow Polish and Sonorant Right >> SPEC in Warsaw Polish.

Words such as *kot+n+y* 'pregnant' (about a cat) have [t] in both dialects, but this is not a problem. In fact, we predict exactly this result. In *kot+n+y* the *t* is not at the end of the word, so Final Devoicing is inapplicable. The predicted optimal candidate is like (4) in (39), but there is no violation of Final Devoicing.

In sum, the restriction of assimilation to word boundaries in Cracow Polish is a consequence of the fact that Final Devoicing is an active constraint. (This fact was established earlier in the analysis of *kod* 'code' in (36) which is the same in all dialects.) Whether [voice] is spread from a sonorant or not follows from the difference in the interaction of Sonorant Right and SPEC in Cracow Polish and in Warsaw Polish.

Finally, let us note that the contrast in Cracow Polish between *kotny* and *kot nasz* can be accounted for easily on the condition that [voice] is a binary feature. Only then can we draw the necessary distinction between the parsed [-voice] on the *t* in *kotny* and the unparsed [-voice] on the *t* in *kot nasz*. In the privative theory, voicelessness is interpreted as the absence of the feature [voice], but then Final Devoicing is inapplicable to *kot nasz*. Consequently, *kot nasz* and *kotny* are nondistinct and we predict, falsely, that either both or none of them can be subject to Cracow Voicing.[23]

3. Excursus: other languages

While it is not the goal of this paper to analyze Voice Assimilation in languages other than Polish, it is interesting to see whether our constraints have the potential of being used on a wider scale. We begin with the parsing constraints (Kannada, Ukrainian and English). Then, we look at Final Devoicing (Catalan and German) and at the constraints that militate against parasitic licensing (German). Finally, we consider Obstruent License (Hungarian,

Serbian and Yiddish). A review of these languages is based, for most part, on the earlier work by Cho (1990b) and Lombardi (1991, 1995).

Parsing constraints are put to an extreme use in Kannada. Drawing on the analysis of Mohadevan (1968), Cho (1990b) points out that Kannada has no Voice Assimilation and Final Devoicing. Thus, obstruent clusters may disagree in [voice]: *ha:kda* 'he dropped', *mudka* 'old man'. This means that the parsing constraints must dominate both Obstruent License and Final Devoicing.

(40) *Kannada*: $\text{Parse}_{[\text{-voice}]}$, $\text{Parse}_{[\text{+voice}]}$ >> ObstrLic, $\text{FinDev}_{\text{PW}}$

The ranking in (40) mandates that [voice] be parsed, even if this were to violate Obstruent License and Final Devoicing. The result is that the optimal output is one that is fully faithful to the underlying representation; that is, the underlying [voice] is present in the output.

Ukrainian is a less extreme case than Kannada. Like the latter, it has no Final Devoicing, but it has Voice Assimilation. However, the assimilation is of only one type: voiceless obstruents become voiced before voiced obstruents[24] (Sinjavs'kyj 1967, Yaroslav Stelmakh p.c., Lombardi 1995 based on Zilyns'kyj 1979, Humesky 1980 and Bethin 1987).

(41) /borot'+b+a/ → [borod'+b+a] 'fight'
/rok za rok+om/ → [rig za rok+om] 'year after year'
versus [did] 'grandfather', [švɨd+k+o] 'quickly', [pered kɨm] 'before whom'

These facts are accounted for if the constraints are ranked as follows.

(42) *Ukrainian*: $\text{Parse}_{[\text{+voice}]}$ >> ObstrLic >> $\text{Parse}_{[\text{-voice}]}$, $\text{FinDev}_{\text{PW}}$

This means that underlying [+voice] must be preserved in the optimal output (that is, no devoicing). In contrast, [-voice] can only surface if Obstruent License is not violated; that is, before sonorants. Before an obstruent, underlying [-voice] is not licensed, and SPEC induces the spreading of [voice] from the following obstruent.

English is minimally different from Ukrainian in the sense that $\text{Parse}_{[\text{+voice}]}$ and $\text{Parse}_{[\text{-voice}]}$ change places while all the other rankings remain the same. That is, English has devoicing but not voicing.

(43) *describe* [b] - *descrip+tive* [p], *five* [v] - *fif+th* [f], *leave* [v] - *lef+t* [f]
AND *cat+s* /k t+z/[25]

This leads to the following ranking:[26]

(44) *English*: $\text{Parse}_{[\text{-voice}]}$ >> ObstrLic >> $\text{Parse}_{[\text{+voice}]}$, $\text{FinDev}_{\text{PW}}$

Catalan contributes to our understanding of Final Devoicing by revealing a new instantiation of this constraint. In Catalan, Voice Assimilation is the same as in Polish with one significant difference: Final Devoicing occurs at the end of the syllable; that is, in a coda (Lombardi 1991 based on Mascaró 1976 and 1987). We therefore have the following ranking:

(45) *Catalan*: ObstrLic , FinDev_{σ}[27], $\text{FinDev}_{\text{PW}}$ >> $\text{Parse}_{[\text{-voice}]}$, $\text{Parse}_{[\text{+voice}]}$

This means that obstruents cannot preserve their underlying [voice] before an obstruent or in a coda. As usual, SPEC and Voice Default make sure that the phonetic output is fully specified for [voice].

$\text{FinDev}_{\text{PW}}$ has no tangible effects in Catalan, since word-final obstruents are also syllable-final.[28] This, however, is not always the case in German.

In German, obstruents are devoiced syllable-finally (Vennemann 1982). The following examples are taken from a standard pronouncing dictionary of German, *Großes Wörterbuch der deutschen Aussprache*:

(46) *Bild+nis* [bIlt.nIs] 'portrait', *bild+lich* [bIlt.lIç] 'figurative', *Ergeb+nis* [gep.nIs] 'result', *Jag+d+en* [jak.dən] 'hunting' (pl.); compare the alternations in *bild+en* [bIl.dən] 'create', ergeb+en [ge.bən] 'give' and *jag+en* [ja.gən] 'to hunt'

However, $\text{FinDev}_{\text{PW}}$ is also active. It occurs in words such as *Feind* [t] 'enemy' in which the final obstruent is not in the coda. This assertion, due to Halle and Vergnaud (1980), is based on the observation that German permits a maximum of three segments in a rhyme. Since *Feind* has a diphthong, only *n* but not *d* can go into the coda. The *d* is therefore in what Halle and Vergnaud call an appendix, a concept originally due to Fudge (1969).

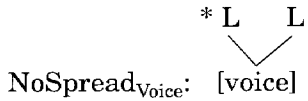
The word *Jag+d* [k+t] 'hunting' (sg.) must be analyzed along the lines of *Feind*, though for a different reason. The underlying representation is /jag+d/, as shown by the alternations in *jag+en* [ja.gən] 'to hunt' and *Jag+d+en* [jak.dən] 'hunting' (pl.). The *d* in *Jag+d* cannot go into the coda because it would cause sonority violations. It is

therefore in an appendix, exactly as the d in *Feind*. But then, how can this *d* devoice if it is not in the coda? The answer is straightforward: the appendix is at the end of the word, hence $\text{FinDev}_{\text{PW}}$ takes effect. In sum, both FinDev_{σ} and $\text{FinDev}_{\text{PW}}$ are active in German.

The data in (46) highlight yet another problem. If Final Devoicing is a licensing constraint, then it says that [voice] cannot reside solely on the final consonant (but, naturally, [voice] may come from spreading). Dominant Sonorant Left and Sonorant Right can stop the undesired spreading from *l* and *n*, respectively, in *Bildnis* [bIlt.nIs]; but *Jagden* [jak.dən] is a problem. How can we avoid the spreading from *d* to *g* which would produce the incorrect *[gd]?

The existence of Sonorant Left and Sonorant Right prompts the following line of reasoning. As is typically the case, specific constraints are instantiations of a certain general type of constraint. For example, $\text{Parse}_{\text{Feature}}$ is spelled out into specific constraints: $\text{Parse}_{\text{Coronal}}$, $\text{Parse}_{\text{Voice}}$ (and further $\text{Parse}_{[\text{-voice}]}$, $\text{Parse}_{[\text{+voice}]}$) and so forth. It therefore seems reasonable to treat Sonorant Left and Sonorant Right as members of the NoSpread family with the superordinate constraint being the one in (47).

(47)



Then, it is (47) that is active in German.[29] It prohibits parasitic licensing of [voice]. In languages that permit parasitic licensing, (47) is below SPEC, though its instantiations may or may not outrank SPEC, as shown by Warsaw and Cracow Polish. (Recall the interaction between SPEC and Sonorant Right.) However, by the Elsewhere Condition (Kiparsky 1973), Sonorant Left and Sonorant Right are higher than NoSpread.

The constraint system in German is summed up in (48).[30]

(48) *German*: FinDev, $\text{FinDev}_{\sigma\text{PW}}$, NoSpread >> $\text{Parse}_{[\text{-voice}]}$, $\text{Parse}_{[\text{+voice}]}$ >> ObstrLic

This means that underlying [voice] is parsed everywhere except in the coda and word-finally (the appendix).

Finally, we look at Obstruent License. Our examples are Hungarian, Serbian and Yiddish. Lombardi (1991, 1995) claims that

these languages constitute a class which exhibits the operation of her Laryngeal Constraint, Spreading and Final Exceptionality (see below).[31] From the point of view of this paper, the contribution of these languages lies in the fact that they strengthen the argument from Polish, showing that Obstruent License refers to sequences of obstruents.

Vago (1980 and p.c.) points out that Hungarian has Voice Assimilation in obstruent clusters but no Final Devoicing. A sample of his examples is given in (49). The suffixes *-tól* and *-ban* mean 'from' and 'in', respectively.

(49) *rab* [b] 'prisoner' - *rab+tól* [p+t]
*kala*p [p] 'hat' - *kalap+ban* [b+b]

The constraint system is as follows:

(50) *Hungarian*: ObstrLic >> $\text{Parse}_{[\text{-voice}]}$, $\text{Parse}_{[\text{+voice}]}$ >> FinDev_{σ}, $\text{FinDev}_{\text{PW}}$

This means that [voice] is parsed everywhere except before an obstruent. Given our statement of Obstruent License, it does not matter whether the following obstruent is inside the same word or across a word juncture. This is fully confirmed by Hungarian. Vago (1980 and p.c.) points out that assimilation occurs when the next word begins with an obstruent but not when it begins with a sonorant.

(51) *nagy kalap* [c##k] 'big hat', *rab#szolga* [p#s] 'slave' ('prisoner servant'), *szép baba* [b##b] 'beautiful doll' vs. *kis lakás* [š##l] 'small apartment'

That Hungarian is not isolated in this type of assimilation is documented by Serbian (de Bray 1980, Rasio Dunatov p.c.). The situation in Serbian is the same as in Hungarian: no Final Devoicing, but Voice Assimilation word-internally and across word boundaries before an obstruent.[32]

(52) a. no Final Devoicing:
hleb [b] 'bread', *grad* [d] 'town', *vožd* [žd] 'leader'
b. Voice Assimilation word-internally:
Srb [b] 'Serb' - *sr*[p+s]*ki* 'Serbian'
svedoč+i+ti [ʧ] 'to witness' - *svedo*[ʤ+b]*a* 'proof'

c. both voiced and voiceless obstruents before a sonorant inside words and across word boundaries:
ra[z]*ni* 'different', *nezavi*[s]*ni* 'independent', *bra*[t] *naš* 'our brother', *hle*[b] *naš* 'our bread', *gra*[d] *ili selo* 'town or village'
d. assimilation across word boundaries before obstruents:
hle[p##t]*i je dobar* 'your bread is good', *gra*[t##p]*un naroda* 'town full of people', *bra*[d##g]*ovori engelski* 'my brother speaks English'

Yiddish works in the same way that Hungarian and Serbian do: it has Voice Assimilation but no Final Devoicing (Lombardi 1991, 1995 based on Katz 1987). Crucial for our purposes is the observation that Voice Assimilation occurs before obstruents; the essential examples are those involving a word boundary. The data in (53) come from Katz (1987)[33], except for the phrases meaning 'he has eaten' and 'he has criticized' which have been provided to me by Niel Jacobs (p.c.).

(53) a. voicing:
/kuš/ 'kiss' - [kuž ##gebm] 'give a kiss', /eršt/ 'just' - [eržd##gəšen] 'just happen', /hɔt/ 'has' - [er hɔd#gegesn] 'he has eaten'
b. devoicing:
/klug/ 'clever' - [kluk##kind] 'clever child', /hɔb/ 'have' - [hɔp#kritikirt] 'I have criticized'

The significance of the data from Hungarian, Serbian and Yiddish is that they confirm the statement of Obstruent License as a constraint sensitive to the configuration "an obstruent before an obstruent" rather than to the presence of a following sonorant in an onset. Syllable-oriented statements of licensing, such as the Laryngeal Constraint of Lombardi (1991, 1995), license [voice] on obstruents in an onset before sonorants. This means that word-final obstruents are not licensed for [voice] because they are not in an onset. The prediction is that they are voiceless. In order to account for the lack of Final Devoicing in languages such as Serbian, Lombardi evokes Final Exceptionality. This is "a positive licensing constraint" which licenses [voice] word-finally in the languages that have no Final Devoicing.[34] However, Lombardi's analysis is problematic.

Final Exceptionality predicts that word-final obstruents should surface with the value for [voice] that they have in the underlying

representation. But, as shown by the facts of Serbian, Hungarian and Yiddish, this is true only before a pause and before a sonorant in the following word. If the next word begins with an obstruent, then Voice Assimilation takes place, exactly as predicted by our Obstruent License but counter to Lombardi's Final Exceptionality.

It should be noted that Lombardi's theory differs from the theory presented in this paper by assuming that [voice] is privative rather than binary. Could privativity be a solution to the Voice Assimilation dilemma?

In a privative theory, voiced and voiceless obstruents are distinguished by the presence versus the absence of [voice]; that is, voiceless obstruents are simply unspecified for [voice]. Now consider what will happen to obstruent clusters across word boundaries in a language that is subject to Final Exceptionality, such as Serbian. The underlying repesentations of the relevant obstruents are given in (54a); the predicted result is that in (54b). Our examples are the phrases cited earlier in (52): *grad pun naroda* 'town full of people' and *brat govori* 'my brother speaks'. We look only at the relevant part of these phrases.

(54) a. gra/d##p/un bra/t##g/ovori

+v +v

b. *[d##p] [t##g]

+v +v

Lombardi's theory predicts *[d##p] and [d##g]. The latter is correct, but the former is not. The reason why the /d/ in *grad* cannot devoice (that is, lose [voice]) is that [voice] is licensed word-finally by Final Exceptionality. However, the /t/ of *brat* has no voice specification in the privative theory. Since languages such as Serbian permit spreading (Lombardi 1991, 1995), the /t/ becomes voiced in (54b). Thus, with obstruents across word boundaries, we obtain the pattern familiar from Ukrainian: voiced obstruents remain unaffected whereas voiceless obstruents become voiced. Word-internally, however, we have the Polish pattern: both voicing and devoicing. But this is not what the facts require. The analysis is incorrect.

The theory presented in this paper does not face any of these difficulties. Obstruent License is active and accounts for the assimilation of obstruents before obstruents, regardless of whether they are

word-internal or at word junctures. In contrast, Final Devoicing is inactive, because it is ranked below Parse, as shown in (50).[35]

In the next section we return to Polish and look at Progressive Devoicing. This is interesting for several reasons. Most importantly, Progressive Devoicing demonstrates the superiority of OT over derivational theories. It also documents the domination of $\text{Parse}_{[\text{-voice}]}$ over $\text{Parse}_{[\text{+voice}]}$ and introduces Align Right as a new constraint.

4. Progressive Devoicing

Progressive Devoicing highlights three kinds of problems. We will discuss these problems by looking at the alternations of [v] and [f]. First, Progressive Devoicing operates on a subset of data covered by Voice Assimilation. The two processes are incompatible since the application of one blocks the other. Second, Progressive Devoicing is restricted to fricatives as an input. Third, the generalization is arbitrarily restricted to the devoicing rather than to the assimilation of [voice] in general, even though the environment of both would be met in the same type of structure.

The first problem is illustrated by the contrast between *tratw+a* [tf] 'raft' and *kot wasz* [d v] 'your cat'.The input in both cases is /tv/, which is motivated by alternations; compare *tratew+ek* [tev] 'raft' (dimn. gen.pl.) and *kot+y* [t] 'cats'. The standard theory solves the dilemma of distinguishing between /tv/ → [tf] and /tv/ → [dv] by assuming that Progressive Devoicing is a lexical word level rule while Voice Assimilation is a postlexical rule (Booij and Rubach 1987). At the word level, *kot wasz* does not exist yet, because it is a syntactic phrase and, consequently, is formed outside the lexicon. At this stage in the derivation, Progressive Devoicing is inapplicable, because it is assigned to the lexical rather than to the postlexical component of the grammar. Voice Assimilation, on the other hand, is assigned to the postlexical component and is thus not available at the lexical stage of the derivation. This reasoning is summarized up in (55).

(55)

tratv+a tratf+a			*Postcyclic lexical component* Progressive Devoicing
tratf+a	kot	vaš	*Postlexical component*
—	kod	vaš	Voice Assimilation

The second problem highlighted by Progressive Devoicing, the

restriction of the input to fricatives, is motivated by the contrast between *tratw+a* [tf] 'raft' and *proś+b+a* [proʒ+b+a] 'request'. The latter derives from /proɕ+b+a/; compare *pros+i+ć* [proɕ+i+tɕ] 'to request'. The derivation is as follows.

(56)

tratv+a proɕ+b+a		*Postcyclic lexical component*
tratf+a	—	Progressive Devoicing
tratf+a	proɕ+b+a	*Postlexical component*
—	proʒ+b+a	Voice Assimilation

The *b* in /proɕ+b+a/ is not affected by Progressive Devoicing because it is a stop rather than a fricative.

The third problem – the limitation of assimilation to devoicing – is illustrated by a minimal pair in (57).

(57) *szw+y* [šf+i] 'seams' (nom.pl.) - *szew+ek* [šev+ek] (dimin. nom.sg.)
wsz+y [fš+i] 'lice' (nom.pl.) - *wesz* [veš] (nom.sg.)

The relevant inputs are /šv+i/ 'seams' and /vš+i/ 'lice'.

(58)

šv+i	vš+i	*Postcyclic lexical component*
šf+i	—	Progressive Devoicing
šf+i	vš+i	*Postlexical component*
—	fš+i	Voice Assimilation

If progressive assimilation could effect both the devoicing and the voicing changes, then /vš+i/ would surface as *[vž+i], which is incorrect.

These facts present a challenge to Optimality Theory. How is it possible to reconcile the diametrically opposed surface realizations of /tv/ in *tratw+a* [tf] 'raft' and *kot wasz* [dv] 'your cat'? This is easy if one is permitted to have derivational stages, but this is not an attractive option in Optimality Theory which regards serialism as undesirable. Are we going to posit a constraint that bans the devoicing of stops in order to account for the difference between *tratw+a* [tf]'raft' and *proś+b+a* [ʒb] 'request' (progressive devoicing versus regressive voicing)? Such a constraint is unenlightening and it is unclear how it would work since stops can devoice, as shown in (3a) in section 1 (see also table (34) for an analysis). Thus, *proś+b+a* 'request', /proɕ+b+a/

→ [proʒ+b+a], contrasts with *ud+k+o* 'thigh' (dimin.), /ud+k+o/ → [ut+k+o]. Finally, how can we account for the pair in (57)?

Closer examination of the facts reveals a generalization that has never been stated before: all instances of alternation that fall under Progressive Devoicing are invariably inside morphemes. (They arise as a result of Yer Deletion, see section 1.)

Let us look closely at morpheme-internal clusters of obstruents. They are of three types, two of which are illustrated in (59).

(59) a. nonalternating forms (see (17) in section 1):
twarz [tf] 'face', *skarg+a* [sk] 'complaint', *kto* [kt][36] 'who'
dwa [dv] 'two, *zgag+a* [zg] 'heartburn', *gdy* [gd] 'when'

b. alternating forms with no need for progressive assimilation:
pies 'dog' - *ps+y* [ps] 'dogs'
sech+ł 'he dried' - *sch+ł+a* [sx] 'she dried'
bez 'lilac' - *bz+y* [bz] 'lilacs'
pozew 'summons' - *pozw+y* [zv] (pl.)

The clusters in (59a) are straightforward. As remarked in section 1, they derive from underlying archiphonemic representations, for example, /Df/ for [tf] and /Dv/ for [dv]. The selection of the optimal candidate is then the function of SPEC.[37]

The words in (59b) have [voice] specified in the underlying representation on each of the two obstruents separately. The motivation here is that [voice] cannot come from assimilation in the forms on the left in (59b) in which the underlying yer has vocalized. The evaluation of the forms on the right follows straightforwardly from our system of constraints. In (60) we look at *bz+y* 'lilacs'. The constraints in (60) and in subsequent tables are ranked as in Cracow Polish, but this is not significant for the data under analysis. The optimal outputs are the same in both dialects, which follows from the fact that for this particular set of data, Final Devoicing is inactive.[38]

(60) /b z + i̯/

	Son-L	FinDev	ObstrLic	SonDef	SPEC	Son-R	Parse-v	Parse+v
1. b z + i̯ ← (L L L; +v +v)								*
2. b z + i̯ (L L L; +v +v +v)			*!					
3. b z + i̯ (L L L; +v)						*!		**
4. b z + i̯ (L L L; +v)					**!			**
5. b z + i̯ (L L L; +v +v)					*!			*
6. b z + i̯ (L L L; +v +v)			*!		*			*

The evaluation of voiceless clusters such as the one in *ps+y* 'dogs' is fully parallel to the evaluation in (60), but the active parsing constraint is $\text{Parse}_{[-\text{voice}]}$ rather than $\text{Parse}_{[+\text{voice}]}$.

The third class of morpheme-internal clusters is the familiar alternations of voiced and voiceless obstruents repeated in part in (61).

(61) a. *szw+y* [šf+i̯] 'seam' - *szew+ek* [šev] (dimin. masc.nom.sg.)
pochw+a [xf] 'sheath' - *pochew+ek* [xev] (dimin. fem.gen.pl.)

b. *wesz* [veš] 'louse' - *wsz+y* [fš+i̯] 'lice'
owies [vjes] 'oats' - *ows+a* [fs] (gen.sg.)[39]

There is a striking observation that emerges from (61): morpheme-internal assimilation is always in favour of devoicing, regardless of the direction in which it proceeds. Thus, both /šv/ and /vš/ have [f] in their phonetic representation. In OT terms this generalization calls for the ranking of $\text{Parse}_{[-\text{voice}]}$ over $\text{Prase}_{[+\text{voice}]}$. (In fact, we have already postulated precisely this ranking for independent reasons, see table (34) in section 2.) In (62) we evaluate the candidates for *szw+y* 'seams'.

(62) /š v + i̯/

	Son-L	FinDev	ObstrLic	SonDef	SPEC	Son-R	Parse-v	Parse+v
1. š v + i̯ ← (L L L; -v +v)								*
2. š v + i̯ (L L L; +v +v)							*!	
3. š v + i̯ (L L L; -v +v +v)			*!					
4. š v + i̯ (L L L; +v +v)					*!		*	
5. š v + i̯ (L L L; -v +v)			*!		*			*
6. š v + i̯ (L L L; +v)					**!		*	*
7. š v + i̯ (L L L; +v)					*!	*	*	*
8. š v + i̯ (L L L; -v +v)			*!			*		*

Notice that both candidate (1) and candidate (2) satisfy Obstruent License. The feature [voice] is not only linked to [š] but also to [v], and the latter is a licenser since its laryngeal node is adjacent to the laryngeal node of a sonorant and not of an obstruent. Consequently, in order to select (1) over (2), we need $\text{Parse}_{[\text{-voice}]} >> \text{Prase}_{[\text{+voice}]}$.

The evaluation of *wsz+y* 'lice' proceeds in a similar way.

(63) /v š + i̷/

L L

+v -v

	Son-L	FinDev	ObstrLic	SonDef	SPEC	Son-R	Parse-v	Parse+v
1. v š + i̷ ← L L L, -v +v								*
2. v š + i̷ L L L, +v +v							*!	
3. v š + i̷ L L L, +v -v +v			*!					
4. v š + i̷ L L L, -v +v					*!			*
5. v š + i̷ L L L, +v +v			*!		*		*	
6. v š + i̷ L L L, +v					**!		*	*
7. v š + i̷ L L L, +v					*!	*	*	*
8. v š + i̷ L L L, +v +v			*! [40]			*	*	

To summarize, the disagreement of voicing in /vš/ and /šv/ is resolved in favour of devoicing, because $\text{Parse}_{[\text{-voice}]}$ dominates $\text{Parse}_{[\text{+voice}]}$. However, in *proś+b+a* /proć+b+a/ 'request', cited in (56), the correct output is one in which the cluster is voiced: [proʒ+b+a]. The same is true when a voiceless and a voiced obstruent come together across a word boundary, as in *kot wasz* in (55): underlying /t##v/ but phonetic [d##v].

The standard theory achieves the desired result by appealing to two different properties of the offending examples. First, in /proć+b+a/ the devoicing of *b* to *p* is circumvented by restricting Progressive Devoicing to fricatives as an input: *b* is a stop and therefore escapes devoicing. Second, in *kot wasz* Progressive Devoicing is inapplicable by virtue of the fact that it is designated as a word level rule and, consequently, cannot apply across word boundaries. But the generalization is different. The distinguishing property of inputs such as /proć+b+a/ and *kot wasz* /t##v/ as opposed to /šv+i̷/ 'seams' and /vš+i̷/ 'lice' in (62-63) is that the cluster straddles a morpheme boundary in /proć+b+a/ and /t##v/. The fact that there is a stop in /proć+b+a/ and a word boundary in /t##v/ is irrelevant. To see this clearly, let us summarize the various situations in which assimilation takes place.

(64) a. inside morphemes in both directions:
szw+y 'seams' /šv+i̷/ → [šf+i̷]; *wsz+y* 'lice' /vš+i̷/ → [fš+i̷]

b. between morphemes only from right to left:
ud+k+o 'thigh' (dimin.) /ud+k+o/ → [ut+k+o]; see (34)
ud tych 'these thighs' (gen.pl.) /ud##tix/ → [ut##tix]
proś+b+a 'request' /proć+b+a/ → [proʒ+b+a]
kot wasz 'your cat' /kot##vaš/ → [kod##vaš]

The prohibited configuration is a left-to-right spread across morphemes, as in /proć+b+a/ → *[proć+p+a] and /kot##vaš/ → *[kot##faš]. Cheryl Zoll points out to me that the relevant generalization follows from Align Right, understood to apply in a crisp way (Itô and Mester 1994). What we align is the feature [voice] and the right edge of the morphological root, as in *tratw+a* [tf] 'raft', *wsz+y* [fš] 'lice' and *szw+y* [šf] [41] 'seams'. A review of further data shows that the correct constituent for alignment is more general than the root: it is the morpheme, because progressive assimilation is also found in the suffix *-stw* /stv/; compare:

(65) *głup+i* 'stupid' - *głup+stw+o* [stf] 'little detail' - *głup+stew+k+o* [stef] (dimin. nom.sg.) - *głup+stew+ek* [stev] (gen.pl.)

We conclude that the relevant constraint is (66).

(66) Align Right ([voice], morpheme)

Align Right must be ranked below Sonorant Default and the familiar "no crossing of the lines" constraint. This is to make sure that, for example, *b* and *u* may retain their [+voice] in *but+y* 'shoes'. Table (67) for *proś+b+a* /proc+b+a/ 'request' illustrates the operation of Align Right which we abbreviate Align-R. We look at the last three segments only.

(67)
```
/c  +  b  + a/
|     |
L     L
|     |
-v    +v
```

	Son-L	FinDev	ObstrLic	SonDef	SPEC	Son-R	Align-R	Parse-v	Parse+v
1. c + b + a ← (+v +v)								*	
2. c + b + a (-v +v)							*		*!
3. c + b + a (-v +v +v)			*!						
4. c + b + a (+v +v)					*!			*	
5. c + b + a (-v +v)			*!		*				*
6. c + b + a (+v)					**!			*	*
7. c + b + a (+v)						*		*!	*

Align Right distinguishes between candidates (2) and (1) in favour of the latter. Candidate (1) does not violate Align Right because the right edge of [+voice] in the nominalizing morpheme *b* is not affected by spreading to the left. (The left edge is affected, but this is irrelevant since there is no constraint requiring that the left edge and [voice] need to coincide.) In contrast, the extension of [-voice] to *b* in candidate (2) violates Align Right for the morpheme /proc/, because the right edge of [-voice] does not coincide with the right edge of the morpheme /proc/. Notice further that in order for candidate (1) to win, Align Right cannot be ranked lower than $\text{Parse}_{[\text{-voice}]}$.

The evaluation of *kot wasz* /kot##vaš/ is fully parallel to that of *proś+b+a* /proc+b+a/. The relevant portion of this phrase is analyzed in (68).

(68)
```
/t  ##  v a/
|       |
L       L
|       |
-v      +v
```

	Son-L	FinDev	ObstrLic	SonDef	SPEC	Son-R	Align-R	Parse-v	Parse+v
1. t##v a ← (+v+v)								*	
2. t##v a (-v +v)							*		*!
3. t##v a (+v +v)						*!		*	
4. t##v a (+v -v+v)			*!	*					

As was the case in (67), candidates (1) and (2) both satisfy Obstruent License as *v* is a legal licenser. By the same token, they satisfy Final Devoicing. However, candidate (2) fails on Align Right, which is fatal.

We sum up our discussion by looking at the analysis of *próśb*

naszych 'our requests' (gen.pl.). The underlying representation is /pruc+b##našix/. In Cracow Polish, analyzed in (69), the desired output is [pruʒ+b###našix]. We look at the relevant portion of the phrase only.

(69) /u ç + b ## n/

L L

-v +v

	Son-L	FinDev	ObstrLic	SonDef	SPEC	Son-R	Align-R	Parse-v	Parse+v
1. u ç+b##n← +v +v						*		*	*
2. u ç+b##n +v -v +v		*!					*		*
3. u ç+b##n +v -v +v			*!			*			*
4. u ç+b##n +v -v +v +v		*!	*						
5. u ç+b##n +v -v +v			*!		*				*
6. u ç+b##n +v +v					**!			*	*
7. u ç+b##n +v +v +v		*!			*			*	
8. u ç+b##n +v +v	*!					*		*	*
9. u ç+b##n +v				*!	*	*		*	*

Note that in candidate (2), Obstruent License is satisfied as the laryngeal node of *b* is before the laryngeal node of the sonorant *n* rather than that of an obstruent. However, *b* fails as a licenser by virtue of Final Devoicing: its laryngeal node is at the end of the word. The desired output in Warsaw Polish is candidate (6). (Voice Default fills in [-voice] in the phonetic interpretation component.) This candidate will be selected as optimal once the constraints are ranked as required by the Warsaw dialect: SPEC and Sonorant Right must change places.

Finally, the question is whether the newly discovered generalization that the effects of the traditional Progressive Devoicing are reducible to morpheme-internal assimilation can be expressed in the standard derivational theory. The answer is that they cannot.The difficulty is that the derivational theory runs into the following paradox: Progressive Devoicing applies only inside morphemes, but in order to determine whether or not it should apply, we must first look at fully derived words. This paradox is demonstrated by both types of alternations exemplified in (14) in section 1: [r] - [š] and [v] - [f].

Recall that underlying /r/ alternates with [š] in words such as *Piotr* 'Peter' - *Piotrz+e* [pjotš+e] (voc.sg.). The analysis is that /r/ changes into /ž/ and is further devoiced to [š] after a voiceless obstruent. The [ž] is found phonetically in contexts that do not warrant Progressive Devoicing, for example, *bar* 'bar' - *barz+e* [baž+e] (loc.sg.) and *wiadr+o* 'bucket' - *wiadrz+e* [vjadž+e] (loc.sg.). The alternation between *r* and the fricative is regular and exceptionless. It occurs before front vowels,[42] as has been amply demonstrated in the literature (see, for example, Rubach 1984 and Bethin 1992). But to see the front vowel, we must first look at the inflected form *Piotrz+e*; only then can we know whether the /r/ should have a fricative as its output or not. That is, the root morpheme *Piotr* does not carry the relevant information since the environment for the *r* → ž change, the front vowel of the vocative singular, is present at the word level.[43]

Similarly, whether /v/ should devoice or not can only be determined at the word level. If the underlying yer in the morpheme /tratEv/ 'raft' has not vocalized, then /v/ is devoiced to [f], as in *tratw+a*. However, if it has vocalized, as in *tratew+ek* 'raft' (dimin. gen.pl.), the devoicing is blocked by the intervening vowel. Whether or not the yer in roots such as /tratEv/ vocalizes depends on the type of suffix that is appended, but then we must look at the word level before we can look at the morpheme level (recall the discussion in section 1). This mode of processing is incompatible with Lexical Phonology whose principal tenet is that phonological rules apply first to morphemes

and their combinations before they can apply to fully derived words.[44] This assumption leads to a paradox for the data under analysis. The generalization that there is devoicing in morphemes can only be stated over fully derived words, but once the words are fully derived, there is no way of returning to the domain of the morpheme.

This paradox encountered by standard derivational theories such as SPE [45] and Lexical Phonology does not exist in Optimality Theory. The reason is that phonological generalizations are stated over output forms; therefore we know whether we are looking at *Piotr* or *Piotrz+e* and likewise *tratw+a* or *tratew+ek*.

5. Conclusion

The system of constraints developed in this paper can successfully account for the same range of rather intricate facts of Polish as the derivational systems can. The main constraints, Obstruent License and Final Devoicing, have been formulated with reference to the weak position (membership in a cluster of similar segments; final position). The underlying methodology is thus the reverse of that proposed by Lombardi (1991, 1995), who formulates her constraints with reference to the salient or strong position (that of an onset). However, as argued in Rubach (1996), this methodology does not work for Polish which maintains [voice] contrast in coda obstruents, as in *srebrny* 'silver' (Adj.).

An unexpected result of this paper is the discovery of the generalization that progressive assimilation finds its proper locus in the morpheme. This generalization is expressed straightforwardly by right alignment in Optimality Theory. In derivational theories, an attempt to restrict progressive assimilation to the domain of the morpheme leads to a paradox. The generalization in question refers to morphemes, but no sense can be made of this observation unless we look at fully derived words.

This paper lends strong support to the concept of licensing (Itô 1986) by demonstrating that regressive and progressive assimilation of voicing can be accounted for by the same system of constraints. A further result is that [voice] is better regarded as binary rather than privative. This is documented by the transparency effects of unsyllabified sonorants; Cracow Voicing; Voice Assimilation in Serbian, Hungarian and Yiddish; and the dominant [-voice] in morpheme-internal assimilation in Polish.

Finally, our analysis of Warsaw and Cracow Polish reveals that these dialects differ in one respect only: the ranking of two constraints. In Warsaw Polish, Sonorant Right outranks SPEC while in Cracow Polish the ranking is reversed. Similarly, as shown in the excursus, various rankings of the constraints developed for Polish yield a typology of different languages with regard to voicing in consonants. This is an expected situation in Optimality Theory which claims that constraints are universal and languages differ in the way in which they rank these universal constraints.

Appendix

A reviewer has drawn my attention to an unpublished paper by Lombardi (1996) and asked that I indicate the main points of difference between Lombardi's analysis and my analysis. Our two papers differ both in scope and in the basic assumptions. Lombardi's approach is typological; while she considers many languages, she limits her discussion to obstruent-triggered assimilation.[46] My aim is to present an in-depth study of one language. Lombardi focuses on the perceptually strong position (that of an onset). In contrast, I focus on the perceptually weak position (cluster, final position). Lombardi's analysis is based on two assumptions: first, that all voice assimilation and devoicing is syllable-based (in particular, it is driven by the faithfulness to the onset) and, second, that [voice] is privative. However, my detailed investigations of Polish and Slovak indicate that these assumptions cannot be maintained.

The syllable-based theory is problematic in two ways. First, it is unable to capture the generalization that underlies assimilation in Polish. Second, it confuses coda devoicing with word-final devoicing, which predicts the incorrect candidate as optimal. To see the first problem, let us look at *proś+b+a* [proʒ+b+a] 'request'. As explained in section 4, the underlying representation has a voiceless fricative /proɕ+b+a/. The /ɕ/ is motivated by the alternation in *pros+i+ć* [proɕ+i+tɕ] 'to request'. Since Polish maximizes onsets and VCCV is syllabified as V.CCV (the unmarked pattern, see Rubach and Booij 1990b), *prośba* has the structure *pro.śba*.[47] Now both a voiceless and a voiced obstruent are in the onset. On the surface it seems that Lombardi's $\text{Ident}_{\text{Onset}}$ ("Onsets should be faithful to underlying laryngeal specification") is unable to choose between between the candidate containing [ʒb] and the one containing [ɕp] as both candidates violate $\text{Ident}_{\text{Onset}}$ once. Agree ("Obstruent clusters should agree in voicing") plays no role since it is satisfied by both candidates. Consequently, the selection of the optimal candidate is passed on to the lower-ranking *Lar ("Don't have laryngeal features"). This constraint penalizes voiced obstruents. (Recall that in Lombardi's theory

[voice] is privative, hence only voiced obstruents have laryngeal features.) *Lar selects *[procpa] as the optimal candidate, which is incorrect. However, Lombardi defines onset in a nonstandard way: the obstruent that counts for onset faithfulness is the one before a sonorant (a vowel or a sonorant consonant). Consequently, even though the *ś* in *pro.śba* is in the onset, it does not count as being in the onset from the point of view of $\text{Ident}_{\text{Onset}}$. But notice that, given this interpretation, reference to the onset in the traditional sense plays no role here. What matters is the adjacency to the sonorant, or, to put it negatively, the fact that an obstruent is not followed by an obstruent. But then Lombardi and I are in agreement on this point. We are both building on the same classic generalization (due to Trubetzkoy 1939) that only the rightmost obstruent in the cluster is distinctive in voice assimilation. One way of expressing this generalization is to postulate Obstruent License, as in (29). Another way would be to mandate the preservation of the underlying [voice] on an obstruent before a sonorant. In the latter case, Progressive Devoicing and Regressive Voice Assimilation would call for two distinct derivational levels, as indeed suggested in the earlier analysis of Booij and Rubach (1987). The need for levels is made clear by the example in (62): /šv+i̯/ 'seams', phonetic [šf+i̯]. If [voice] must be preserved before a sonorant, then the *š* in /šv+i̯/ would voice, which is incorrect. A judicious use of levels and reranking would probably solve this problem, but I have not investigated the details of this analysis. While postulating levels is not incompatible with OT (McCarthy and Prince 1993a), it is not the unmarked option in an OT analysis. Whatever the final solution may be, one point is clear: a purely onset-based constraint does not capture the generalization that is relevant for Polish voice assimilation. The relevant constraint must look at segmental adjacency and check for the following obstruent or sonorant, depending how the constraint is formulated. It is this segmental and not syllable-based constraint that accounts for assimilation.

A different tenet of Lombardi's theory is the claim that word-final devoicing can be subsumed under coda devoicing. It is therefore not possible to restrict devoicing to the word-final position only. But it is precisely this restriction that is required by some facts of Polish and, robustly, by the facts of Slovak. The Polish evidence has been discussed in Rubach (1996). Below I briefly outline the generalization about Slovak and make reference to Czech and Macedonian.

Slovak, like Polish, exhibits final devoicing, for example, *zub* [zup] 'tooth', compare the gen.sg. *zub+a* [zub+a] (Král' 1988, Rubach 1993). However, unlike Polish, it does not maximize onsets and VCCV is syllabified as VC.CV.[48] Consequently, the adjective *zub+n+y* has the structure *zub.ny*. The [b] is in the coda and yet it does not devoice, a fact that has no analysis in Lombardi's theory. Czech is another counterexample. Like Slovak, it adheres to the VC.CV pattern (Ladislav Zgusta, p.c. and field

notes). There is word-final devoicing but not coda devoicing: *zub* [zup] 'tooth' (compare the gen.sg. *zub+u* [b]) versus *zub+n+í* [zub.ni:] 'tooth' (Adj.). It should be added that both Slovak and Czech contrast obstruents before sonorants, compare Slovak *žup+n+ý* [p] 'regional' and Czech *vstup+n+í* [p] 'initial'.

More generally, Lombardi's theory predicts that languages with final devoicing and presonorant voice contrast in the coda must maximize onsets. In particular, VCCV, where the first C is an obstruent and the second C is a sonorant, must be syllabified V.CCV. However, this may be but need not be the case, that is, there is no such correlation. Polish maximizes onsets but Slovak, Czech and Macedonian do not. (I have no syllabification data for other Slavic languages, but all of these languages, with the exception of Serbian/Croatian and Ukrainian, have final devoicing and presonorant voice contrast.)

To conclude, the generalization about coda devoicing is that word-internal codas and word-final codas need not act as a class. While the coda, like the presence of a following obstruent, is a weak position facilitating the loss of contrast, there is a hierarchy in the weakening process: internal codas are 'stronger' than final codas. A language such as German which has devoicing of word-internal codas is predicted to have devoicing of word-final codas. But the reverse is not true: devoicing of word-final codas does not imply devoicing of word-internal codas. This is the situation in Slavic languages whose cutoff point for final devoicing is below word-internal coda devoicing. In sum, there is a significant generalization that Lombardi's theory cannot capture.

Recall that in addition to the claim that all voice assimilation is syllable-based, Lombardi assumes that [voice] is privative. This assumption, like the previous one, is problematic, which is shown by Slovak. The relevant facts are the same as in the Cracow dialect of Polish: there is voicing of obstruents before sonorants across word boundaries but not word-internally: *brat Nataše* [brad nataše] 'Nataša's brother' (compare *brat+a* [brata], gen.sg.) versus *zvrat+n+ý* [zvratni:] 'reflexive'. If [voice] is privative, then voiceless obstruents cannot act as blockers because they are not represented at the laryngeal tier. We predict voicing across voiceless obstruents, as in *brat sníva* 'my brother dreams', but this is incorrect: *s* blocks the spread of [voice] from the *n* of *sníva* and *brat* surfaces with [t] rather than with [d].[49] These difficulties do not arise in my analysis: Slovak follows the pattern of the Cracow dialect while Czech and Macedonian follow the pattern of the Warsaw dialect.

Finally, let me note that it is unclear at this stage in the development of the theory whether licensing should be replaced by positional faithfulness,[50] an idea that is due to Beckman (1995). Should such a replacement occur, then one of the results of this paper is that Polish voice assimilation and devoicing require a level distinction, as suggested earlier. While the determination whether licensing or positional faithful-

ness is a better theory remains an open question, one point is clear: Lombardi's theory, with its assumptions that all voice assimilation and devoicing is syllable-based and that [voice] is privative, is inadequate as it stands and requires modification.

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Notes

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1 Actually Cho discusses Russian rather than Polish, but for the most part her analysis is applicable to Polish as well.

2 I will adopt the practice of indicating morpheme boundaries in all instances in which they are potentially relevant. Transcriptions will be provided whenever the facts are not self-explanatory on the basis of the spelling. In particular, note the following:

[š ž] - postalveolar fricatives spelled *sz*, *rz* or *ż*
[ʧ ʤ] - postalveolar affricates spelled *cz*, *dż*
[ɕ ʒ] - prepalatal fricatives spelled *ś*, *ź* or *si*, *zi*
[tɕ dʒ] - prepalatal affricates spelled *ć*, *dź* or *ci*, *dzi*

Surface palatalization, which is allophonic, will be suppressed in the transcriptions (see Rubach 1984).

3 Consonants are never syllabic in Polish, hence *bóbr* is monosyllabic.

4 Initial sonorants behave differently (see Rubach and Booij 1990a and Bethin 1992). I am not discussing them here (but see footnote 13).

5 Historically [v] comes from ProtoSlavic [w]. This, however, is of no relevance, since Polish is different from other Slavic languages in that it provides clear evidence that the historical /w/ has restructured as /v/, see Rubach (1996).

6 For a recent discussion, see especially Kenstowicz and Rubach (1987), Bethin (1992), Zoll (1993), and Yearley (1994).

7 The absence of unvocalized yers in the output representation is predicted by the recent correspondence version of Optimality Theory (McCarthy and Prince 1995) which assumes that unparsed material is automatically deleted. However, the inability for unvocalized yers to block Voice Assimilation can also be accounted for in the classic OT in which unparsed material is present in the output. As I explain later (see Sonorant Default), unsyllabified sonorants (here: unvocalized

yers) cannot be specified for [voice] in the output form. Consequently, they have no representation at the laryngeal tier and are thus transparent.

8 I use the better known Parse rather than the newly introduced Ident constraints (correspondence theory). The effect for my analysis would be the same on either assumption.

9 Gen may supply underspecified candidates and SPEC must militate against them.

10 The classic Slavic assumption that the underlying representation of nonalternating obstruents in a cluster contains archiphonemes is not a necessary one. As demonstrated later, the same outputs would be selected as optimal if the representations were fully specified, as predicted by Lexicon Optimization (Prince and Smolensky 1993). SPEC would still be necessary in order to have a way of showing preference for fully specified output representations.

11 The candidates (not considered here) with [voice] on *b* and *z* coming from insertion rather than from spreading are excluded by dominant $\text{FILL}_{[\text{voice}]}$. Note also that the missing laryngeal nodes in candidate (1) are supplied automatically by convention once spreading takes place (Sagey 1986).

12 Conceivably, (22) subsumes two separate constraints: one mandating [+voice] on sonorants and the other prohibiting unsyllabified segments to be linked to laryngeal features. I leave this matter open.

13 I will not discuss here the set of constraints leading to the representation in (24). This problem as well as the treatment of instances falling under Initial Adjunction in Rubach and Booij (1990a) are discussed in Rubach (1997). However, let me note for the interested reader that Initial Adjunction must be made to the syllable rather than to the PW node, as has been proposed by Bethin (1992). This will account for the blocking effects that I am not discussing here.

14 What matters for the purposes of Obstruent License is the configuration "an obstruent before an obstruent", exactly as stated. There is reason not to restrict Obstruent License to clusters of obstruents inside the same word, see the analysis of Hungarian, Serbian and Yiddish in section 3.

15 It is not true that Sonorant Left is universally unviolable. (Had this been the case, it would have been a constraint on Gen.) As is well known (Itô 1986), Japanese has voicing in the configuration prohibited by Sonorant Left but the sonorants are limited to nasals.

16 This underlying representation has sonorants underspecified for [voice], as assumed traditionally. I will retain underspecification for expository purposes, noting that full specification, as mandated by Lexicon Optimization (Prince and Smolensky 1993), is probably a better option. The point is that, given Sonorant Default (22), it does not make any difference whether the underlying representation is fully specified or underspecified. If the sonorant is syllabified, then the optimal candidate is always the one that is fully specified, and conversely, if the sonorant is not syllabified, then Sonorant Default selects as optimal the candidate that is underspecified for [voice].

17 In (34) we did not consider a candidate in which an obstruent would lack a laryngeal node in the output and thus would be transparent to Voice Assimilation. Such candidates are ruled out by the undominated $\text{Parse}_{[\text{Laryngeal}]}$.

18 I point out in section 4 that the type of linking exhibited by candidate (2) is a violation of Align Right. This constraint prohibits progressive spread (that is, from left-to-right) across morphemes.

19 As a matter of fact, the restriction to obstruents is probably not necessary. Without this restriction, (35) would also extend to sonorants, but this is not a problem. Syllabified sonorants must be [+voice] by virtue of Sonorant Default. This constraint, in conjunction with SPEC, would make sure that, for example, the *m*

in *dom* 'house' cannot remain unspecified for voicing. That is, leaving the *m* unspecified for voicing would satisfy Final Devoicing but it would violate both Sonorant Default and SPEC.

[20] As pointed out to me by Cathie Ringen, Final Devoicing and Obstruent License should be collapsed into a single constraint because they cooperate in determining the well-formedness of final clusters. The results of the analysis are the same, regardless of whether the constraints are collapsed or not.

[21] In (38) we have not considered two further candidates patterned on candidate (6): (a) a candidate in which [-voice] from [ʧ] is spread to [d], and, (b) a candidate in which [-voice] from [ʧ] is spread to both [ʒ] and [d]. These candidates are excluded by Align Right, a constraint that we introduce in section 4, see footnote 18.

[22] Recall that SPEC must be outranked by Final Devoicing and Sonorant Left, see (36).

[23] See Rubach (1996) for a discussion showing why privative [voice] and Lombradi's Laryngeal Constraint (1991, 1995) are unable to account fot the Cracow Voicing type of assimilation.

[24] However, the preposition/prefix *z* always devoices to [s] before a voiceless obstruent while *bez* and *roz* do so optionally (Humesky 1980). While the latter two clearly require some special stipulation, the former does not. The difference between *z* and other prefixes/prepostions (*bez, roz, ob, nad,* etc.) is that *z* is asyllabic. Consequently, in order to be pronounced it must go into the onset of the following word: [s pol'a] 'from the field'. But then Jespersen's Sonority Constraint takes effect: the [voice] on *z* is not licensed and SPEC makes sure that the optimal candidate is one with [-voice] spreading from *p* to *z*. The active constraint here goes back to Jespersen (1904), who claims that voiceless obstruents are lower in the sonority hierarchy than voiced obstruents. Consequently, onsets containing a voiced obstruent before a voiceless one and codas containing a voiceless obstruent followed by a voiced one are ill-formed; schematically: *zt- onsets and *-sd codas. Jespersen's Sonority Constraint, introduced into generative phonology in a pioneering paper by Harms (1978), has been successfully used by Mester and Itô (1989), Cho (1990a and 1990b), Lombardi (1991) and others.

[25] As pointed out originally by Harms (1978), the devoicing of /z/ to [s] follows from Jespersen's Sonority Constraint, see footnote 24.

[26] English presents some difficulties for which I have no analysis. First, as is well known, the devoicing generalization is limited to level 1 phonology. Second, English shows derived environment effects in the sense that the devoicing does not occur morpheme-internally: *obscure, absorb, magpie*. Third, English has partial devoicing in absolute initial and final positions as well as in devoicing contexts.

[27] In Polish, FinDev_{σ} is ranked below the parsing constraints, which accounts for the fact that obstruents are not devoiced syllable-finally.

[28] Consequently, $\text{FinDev}_{\text{PW}}$ could be ranked anywhere in the hierarchy.

[29] Voiceless obstruents before voiceless obstruents such as [š] in *sparen* [šp] 'save' would then be accounted for by Jespersen's Sonority Constraint, see footnote 24.

[30] Alternatively, $\text{Parse}_{[\text{-voice}]}$ is placed higher, together with the Final Devoicing constraints. Then, syllable-final and word-final obstruents specified as [-voice] in their underlying representation would retain their [-voice] and hence not be subject to Voice Default in the phonetic interpretation.

[31] Actually, in Lombardi (1995), Hungarian is deleted from this class of languages on the grounds that its Voice Assimilation is optional and, consequently, "a late rule".

[32] This assimilation is obligatory (Rasio Dunatov, p.c.).

[33] Katz says that the assimilation may be optional.

[34] Final Devoicing does not exist as a rule or constraint in Lombardi's theory.

[35] A review of various facts in this section has shown that the constraints developed for Polish play a role in other languages; thus, we have achieved the intended goal. An unanswered question is how to avoid generating various unattested systems by unrestricted reranking of the existing constraints. Clearly, this is a problem that extends beyond the constraint system proposed for Voice Assimilation. Notice that, for example, 10 constraints, when ranked in all possible ways, give a rather formidable number of various configurations. However, many of the theoretically possible rankings will have the same effect. For instance, dominant Parse, as in Kannada, renders all rankings of Voice Assimilation constraints vacuous because the underlying specification for voicing must surface unchanged in the optimal candidate. Similarly, ranking plays no role if Parse is the lowest constraint, as in Catalan, because then all Voice Assimilation constraints may apply. Furthermore, one might introduce various implicational generalizations, as indeed proposed by Prince and Smolensky (1993). For example, a system of possible margins carries implications such as 'if *i* and *u* (that is, [j] and [w]) are not possible margins, then other vowels also cannot be margins'. Along the same lines, one might, for instance, propose that the operation of FinDev_{σ} in a given language implies the operation of $\text{FinDev}_{\text{PW}}$, as has been observed by Lombardi (1991). Notice that the reverse is not true: in Polish, $\text{FinDev}_{\text{PW}}$ is active while FinDev is dominated by the parsing constraints.

[36] All of these clusters are fully syllabified since Polish suspends the Sonority Sequencing Generalization in the class of obstruents. That is, all kinds of configurations are well-formed onsets and codas: stop-fricative, fricative-stop, stop-stop, and fricative-fricative; see Rubach and Booij (1990b).

[37] Let me note that this account would work also if the underlying representations were to be fully specified, as mandated by Lexicon Optimization (Prince and Smolensky 1993). The optimal output form would then be one selected not on the basis of SPEC alone but rather on the basis of Obstruent License and SPEC.

[38] Unvocalized yers are not present in the output forms.

[39] There are other examples as well but in this section we are using the [v] - [f] alternation as a diagnostic; see section 1, for instance, *dech* [dex] 'breath' - *tch+u* [tx] (gen.sg.), *łyżek* [wižek] 'spoon' (gen.pl.) - *łyżk+a* [wišk+a] (nom.sg.).

[40] Obstruent License is violated by *v* in this candidate.

[41] The fact that [-voice] resides on the left consonant in the underlying representation of *szw+y* 'seams' is irrelevant. At the output level it is the rightmost [voice] feature in the root, see (62).

[42] How this alternation should be expressed in OT is not clear at the current stage in the development of the theory, but this does not affect the point we are making.

[43] In *wiadrz+e*, the representation submitted to evaluation for voice assimilation is /vjadž+e/, where /dž/ is a sequence of obstruents and not an affricate. Both consonants are voiced: /d/ in the underlying representation (compare *wiadr+o*, nom.sg.) and /ž/ as a result of palatalization (compare *bar* 'bar' - *barz+e* [baž+e], loc.sg.). Obstruent License and SPEC select as optimal the candidate that shares [+voice]. This case is parallel to the voice assimilation cases discussed in section 3.

[44] Progressive Devoicing is a postcyclic and not a cyclic rule in Lexical Phonology, see Booij and Rubach (1987).

[45] In SPE, the default assumption is that a rule which applies inside morphemes also applies across morpheme boundaries. It is possible to restrict the application of a rule to morpheme junctures by writing a morpheme boundary into the rule. However, no rule may be restricted to apply only morpheme-internally. Yet, it is precisely this restriction that would be necessary for Progressive Devoicing.

Thanks to Cathie Ringen for drawing my attention to the problem with an SPE analysis.

[46] Lombardi has an analysis of Polish but she does not address the full complexity of the facts discussed in Rubach (1996).

[47] Recall that stops and fricatives can appear in either order in Polish onsets and codas, see footnote 36.

[48] This is motivated not only by native speaker intuitions but also by phonological evidence such as that relating to gliding. CiV strings are syllabified as [CjV] in Polish and but [Ci.V] in Slovak, for example, *dialekt* 'dialect': Polish [dja.lekt], Slovak [di.a.lekt]. This follows from the maximization of onsets in Polish (Onset >> $*Complex_{Onset}$) and the ban on onset maximization in Slovak ($*Complex_{Onset}$ >> Onset).

[49] This example extends directly to the Cracow dialect of Polish. The problem is the same.

[50] Then, the weak positions (cluster and final position) need to be stated in terms of unfaithfulness rather than in terms of parasitic licensing.

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