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THE TYPOLOGY OF VOICING AND DEVOICING

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This article provides empirical evidence against the claims that [voice] is a privative feature and that word-internal devoicing can occur in a language without word-final devoicing. The study of voice patterns in a number of languages shows that the feature value [−voice] although it is the unmarked value of the laryngeal feature [voice], can be active phonologically in a fashion parallel to the marked value [+voice]. Across languages, voice assimilation may occur independently of devoicing and, although it normally affects both [+voice] and [−voice], it may affect only one value in some languages.*

Final devoicing and voicing assimilation are two phenomena that have received broad attention in the literature. In this article we re-examine these phenomena, focusing on the representation of [±voice] and on the proper formulation of the mechanisms responsible for surface (de)voicing effects. Our objective is to argue against a number of assumptions on (de)voicing that underlie recent discussions of these phenomena. One assumption is that there are languages—Yiddish, Serbo-Croatian, and Rumanian are claimed to belong to this class—in which word-final coda consonants constitute exceptions to syllable-final devoicing. We will argue, instead, that these languages have no syllable-final devoicing. We will also show that there is no empirical evidence in favor of the claim that devoicing can affect only part of a cluster of voiced consonants without being prosodically conditioned. It furthermore appears that languages that apply devoicing to a class of segments at the end of a prosodic category n, devoice the same set of segments at the end of all prosodic categories that contain n, i.e. syllable-final devoicing implies word-final devoicing, etc. Most importantly, we will empirically falsify the claim that [−voice] does not belong to the universal set of phonological features by illustrating the assimilation of [−voice] in a variety of languages, postlexically as well as lexically. Our conclusion is that [voice] is a binary feature.

1. A PRELIMINARY TYPOLOGY OF VOICE ASSIMILATION AND DEVOICING. In some languages voice neutralization (devoicing) occurs at the end of the syllable. In the same language, voice assimilation may or may not occur. Whereas Dutch has voice assimilation, German does not, as is illustrated in Table 1. For the sake of comparison, we add Yiddish,[1] which has only assimilation, and Berber, which shows neither devoicing nor generalized assimilation.[2]

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[1] The typology of Yiddish (de)voicing appears to be controversial. We will extensively discuss the Yiddish facts in §3.1.

[2] Most of the examples that illustrate word-internal devoicing are compounds. This raises the question of whether compound boundaries should be considered word-internal rather than word-final or word-initial. We will sidestep this question. Suffice it to say that all the languages considered here show the same syllable-final voicing properties in nonderived words. The Berber examples are from Elmedlaoui 1989. The dialect described by Elmedlaoui, the Tashlhiyt of Imdlawn, has a restricted rule of voicing assimilation that applies to clusters identical except for voicing. Moroccan Arabic is similar to Berber with respect to voicing (see Harrell 1962). Cho (1990a:166–67, 1990b:149) gives examples of other languages without voicing effects (Santee, Kannada, and Tulu).

CONTRAST	σ-FINAL DEVOICING: WORD-FINAL	σ-FINAL DEVOICING: WORD-INTERNAL	ASSIMILATION
I. German	yes	yes	no
ei[z]ig 'icy'	Ei[s] 'ice'	Ei[s]lauf 'skating race'	Ei[sb]är 'polar bear'
wei[s]er 'whiter'	wei[s] 'white'	Wei[s]ling 'butterfly, species'	Wei[sb]ier 'wheat beer'
II. Yiddish	no	no	yes
ge[z]unt 'healthy'	hoy[z] 'house'	hoy[z]maynster 'handyman'	hoy[sf]un 'house of'
be[s]er 'better'	zi[s] 'sweet'	mo[s]mitl 'measure'	zi[zv]arg 'candy products'
III. Dutch	yes	yes	yes
ij[z]ig 'icy'	ij[s] 'ice'	ij[s]lolly 'ice lolly'	ij[zb]eer 'polar bear'
bo[s]en 'woods'	bo[s] 'wood'	bo[s]land 'woodland'	bo[zb]ouw 'wood management'
IV. Berber	no	no	no
ak^{w}zar 'fig'	igmz 'cap'	izwi 'he has beaten'	tisgg^{w}in 'side'
aksar 'descending slope'		iswi 'unevacuated animal excrement'	radsun 'they will drink'

TABLE 1. A typology of voicing assimilation and devoicing.

Standard autosegmental analyses derive surface forms from underlying voiced/voiceless distinctions with rules that change the voicing value through delinking (devoicing) and delinking cum spreading (assimilation). In Table 2 the upper set of structures illustrates the effect of delinking cum spreading, the lower set illustrates delinking in final position (C) and before sonorant consonants [−voc(alic), +son(orant)].[3] The representations in the first column of Table 2 show the initial structures, which also correspond to the surface structures in languages like English, which do not show general devoicing or assimilatory effects. In column 2, coda delinking results in devoicing, both in potential assimilatory environments and before sonorants, as in German. If a language has both delinking and spreading, the resulting structures are those in column 3, the Dutch case. Yiddish, which has no delinking in nonassimilatory environments, but where assimilatory environments trigger delinking cum spreading, exemplifies the fourth possibility.[4]

VOICE EFFECTS BEFORE [−sonorant]

1. no action	2. (coda) delinking	3. delinking and spreading	4. spreading
Berber	German	Dutch	Yiddish
αvoice βvoice	αvoice βvoice	αvoice βvoice	αvoice βvoice
| |	|	⋰ |	⋰ |
C C	C C	C C	C C
ti[s gg^{w}]in	Ei[s bär]	ij[z b]eer	hoy[s f]un
ra[d s]un		bo[z b]ouw	si[z v]arg

VOICE EFFECTS BEFORE [+voc, +son] AND FINAL

αvoice	αvoice	αvoice	αvoice
|			|
C ([−voc, +son])	C ([−voc, +son])	C ([−voc, +son])	C ([−voc, +son])
igmz	Ei[s]	ij[s]	hoy[z]
izwi	Ei[s]lauf	ij[s]lolly	hoy[z]maynster

TABLE 2. Voice effects.

[3] We will henceforth use C to represent a nonsonorant consonant, unless otherwise indicated.

[4] There are languages like Catalan (see n. 20), Spanish (Navarro Tomás 1961), and Sanskrit (Whitney 1977) that have assimilation of obstruents to both obstruents and sonorants.

In many languages devoicing and voicing assimilation are not controlled by syllable structure. In such languages devoicing may occur, but is restricted to a word- or phrase-final (sequence of) obstruent(s). Word-internally before sonorant consonants, a voice contrast is maintained. If assimilation occurs, the last obstruent in a sequence determines the voice value of the complete cluster. The basic typology for non-syllable-final devoicing languages, i.e. types II and IV in Table 1, is shown in Table 3, where Serbo-Croatian is in all relevant respects like Yiddish. Berber again exemplifies a no-effect language.[5]

CONTRAST	WORD-FINAL DEVOICING	ASSIMILATION
I. ?	yes	no
IIa. Serbo-Croatian	no	yes
vo[z] 'train'	bo[g] 'god-NOM.SG'	ne[gd]a 'sometimes'
pa[s] 'dog'		ro[pst]avo 'slavery'
IIb. Ukrainian	no	yes (only [+voice])
lo[b] 'forehead'	sa[d] 'garden'	na[ʒd]id 'our grandfather'
sni[p] 'our'		bere[zk]a 'little birch'
III. Russian	yes	yes
[z]nat' 'know'	klu[p] 'club-NOM.SG'	koro[fk]a 'little cow'
[s]n' at' 'take away'	klu[b]a 'club-GEN.SG'	[gd]e 'where'
IV. Berber	no	no
ak^{w}[z]ar 'fig'	igm[z] 'cap'	ti[sgg^{w}]in 'side'
ak[s]ar 'descending slope'		ra[ds]un 'they will drink'

TABLE 3. Voicing assimilation and devoicing in languages without syllable-controlled devoicing.

Serbo-Croatian has voicing assimilation of all obstruents to the last obstruent in a sequence: *ro*/b/ 'slave' ~ *ro*[pst]*avo* 'slavery', *ne*/k/*ad* 'or' ~ *ne*[gd]*a* 'sometimes', /s/*bogom* → [zb]*ogom* 'with God', 'farewell'. Ukrainian has the same voicing effects, except for the fact that regressive voicing only involves [+voice]: *na*/ʃ/ 'our' ~ *na*[ʒd]*id* 'our grandfather', *bere*/z/*a* 'birch' ~ *bere*[zk]*a* 'little birch'. A different language type combines assimilation inside obstruent clusters with word-final devoicing (but lacks word-internal devoicing). A number of Slavic languages, like Polish and Russian, are of this type (see Rubach 1996, for a recent detailed analysis of Polish voicing). Similarly, Francard and Morin (1986) argue that some dialects of Walloon maintain a voice contrast word-internally in heterosyllabic CN clusters but neutralize the voice distinction word-finally. For example, in the dialect of Liège one encounters devoicing at the end of a lexical word such as *wåde-lu* [wɔ:tly] 'keep it', but not inside a similarly structured word such as *wåd'ler* [wɔ:dle] 'to support mine walls with billets' (Francard & Morin 1986:460).

2. FORMAL ACCOUNTS OF VOICE ASSIMILATION AND DEVOICING. Most nonlinear analyses agree in the way they make use of the spreading mechanism to account for voice assimilation. And, most nonlinear accounts formalize devoicing as delinking of [+voice]. In theories that recognize a binary feature [±voice], full interpretation of elements that have become underspecified in the course of the derivation is obtained by a universal default rule like 1a or 1b (see Steriade 1995, for a general assessment of underspecification, and Archangeli & Pulleyblank 1996 for 'combinatorial specification', a variant of radical and contrastive underspecification).

[5] We use the following abbreviations: ADJ = adjective, ATTR = attributive, FEM = feminine, GER = gerund, IMP = imperative, IMPF = imperfect, INDIC = indicative, INF = infinitive, INSTR = instrumental, INTRANS = intransitivizer, MASC = masculine, N = neuter, NEG = negation, NOM = nominative, OBJ = object, PART = participle, SG = singular, SUBJ = subject, TEMP SUBORD = temporal subordinator, VERBLR = verbalizer.

(1) Voicing Default

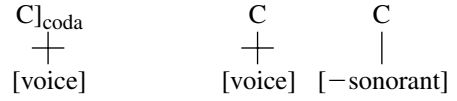
a. [αsonorant] → [αvoice] b. [ ] → [αvoice] / $\left[\ \underline{\quad}\ \right]_{\alpha\text{sonorant}}$

Under a theory of privative features (or nodes), the specifying elements express phonological properties that are not binary in nature. Consequently, surface representations do not contain binary values. Phonetics will interpret [voice] as phonetic 'voicedness' and the absence of [voice] as phonetic 'voicelessness'. The extreme position, privativity, has been advocated for voicing in Mester & Itô 1989, Cho 1990a, b, and by Lombardi 1991, 1995a,b,c, 1996a,b, 1999; whereas other analyses, e.g., Mascaró 1987, assume some version of radical underspecification. In §4 we will present our reasons for rejecting the claim that privativity constitutes the appropriate way to represent voicing contrasts. First, we will briefly review the (de)voicing typologies predicted by Cho and Lombardi.

2.1. CHO'S PRIVATIVE THEORY. Cho (1990a,b) proposes that the difference between DEVOICING-ONLY languages like German, ASSIMILATION-AND-DEVOICING languages like Dutch, ASSIMILATION-ONLY languages like Yiddish, and NO-EFFECT languages like Kannada and Tulu, is due to the triple parametric choice among coda devoicing (2a.1), cluster devoicing (2a.2), and no devoicing (2a.3). Another parameter, SPREADING, is two-valued (yes/no), represented in 2b.

(2) a. Devoicing parameter

1. Coda Devoicing 2. Cluster Devoicing 3. No Devoicing



b. Spreading parameter (Yes/No)

The parametric choices in 2 predict the existence of six types of voicing behavior. In Table 4 we show all the possibilities with the hypothetical sequence /z + taz + tas + dad/, based upon Cho 1990a: 149–68. The affected underlying segments have been marked by boldface. The Roman numerals I–IV refer to the classification in Table 1.

			/z + taz + tas + dad/
coda devoicing		I. German	[z + ta**s** + tas + da**t**]
cluster devoicing	spreading	II. Yiddish	[**s** + ta**s** + ta**z** + dad]
coda devoicing	spreading	III. Dutch	[z + ta**s** + ta**z** + da**t**]
		IV. Berber	[z + taz + tas + dad]
cluster devoicing		? Kirghiz	[**s** + ta**s** + tas + dad]
	spreading	Ukrainian	[z + taz + ta**z** + dad]

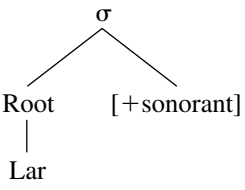
TABLE 4. Possible voicing and devoicing effects, according to Cho.

Cho's analysis incorporates the basic distinction between syllable-coda delinking and cluster delinking. Since languages choose between the parametric options permitted by the theory, Cho's proposal predicts that languages that have no syllable-controlled devoicing, but do have cluster devoicing, will have assimilation to the last C of a C . . . C sequence of obstruents. Since this happens independently of syllable structure, it must also occur in onsets. For example, in a cluster devoicing plus assimilation

language such as Serbo-Croatian, it is correctly predicted that the underlying sequence /s/ + /b/*ogom* is realized [zb]*ogom* 'farewell'. Similarly, in a language like Dutch, which has syllable-final devoicing, cluster devoicing cannot also occur. This is why the initial cluster /zt/ remains unassimilated. But although word-initial clusters are always nonderived in Dutch (and voice-homogeneous), the hypothesis that this language would tolerate nonhomogeneous derived onsets goes against our intuition. To be sure, Cho would predict assimilation in this case, because onset clusters like /zt/, of which the voiceless consonant is closer to the syllable nucleus than the voiced one, are ruled out by a general principle, which she calls Harms's constraint (see also Harms 1973). The situation in languages like Russian and Polish is a little more complicated, because they have cluster (de)voicing as well as word-final devoicing. Since cluster devoicing, as opposed to coda devoicing, does not cause word-final devoicing, the prediction is that in cluster devoicing languages no final devoicing is possible. To solve this problem, Cho proposes an independent rule of word-final devoicing that is part of the grammar of languages like Polish, but not of the grammar of Yiddish or Serbo-Croatian. Further, Cho's theory predicts the existence of languages that have cluster devoicing without spreading. In Cho 1990a:163, Kirghiz is mentioned as an example of this language type, but as Lombardi (1991:98) points out, Cho's classification of Kirghiz is based on an erroneous interpretation of Kirghiz phonetics. To date, no one has encountered a language that has cluster devoicing without spreading, which would result in devoicing of all but the last obstruent in a sequence. This is of course an important fact, because if delinking which is not controlled by syllable structure always goes hand in hand with spreading, one can hardly avoid the conclusion that spreading is the basic mechanism involved in this assimilation type. Notice that, if cluster devoicing (delinking) does not exist as an independent operation, it is not possible to account for homogeneous [−voice][−voice] clusters by delinking of [(+)voice] from the first member. Finally, Cho's proposal correctly predicts that no language can exist that, like Yiddish, maintains a voicing contrast word-finally, but which, unlike Yiddish, has word-internal syllable-final devoicing: according to Cho, word-internal coda devoicing always implies word-final coda devoicing. It seems indeed that no language of this type has been encountered so far. In this respect, the predictions of Cho's theory differ radically from the predictions made by Lombardi's theory, to which we turn now.

2.2. LOMBARDI'S PRIVATIVE THEORY. Lombardi (1991, 1995a,b) views devoicing as the language-particular implementation of a Universal Grammar parameter, the VOICE CONSTRAINT. The voice constraint 3a allows voiced obstruents only before a tautosyllabic sonorant segment. FINAL EXCEPTIONALITY (3b) allows a laryngeal node word-finally.

(3) a. Voice Constraint



b. Final Exceptionality

Lar]$_w$

In languages that activate the Voice Constraint, unlicensed laryngeal nodes will automatically delink. Since [voice] is privative, the effect of this operation will be word-internal devoicing before heterosyllabic sonorants and final devoicing; if spreading

takes place, phonetically homogeneous voiced clusters will be obtained by spreading the [voice] feature out of the licensed onset position, structurally [$_{\text{voice}}$CC], a CC cluster linked to [voice]. In contrast, homogeneous voiceless clusters are either underlyingly voiceless, or are the result of the voice constraint, which causes delinking of privative [voice] before a voiceless obstruent—they will have the unlinked structure CC with voice unspecified. For languages like Yiddish or Serbo-Croatian, which maintain a word-final voicing contrast, but which have word-internal homogeneous voice clusters, the principle of final consonant exceptionality (3b) is invoked, which blocks delinking of the voice feature word-finally. Final consonant exceptionality is, in a sense, the reverse of Cho's rule of word-final devoicing mentioned in the preceding section. In Table 5 below, the (de)voicing typology predicted by Lombardi (1991) is, as before,

VOICE CONSTRAINT	SPREADING	FINAL EXC.		/z + taz + tas + dad/
yes	no	no	I. German	[**s** + ta**s** + tas + da**t**]
yes	yes	yes	II. Yiddish	[**s** + ta**s** + ta**z** + dad]
yes	yes	no	III. Dutch	[**s** + ta**s** + ta**z** + da**t**]
no	no	no	IV. Berber	[z + taz + tas + dad]
yes	no	yes	?	[**s** + ta**s** + tas + dad]
no	yes	no	Ukrainian	[z + taz + ta**z** + dad]

TABLE 5. Possible voicing and devoicing effects, according to Lombardi.

illustrated with the hypothetical /z + taz + tas + dad/. Voiced obstruents before a tautosyllabic sonorant are those licensed by the voice constraint. When they appear word-finally, they are licensed by final exceptionality. Elsewhere the (boldface) consonant is devoiced. Notice that final exceptionality can be active only if the voice constraint is, which explains why Table 5 presents only six parametrical configurations instead of eight.

As in Cho's theory, a language type as yet unattested is predicted. This language, marked with a question mark in Table 5, would be like German, but with a word-final voice contrast. As noted at the end of §2.1, languages with word-internal devoicing always have word-final devoicing, contrary to what the theory in 3 predicts. The proposal, though, leaves no room for the existence of languages like Polish or Walloon that have word-final devoicing without word-internal devoicing. Another problem is posited by languages like Yiddish, Serbo-Croatian, and Rumanian, that demonstrably do not activate the Voice Constraint, but nevertheless, have obstruent clusters that are fully homogeneous for [±voice]. Notice that the voice constraint prohibits not only a word-final voice contrast, but also causes delinking of the [voice] feature from word-internal codas. When there is no assimilation, for example before a heterosyllabic sonorant, deletion should not be blocked. Yet, in Yiddish (as well as in Serbo-Croatian and Rumanian) a voicing contrast does exist in this position, as we will demonstrate below (§§3.1–3.3). In these languages, the actual form of a hypothetical lexical obstruent-sonorant cluster /taz + lad/ is not [tas + lad], but [taz + lad]. However, if we remove the voice constraint—and with it final exceptionality—then spreading in Yiddish should yield the assimilatory pattern observed for Ukrainian. Here we touch at the very heart of the proposal, which combines privative 'voice' with the voice constraint. As far as we can see, languages like Yiddish can only be described with a rule type such as the one proposed by Cho, which delinks [voice] in a cluster of nonsonorant segments. Otherwise, voicelessness must be recognized as a phonological feature. However, as observed above, cluster delinking, which UNDOES laryngeal homorganicity inside obstruent clusters, is very questionable as a rule type altogether, because it predicts a pattern of voicing effects that does not exist in the world's languages.

2.3. PRIVATIVE [voice] IN OPTIMALITY THEORY. In Lombardi 1999, an OT analysis of devoicing and voicing assimilation is proposed, based on the interaction of the constraints in 4 (we replace the original 'laryngeal' used by Lombardi by 'voice').[6]

(4) a. IDENTONSET (VOICE) (IDONSVO): Consonants that are tautosyllabic with a following sonorant segment should be faithful to an underlying voice specification.
b. IDENT (VOICE) (IDVO): Consonants should be faithful to an underlying voice specification
c. *VO: Do not have voice features
d. AGREE: Obstruent clusters should agree in voicing

Constraint 4a demands that a presonorant onset obstruent in the output agree in voice specification with its lexical correspondent. Constraint 4b imposes faithfulness for any underlying voice specification; 4c is a markedness constraint that militates against obstruents that realize a voice node. Finally, 4d requires obstruent clusters to agree with respect to voice specifications. Since [voice] is considered to be privative, for an obstruent cluster to comply with AGREE, either all of its members must be marked with a [voice] specification or none must be. Similarly, the faithfulness constraints IDONSVO and IDVO will penalize any candidate that has a [voice] specification that is not underlying, or that lacks a lexically present [voice] specification. Consider Table 6, which evaluates some relevant output candidates that correspond to the hypothetical input sequence /taz + las + dad/ (here we assume that syllable boundaries coincide with morpheme boundaries).

/taz + las + dad/	AGREE	IDONSVO	*VO	IDVO
☞1) tas + laz + dat			**	***
2) tas + las + tat		*!		***
3) taz + laz + dad			***!*	*
4) tas + las + dat	*!		*	**

TABLE 6. OT analysis of assimilation and syllable-final devoicing (Lombardi 1999).

In the phonological grammar that is characterized by the constraint ranking exemplified in Table 6, clusters that are homogeneous for [voice] will be preferred over clusters that do not agree in voicing. The sequence in 6.4 fatally violates the AGREE constraint. Moreover, assimilation must be regressive, excluding the candidate in 6.2, because the constraint that militates against unfaithful onsets is ranked high in the constraint hierarchy. When AGREE is not relevant, for example in obstruent + sonorant clusters, the obstruent must devoice in languages where such clusters are heterosyllabic. This follows from the relative ordering between *VO and IDVO. Indeed, the ranking in Table 6 accounts for languages like Dutch, where obstruent clusters agree in voicing, but where syllable-final consonants are voiceless before sonorants and in word-final position. In 5, the different constraint rankings with the predicted devoicing effects are listed.

[6] We are assuming that Lombardi 1999 supersedes the proposals of Lombardi 1995a,b and 1996), which we will therefore not discuss.

(5) a.	AGREE, IDONSVO >> *VO >> IDVO	assimilation, σ-final devoicing (Dutch)
b.	IDONSVO, IDVO >> *VO, AGREE	no assimilation, voice faithfulness (English)
c.	IDONSVO >> *VO >> IDVO, AGREE	σ-final devoicing, no assimilation (German)
d.	*VO >> IDONSVO, IDVO, AGREE	only voiceless obstruents (Hawaiian)
e.	IDONSVO, AGREE >> IDVO >> *VO	assimilation, no devoicing (Yiddish)
f.	AGREE(>>), IDVO >> *VO >> IDONSVO	bi-directional assimilation of voicelessness (Swedish)

In 5b, the dominant constraints require faithfulness to any lexical [voice] specification. Lower constraints are irrelevant for evaluation. This ordering accounts for no-assimilation and no-devoicing languages. The constraint order given in 5c, where *VO is ranked between IDONVO and IDVO, characterizes devoicing-only languages like German, which only devoice codas. The constraint order in 5d accounts for languages that exclusively have voiceless obstruents, like Hawaiian. Example 5e predicts a language type that has no word-internal (presonorant) and word-final devoicing, but where obstruent clusters agree in voicing. Yiddish, Rumanian, and Serbo-Croatian are of this type. Lombardi's derivational proposal (see §2.2) characterized these languages as word-internal devoicing languages. In §3, we will see that in this respect the OT grammar in 5e makes the correct predictions. Consider finally the case of Swedish (5f), which is claimed to present bidirectional spreading of voicelessness. Both the ordered AGREE>>IDVO and the unordered AGREE, IDVO give the desired results for two-consonant clusters like /gs/ and /kd/. AGREE prefers the homogeneous clusters [gz], [ks], [gd], [kt], respectively, and *VO eliminates the voiced candidate clusters. Consider next the predictions for triconsonantal clusters like /gds/. If AGREE >> IDVO, then only homogeneous voiced clusters will arise. If AGREE and IDVO are unordered, as claimed in Lombardi 1999, there will be one star for each nonagreement and one star for each violation of faithfulness. Consequently, from underlying /gds/, both [gdz] and [gds] will incur a single violation and *VO will select [gds] as the optimal candidate. But, as Lombardi notes (1999:286), in such cases we don't get [gds], nor [kts], but [gts], as in [byg:d] 'district' ~ [byg:d̥s] 'district-GEN', [hev:d] 'long usage' ~ [hev:d̥s] 'long usage-GEN' (examples are from Hellberg 1974). As it turns out, the Swedish devoicing pattern as well as cases of bidirectional assimilation of voicelessness in general cannot be handled adequately by the constraints in 5f. This is because the privativity hypothesis excludes the possibility of having an AGREE constraint that refers to [−voice]. We will address this issue below and show that such cases can be dealt with only with a conditional AGREE constraint.

We now return to languages like Polish and Walloon, which assimilate obstruent clusters, but where devoicing is restricted to word-final position. They should follow 5a or 5e, but 5a implies word-internal devoicing, which does not occur, whereas 5e predicts no devoicing at all. The (de)voicing pattern of these languages cannot be derived by the constraints in 5. Notice also that Polish has devoicing of obstruents before a sonorant in word-final position: *żu*/br/ → *żu*[pr] 'bisons-NOM.SG', *mo*/gł/ → *mo*[kw] 'he could', *mechani*/zm/ → *mechani*[sm] 'mechanism-NOM.SG' (examples from

Rubach 1996:71), where the cluster is presumably tautosyllabic, hence should preserve the underlying voice specification (cf. 4a). A similar result obtains in Majorcan Catalan, where verbs with root-final obstruent-sonorant clusters preserve voicing in the onset but devoice word-finally in the coda: *arreglar* 'to fix' ~ *arre*[kl] 'I fix', *obrir* 'open' ~ *o*[ps] 'I open'.[7]

Another problem relates to the definition of the IDONSVO constraint, which would seem to permit two interpretations. One is suggested in Lombardi 1999:267, where ONSET is defined as the consonant that is tautosyllabic with a following sonorant segment. Under this interpretation, it is predicted that German devoices all but the presonorant obstruent in a sequence. Consequently, the first member of a complex obstruent onset should also devoice. This prediction is incorrect; witness words like *Budget* [bydʒe] 'budget', *Gin* [dʒɪn] 'gin', *Dschungl* [dʒʊŋl] 'jungle', *Dschihad* [dʒihɑt] 'djihad', and so on, where the cluster /dʒ/ is tautosyllabic.[8] If, on the other hand, onset is understood in its usual meaning as the consonant (cluster) that is tautosyllabic with a following nuclear segment, the predictions would be wrong in the case of, for example, Serbo-Croatian, where a complex onset can be composed of a segment sequence that is lexically not homogeneous for [voice], as in [zbogom] from underlying /s + bogom/ 'with god'. Clearly, some proviso must be made to allow for an adequate description of these languages.

Consider next the words in 6, taken from Dutch.

(6)	/v/allen	'to fall'	o/pv/allen	o[pf]allen	'to strike'
	/z/aag	'saw'	broo/dz/aag	broo[ts]aag	'breadsaw'
	/ɣ/ierig	'greedy'	wee/tɣ/ierig	wee[tχ]ierig	'eager to know'

The examples in 6 show a well-known property of voice assimilation in Dutch, where obstruent clusters are voiceless if the right-hand member of the cluster is a fricative. Very probably the traditional view of this process as progressive devoicing is correct, since one would not expect general devoicing (e.g. *roo*/dv/*os* → (hypothetical) *roo*[df]*os* 'red fox') to occur in languages that do not also have syllable-final devoicing. Obviously these facts cannot be derived with the constraint set in 4, as was also observed by Lombardi (1996b:98).

Finally, it does not seem possible for the constraint set in 4 to account for Ukrainian (see Table 3), where regressive assimilation is exclusively triggered by [+voice], or a language in which the opposite situation obtains, i.e. which has only regressive spreading of [−voice]. We will show below that the latter type of language also exists.[9]

[7] After a nasal, underlying voicing is preserved: *comprar* 'to buy' ~ *com*[pr] 'I buy', *sembrar* 'to sow' ~ *sem*[br] 'I sow', a fact which can be attributed to differences in syllabification (Dols & Wheeler 1995) or to the fact that a preceding nasal favors voicing.

[8] Similarly, nonhomogeneous onset clusters in loans are assimilated, as in the word *Sbirre* 'henchman' (< It *sbirro*), in which /b/ is devoiced (from Krech et al. 1982:486). In Lombardi 1999:293, clusters containing /v/ ([kv], [tsv]) are given to show that mixed-onset clusters exist in German. However, the phonological definition of the *v*-sound is controversial in German, and its phonetics appear to vary. According to Wurzel (1970:244–46), it represents a phonological glide. Wiese (1996:239) notes that in the clusters just mentioned it may be pronounced as a glide, an approximant, a voiced fricative, or a voiceless fricative. He proposes to derive all these variants from an underlying vowel. According to van Lessen Kloeke (1982:39, 133), /v/ in such clusters is voiceless. Kohler (1977:163) claims partial devoicing. See also Cho (1990a: 160) for discussion about the crosslinguistic variation in the behavior of the *v*-sound in processes of voice assimilation.

[9] This is not to say that some other optimality-theoretic approach might not be able to handle both Ukrainian and anti-Ukrainian. For further discussion, see §6.

To sum up, the privative theories of voicing that we have examined predict unattested patterns in the voicing typology. Cho's theory wrongly predicts the existence of languages that have cluster devoicing without spreading, and in Lombardi's derivational theory, the pattern of final as well as internal contrast with assimilation in obstruent clusters (as in Yiddish, Rumanian, or Serbo-Croatian) is predicted not to exist. Her theory also predicts the existence of internal-only coda devoicing languages, and wrongly excludes the possibility of word-final devoicing only (Polish, Walloon). For obvious reasons, none of the privative theories can handle languages that spread [−voice] only. Similar shortcomings were observed for Lombardi's OT analysis. Most of the problems encountered were shown to arise from the hypothesis of [voice] being a privative feature, and would consequently not exist if [−voice] were given a theoretical (phonological) status alongside [+voice]. We will take up the privativity issue explicitly in the following sections, where we will argue that [+voice] and [−voice] not only show parallel behavior but also that there are languages requiring a lexical distinction between [−voice] and [Øvoice]. Before we proceed, however, we need to settle an important typological fact which generates much confusion in the literature on [voice]: the question of whether there are languages that devoice obstruents in word-internal codas but maintain a [voice] contrast word-finally. According to Lombardi (1991, 1995a,b) Yiddish, Rumanian, and Serbo-Croatian are such languages.[10] In the next section we will look into this language type in more detail. These languages have word-internal [−voice] assimilation that cannot be analyzed as cluster devoicing or as syllable-final devoicing. Consequently, these languages are problematic for theories that consider [voice] a privative feature.

3. On the relation between word-internal and word-final coda devoicing.

3.1. Yiddish.[11] Traditionally, three different zones are distinguished within the Yiddish linguistic area: Western Yiddish, spoken in the Netherlands, Germany, Austria, and Lombardy, the Yiddish dialects of Central Europe, spoken in Bohemia, Moravia, Slovakia, Burgenland, and western Hungary, and Eastern Yiddish, spoken in the Slavonic and Baltic countries. The modern standard is based on the eastern dialects, which are themselves classified into Mideastern Yiddish (roughly Polish), Southeastern Yiddish (roughly Ukrainian), and Northeastern Yiddish (roughly Lithuanian). Standard Yiddish pronunciation is closest to Northeastern Yiddish 'especially as cultivated in its centuries-old cultural capital, Vilna' (Katz 1987:xxi). Differences in pronunciation among the eastern dialects mainly concern vowel quality, although, as we conclude from Katz's examples (1987:39), the Mideastern variant has a rule of word-final devoicing, which is lacking in the other eastern dialects. In this section, we will be concerned mainly with Standard Yiddish. According to Katz, 'all the native dialects are nonstandard insofar as none is identical with the standard' (1987:38). A different but closely related variety is described in Birnbaum 1979. Birnbaum takes a critical attitude toward the question of the standard language: 'there is no standard pronunciation of Yiddish' (1979:100). Birnbaum's study does not describe the standard language, but the dialect 'used by most Yiddish people' (1979:101). As for the question of voicing assimilation, it appears that interesting differences exist between the standard dialect described by Katz and the variant described by Birnbaum, although both lack the rule of word-final

[10] Lombardi (1999:284) leaves open the question of whether word-medial CN clusters in these languages are hetero- or tautosyllabic.

[11] Thanks to Harry Bochner for useful comments on the sections on Yiddish and Serbo-Croatian.

devoicing. We will mainly be concerned with the standard dialect, which is also the one on which Lombardi based her claims about final exceptionality (see 3b).

Standard Yiddish has no word-final devoicing, as witnessed by the following examples, taken from Katz (1987:29–31); these show the existence of a word-final voicing contrast.

(7)

[kop]	'head'	[ʃrajb]	'I write'
[vajt]	'far'	[red]	'I speak'
[bak]	'cheek'	[vog]	'weight'
[af]	'(up)on'	[briv]	'letter'
[zis]	'sweet'	[ajz]	'ice'
[raʃ]	'noise'	[ʃantaʒ]	'blackmail'

The words in 8 show that obstruent sequences in Yiddish are homogeneous for voice, in such a way that the rightmost obstruent determines the voice value of the entire cluster.

(8) Regressive voice assimilation

a. Devoicing

/ʃrajb + st/	→ [ʃrajpst]	'you (familiar) write'
/briv + tregər/	→ [briftregər]	'mailman'
/ʃantaʒ + ʃtik/	→ [ʃantaʃʃtik]	'blackmailing tactics'
/ajz + kastn/	→ [ajskastn]	'ice box'
/vog + ʃol/	→ [vokʃol]	'scale'

b. Voicing

/kop + vejtik/	→ [kobvejtik]	'headache'
/bak + bejn/	→ [bagbejn]	'cheekbone'
/vajt + zeəvdik/	→ [vajdzeəvdik]	'farsighted'
/zis + varg/	→ [zizvarg]	'candy products'

Voice assimilation is postlexical. It also applies across word boundaries, as is illustrated by the phrases in 9.

(9)

/erʃt#gəʃen/	→ [erʒdgəʃen]	'just happened'
/(a#)gute#vɔχ/	→ [gudvɔχ]	'(have a) good week'
/lajg#ʃɔjn/	→ [lajkʃɔjn]	'do lay'
/klug#kint/	→ [klukkint]	'clever child'

We turn next to the question of syllable-final devoicing inside words. Obviously, final exceptionality could be relevant for Yiddish only if this language devoices word-internal coda obstruents. To decide this matter, we must know how Yiddish assigns syllable structure to word-internal consonant sequences. In the literature on Yiddish phonology, we have not been able to find information dealing explicitly with matters of syllabification, at least regarding the dialect studied here.[12] What we say below we inferred from our own inspection of the data and checked against sporadic comments on the issue of syllable structure in Birnbaum 1979.

Apart from universal generalizations that relate to the sonority sequencing principle, the theoretical literature dealing with the phonotactics of consonants points to the existence of at least two crosslinguistic tendencies that govern the syllabification of word-internal consonant sequences. One tendency is that, except for accidental gaps, conso-

[12] Lowenstamm (1981:583–96), discusses alternations between syllabic and nonsyllabic sonorants as well as vowel epenthesis in Yiddish. We do not deal with (de)voicing, nor does it bear on the type of sonorant-nonsonorant sequences in the dialects studied here.

nant clusters that do not occur word-initially do not function as complex onsets either, when they appear in intervocalic position. The other tendency is that complex onsets usually do not arise in the process of productive word-formation (derivation).[13] If these tendencies are active in Yiddish, we expect that [f] as in [efʃər] 'maybe' closes the first syllable, because word-initially /f/ only combines with liquids. Also, although /sl/ or /bl/ may occur word-initially in Yiddish, complex onset formation is expected to be blocked inside forms like [ɔjs + leʃn] 'extinguish' or [grob + leχ] 'somewhat rude', because the relevant sequences result from the adjunction of the productive derivational affixes /ɔjs + / and / + leχ/. In light of these hypotheses, we take a closer look at Yiddish word-initial clusters.

	l	r	n	m	f	v	s	ʃ	t	d
p	✓	✓	✓				✓	✓	✓	
b	✓	✓								
t	✓	✓	✓	✓	✓	✓				
d	✓	✓	✓							
k	✓	✓	✓				✓		✓	
g	✓	✓	✓	✓						
f	✓	✓								
v	✓									
s	✓	✓	✓	✓					✓	✓
z	✓	✓	✓	✓						
ʃ	✓	✓	✓	✓		✓			✓	
ʒ				✓						
χ	✓	✓	✓	✓		✓	✓	✓		
ts	✓									
d										
tʃ										
d										
m										
n										
ɲ										
ŋ										
l										
r										

TABLE 7. Yiddish consonants and possible word-initial clusters.

In Table 7 the consonants of Yiddish are listed in the first column. The upper row gives the consonants that may occur as the second member of a word-initial onset. A checkmark at the intersections of rows and columns designates the combination as a word-initial cluster that is actually attested. The table is based on Birnbaum 1979:222, but completed where omissions were observed.

The only triconsonantal clusters allowed in Yiddish are sequences of the type coronal fricative + oral stop + r. Obstruents and sonorants combine quite freely to form two-member onsets, within the limits set by the universal sonority sequencing principle.

[13] Here we understand 'derivation' as opposed to 'inflection'.

Although some clusters seem to be restricted to intervocalic position, their nonoccurrence word-initially looks more like an accidental than a structural fact of Yiddish phonotactics. For example, though we find no word that starts with the combination /ʒn/, we do find this cluster word-internally, as in [vaʒnə] 'impressive'. Considering the fact that /sn, zn, ʃn, sm, zm, ʃm, ʒm/ all exist word-initially, there is little reason to consider the absence of /ʒn/ in this position as a significant fact on which any decisive argument can be based. As it turns out, there aren't many discrepancies between word-initial and word-medial consonant clusters in Yiddish. The only word-initial gap that we would consider systematic involves combinations of labial fricatives with nasal consonants, a fact that we have foregrounded by shading the relevant cells in Table 7. Interestingly, these sequences can sporadically be found word-internally, as in *Ko*[v]*ne* (place name), *da*[v]*nen* 'pray', *li*[f]*ney* 'before'. Clearly, if the /{v,f} + n/ clusters are heterosyllabic in these forms, the first two words show that syllable-final devoicing does not exist word-internally in Yiddish. Let us mention in passing that a word like *li*[f]*ney* 'before', and many others like [vajtleχ] 'somewhat far' or [miʃmaʃ] 'hotch-potch', show that the occurrence of voiced obstruents before sonorants cannot be explained by sonorant-to-obstruent assimilation.

We turn now to the syllabification of heteromorphemic obstruent + sonorant sequences. In Yiddish, obstruent + sonorant clusters can be derived by suffixation of sonorant-initial suffixes to obstruent-final roots, as in 10, or by the attachment of vowel-initial suffixes to roots ending in a syllabic sonorant, as in 11. Our examples are taken from both the standard dialect and the dialect described in Birnbaum 1979, since we have no reason to assume that the dialects differ with regard to syllabification. In 11, an apostrophe marks syllabicity of the preceding sonorant.

(10)	[nud + nik]	'boring person'	(standard)
	[tɔjb + leχ]	'somewhat deaf'	(standard)
	[nɪd + nik]	'the (male) bore'	(Birnbaum)
	[nɪd + nitsi]	'the (female) bore'	(Birnbaum)
(11)	[mɔʃl']	'ruler-SG'	(Birnbaum)
	[mɔʃl + im]	'ruler-PL'	(Birnbaum)
	[kegn']	'against'	(standard)
	[kegn + ər]	'opponent'	(standard)
	[redn']	'speak'	(standard)
	[redn + ər]	'speaker'	(standard)

The examples in 10 speak for themselves. In the words in 11 the attachment of the vowel-initial suffix causes a change in the syllable structure of the root-final sonorant, which ceases to be nuclear in order to become the onset of the word-final syllable. The question then is whether /ʃ/, /g/, or /d/ combine with the resyllabified sonorant to form a complex onset. The only observation that Birnbaum makes about the syllabification of Yiddish refers precisely to this fact. In his discussion of singular/plural pairs like [mɔʃl'] / [mɔʃl + im], he observes that 'if [there is] a syllabic *l*, it becomes unsyllabic and so the BEGINNING of the final syllable' (1979:230, our emphasis). It is clear that at least in words of the type provided in 11 complex onsets cannot be derived in Yiddish, and that, consequently, voiced obstruents may appear in word-internal syllable codas. Furthermore, it seems justified to generalize from these formations to productive derivation in general, such as the suffixation processes exemplified in 11.

We can safely conclude that Yiddish has no word-internal syllable-final devoicing. It follows that the Voice Constraint 3a is not active and that, consequently, Final Excep-

tionality 3b cannot be appealed to in accounting for the word-final voice contrast. This conclusion not only shows the irrelevance of Final Exceptionality in Yiddish, but it affects the very way in which voice neutralization is conceived of in Lombardi's derivational theory (see §2.2). Given the claim that voice is a privative feature, only [+voice] assimilation should exist in a language like Yiddish, because the surfacing of an underlying [+voice] [−voice] sequence as [−voice] [−voice] (e.g. /vog + ʃol/ → [vokʃol]) could only result from the voice constraint or from an ad hoc rule, probably a language-specific version of Cho's cluster devoicing parameter 2.2, which deletes the voice feature before nonsonorant consonants only.

Let us round off the discussion of the Yiddish facts with some general observations. Yiddish unquestionably has a word-internal voice contrast before sonorant consonants. In the foregoing discussion we have used the lack of congruence between word-initial and word-internal clusters, and the prosodic structure of derived obstruent + sonorant clusters as evidence for the claim that at least some obstruent + sonorant clusters are heterosyllabic, and that, consequently, Yiddish has no process of word-internal syllable-final devoicing. It is relevant that, even if it were the case that all obstruent + sonorant clusters of Yiddish are always tautosyllabic, there would still be no proof for the activity of the voice constraint word-internally. This is because word-final codas would constitute the only evidence for the language learner to decide whether Yiddish is a voice-constraint language. As we have seen, word-final consonants do show a voicing contrast. Let us continue playing the devil's advocate, and imagine a language like Yiddish in which all obstruent + sonorant clusters are indeed always tautosyllabic word-internally, and assume moreover that the language learner does attribute the laryngeal homorganicity in word-internal obstruent clusters to the voice constraint. It would still be necessary to account for part of the assimilation facts with an independent ad hoc rule because assimilation in Yiddish applies across word boundaries, as in /erʃt#gəʃen/ ~ [erʒdgəʃen] 'just happened', and /lajg#ʃɔjn/ ~ [lajkʃɔjn] 'do lay'. We know moreover that the voice contrast is maintained inside phrases before words that start with a sonorant consonant, as shown by a compound like *hoy*/z/#*maynster* 'houseboy'. Since /g/ in /lajg#ʃɔjn/ occurs at the end of a prosodic word, it should not devoice, because of final exceptionality. However, it does assimilate to the following voiceless consonant. Again, without a rule that deletes [voice] before a following nonsonorant consonant, this assimilation cannot be accounted for.

In the next sections, we will briefly examine the effects of (de)voicing in Rumanian and Serbo-Croatian, both languages which, like Yiddish, are claimed to activate the voice constraint as well as final exceptionality.

3.2. RUMANIAN.[14] In a very careful study in which she compares English RP and Rumanian standard pronunciation, Tătaru (1975) pays extensive attention to the articulation of the voice features in Rumanian consonant clusters. In derived obstruent sequences, assimilation seems to be categorical in /{s,ʃ} + C/ clusters only, within words, *dezbin* 'I take part', *dezdoi* 'I unbend', *dezgust* 'disgust', *zbat* 'I struggle', *dezveli* 'to uncover' (where the orthography mirrors the voiced pronunciation), but also across words, as in the auxiliary + verb sequence *aş vrea* /aʃ vr^{e}a/ pronounced as [aʒ vr^{e}a] 'I would like' (cf. Tătaru 1975:40, 125, 128). In other derived sequences, i.e. when the

[14] Thanks to Ioana Chitoran for help with the Rumanian data. Chitoran, a native speaker of Rumanian, fully agrees with the conclusions about syllable structure discussed in this section.

first consonant in the cluster is one of the stops /p, b, t, d, k, g/, agreement in voice seems to be less categorical, although it represents the normal case: *subcutanat* [supkutanat] 'subcutaneous', *subpământean* [suppəmintᵉan] 'underground adj.', *totdeauna* [todᵈᵉauna] 'always', and so on. To check the relevance of final exceptionality, we follow the same strategy we applied to Yiddish. If this constraint is a necessary part of the phonological grammar of Rumanian, it must be true that word-internal obstruents systematically appear as voiceless before a heterosyllabic sonorant.

Tătaru and other scholars we consulted pay little attention to the question of the syllabification of intervocalic consonant sequences, but what they do say is enough to raise serious doubts about the claim that word-internal coda-devoicing exists in Rumanian. To be sure, the voice opposition is not neutralized in word-final position, as is shown by the words in 12, taken from Mallinson (1986:336), and Chitoran (1997: 27–30).

(12)	lu[p]	'wolf'	cui[b]	'nest'
	la[t]	'wide'	no[d]	'knot'
	la[k]	'lake'	ba[g]	'I put'
	ba[ts]	'stick'		
	ra[tʃ](i)	'crayfishes'	ba[dʒ](i)	'you put'
	panto[f]	'shoe'	pleşu[v]	'bald'
	pa[s]	'step'	lucre[z]	'I work'
	la[ʃ]	'coward'	pa[ʒ]	'servant'

Also word-internally, both voiced and voiceless obstruents are found before nasal stops: *grabnic* 'fast', *abnegaţie* 'abnegation', *etnic* 'ethnic', *vrednic* 'worthy', *admira* 'to admire', *logodnic* 'fiancé', *dogma* 'dogma', *flegmă* 'catarrh', *regnul* 'kingdom', *reknet* 'roar', *gleznă* 'ankle'. Of these clusters, some may also appear word-initially, in which position one encounters the following obstruent-nasal combinations: /pn/ (*pneumatic*), /gn/ (*gnostic*), /kn/ (*cneaz* 'prince'), /sn/ (*snoavă* 'anecdote'), /ʃn/ (*şnur* 'cord'), /ʒn/ (*jnepen* 'juniper'), /sm/ (*smead* 'swarthy'), /zm/ (*zmeură* 'raspberry'), /ʃm/ (*şmecher* 'cheeky'), of which /pn/, /gn/, and /kn/ are very rare. Nonexistent (or very rare) word-initial sequences are / (pn), bn, tn, dn, (kn), (gn), pm, bm, tm, dm, km, gm/. This set of clusters represents enough of a pattern to suggest that it stands for a structural gap in the distribution of initial clusters in the native vocabulary. If this is correct, it seems safe to assume that these sequences may not function as complex onsets when they appear in intervocalic postion, but instead must be divided over two syllables. As it turns out, one of the very few of Tătaru's observations relevant to syllable structure is directly relevant to our claim: 'the Rumanian /bn, tn/ occur only in different syllables, e.g. *grab-nic*, *et-nic*' (1975:86). Agard (1958:18) goes even further, stating that only clusters of a stop or /f, v/ followed by a liquid may function as an onset in intervocalic position. 'At transition from open to consonant-initial syllables, all C_1 single consonants may occur, but the only C_1 clusters are those composed of stop or /f v/ plus /r l/', where C_1 stands for any consonant or cluster preceding the nucleus. Clearly, before word-internal nasal consonants, obstruents are syllabified in the syllable coda, in which position no devoicing takes place. Rumanian does not activate the voice constraint, and consequently, there is no need to distinguish word-internal and word-final syllables with regard to the process of coda devoicing. Yet, word-internally, assimilation is triggered by voiced and voiceless obstruents alike.

3.3. SERBO-CROATIAN. Finally we turn to Serbo-Croatian.[15] Like Yiddish and Rumanian, Serbo-Croatian has no word-final devoicing; this is illustrated by the contrasting pairs in 13.

(13)

glu[p]	'stupid'	golu[b]	'dove'
sa[t]	'hour'	ra[d]	'work'
preta[k]	'Friday'	razlo[g]	'reason'
pa[s]	'dog'	vo[z]	'train'
jo[ʃ]	'still'	mu[ʒ]	'husband'

Word-internally, obligatory assimilation of [± voice] occurs, as shown in 14.

(14) a. Regressive devoicing

sla/d/ak	'sweet'	sla[tk]a	'sweet-FEM'
dolo/z/ak	'arrival'	dola[sk]a	'arrival-GEN'
te/ʒ/ak	'heavy'	te[ʃk]a	'heavy-FEM'

b. Regressive voicing

ne/k/ad	'or'	ne[gd]a	'sometimes'
to/p/	'cannon'	to[bdʒ]ija	'artilleryman'
sva/t/	'wedding attendant'	sva[db]a	'wedding'

The assimilation of the [− voice] feature is particularly clear across prefix boundaries, because prefixes, when they are of the type (C)VC, all seem to have a voiced final consonant underlyingly. The examples in 15 are taken from Hodge & Jankovic 1965.

(15) Voice assimilation in verbal prefixes

ići	'to go'	i[z + i]ći	'to go out'
buditi	'to awaken'	i[z + b]uditi	'to wake up all'
dici	'to lift'	i[z + d]ici	'to lift up'
gubiti	'to be losing'	i[z + g]ubiti	'to lose'
vršiti	'to perform'	i[z + v]ršiti	'to execute'
prositi	'to beg'	i[s + p]rositi	'to get something by begging'
trošiti	'to spend'	i[s + t]rošiti	'to spend a lot'
kupiti	'to gather'	i[s + k]upiti	'to gather'
nositi	'to carry'	i[z + n]esti	'to carry something out'
jačati	'to strengthen'	na[d + j]ačati	'to overpower'
raditi	'to work'	o[b + r]aditi	'to till'
letiti	'to fly'	u[z + l]etiti	'to fly up'
l^{j}utiti se	'to be angry'	ra[z + l^{j}]utiti se	'to become angry'

Root-internally and before suffix boundaries, Serbo-Croatian presents a voice contrast before nasal consonants, as in *pa*[ʒ + n^{j}]*a* 'attention' versus *dana*[ʃ + n^{j}]*i* 'pertaining to today', or *drža*[v + n]*ik* 'statesman' versus *lje*[tʃ + n]*ik* 'doctor'. We will show next that some of the contrasting obstruents are syllable-final.

In Serbo-Croatian, the stops /p, t, k, b, d, g/ cannot freely combine with each other to make possible onsets. Instead, their combinatory possibilities are very limited: only /pt/, /ptʃ/, /bd/, /tk/, /kć/, /gd/, /gdđ/ occur in word-initial position.[16] Abstracting away from a number of unexpected gaps, we can generalize over these combinations by stating that /P, K/ can only be followed by a coronal stop or affricate, whereas /T/ can only combine with a dorsal stop, where T, P, and K stand for a coronal stop/affricate,

[15] The analysis argued for in this section agrees with syllabification judgments reported by our native informant.

[16] The symbols /ć, đ/ represent a voiceless and a voiced alveolar affricate, respectively.

labial stop, and dorsal stop, respectively. Yet, between vowels we find, *je*[ft]*in* 'cheap', *sva*[d + b]*a* 'wedding', *na*[tp]*is* 'sign' etc., from which we conclude that Serbo-Croatian does permit word-internal codas.

	WORD-INITIAL	WORD-MEDIAL		WORD-INITIAL	WORD-MEDIAL
pm			tn		✓
bm			dn	✓	✓
pn	✓	✓	tnʲ		✓
bn		✓	dnʲ		✓
pnʲ			cn		✓
bnʲ		✓	–		
km	✓	✓	cnʲ		
gm	✓	✓	–		
kn	✓	✓	ćn		✓
gn	✓	✓	ćnʲ		✓
knʲ	✓	✓	đn		
gnʲ	✓	✓	đnʲ		
tm	✓	✓	tʃn		✓
dm		✓	tʃnʲ		✓
cm	✓		dʒn		
–			dʒnʲ		
ćm					
đm					
tʃm	✓	✓			
dʒm					

TABLE 8. Oral stop/affricate plus nasal clusters in Serbo-Croatian.

Table 8, adapted from Hodge 1945, gives an overview of the permissible stop/affricate plus nasal clusters in word-initial and word-medial positions. The second column shows the possible occurrences of word-initial and word-medial coronal clusters; other possible combinations of an oral stop/afficate plus a nasal consonant are shown in the first column. The reason for separating out these cluster types is to visualize the very restricted word-initial occurrences of the coronal clusters as compared to other combinations.

Table 8 shows the almost complete asymmetry in the occurrence of word-initial coronal stop/affricate + coronal nasal clusters as compared to other clusters. For coronal clusters, only /dn/ is possible word-initially, whereas word-internally many more combinations are permitted. In agreement with the reasoning adopted here, we will assume that intervocalic sequences that are structurally avoided word-initially are heterosyllabic intervocalically, as in *dana*[ʃ + nʲ]*i* 'pertaining to today', *ume*[t + n]*ik* 'artist' *sme*[t + nʲ]*a* 'hindrance', *lje*[tʃ + n]*ik* 'doctor', etc. If our assumption is correct, it follows that Serbo-Croatian has word-medial heterosyllabic C + sonorant clusters.

In word-initial clusters of the type /Tm/ or /Pn/, T and P must be voiceless. Another striking fact about word-initial clusters is the absence of the sequence /f,v/ + nasal consonant: at the beginning of a word, /v/ only combines with liquids and /j/, whereas /f/ only combines with /r/: *vrijeme* 'time', *vlaast* 'power', *vjeran* 'true', *francuuskii* 'French'. Consider the words in 16.

(16) drža[v + n]ik 'statesman'
gla[vn]ii 'main'
o[d + m]aati 'to wave'
ra[d + nʲ]a 'action'
sre[d + nʲ]i 'central'
pose[bn]o 'separate-N'

As observed earlier, words like *sva*[d + b]*a* 'wedding', *na*[tp]*is* 'sign', *lje*[tʃ + n]*ik* 'doctor', and so on, show that Serbo-Croatian permits word-internal closed syllables. The examples in 16 present word-medial clusters that do not exist word-initially and most of which are moreover heteromorphemic, as is indicated by the plus sign. It follows that the first consonant of these clusters, which is a voiced obstruent, is in the syllable coda.

Finally, we note that, even if all intervocalic obstruent plus sonorant clusters were tautosyllabic, the voice constraint and final exceptionality would be unable to account for [±voice] assimilation in a coherent way, because, as in Yiddish, assimilation also applies across word boundaries. Consequently, the same argument that was made earlier for Yiddish (see §3.1) can be made for Serbo-Croatian. We conclude that Serbo-Croatian does not qualify either as an example of a word-internal devoicing-only language.

3.4. RE-EVALUATING THE (DE)VOICING TYPOLOGY. Yiddish, Rumanian, and Serbo-Croatian, as well as many other languages, maintain a voice contrast word-finally as well as in word-internal syllable codas. In contrast, there are languages showing word-final devoicing without word-internal devoicing, for example, Polish, Russian, and Walloon. Therefore, the traditional view that final devoicing may apply to the syllable or to the word remains as yet unchallenged. Independent evidence for this view comes from the dialect of Yiddish described in Birnbaum 1979, which has a rule of prepausal devoicing, i.e. oral obstruents are always voiceless 'when followed by a break in speaking, even a short one, and of course, at the end of a sentence' (1979:211), as in the examples in 17.

(17) zaan vaa/b/ → zaan vaa[p], demlt 'his wife, at that time . . . '
er is mii/d/ → er is mii[t], bin ich 'He is tired, so I . . . '
di maa/z/ → di maa[s], er vet 'the mice, he will . . . '

If devoicing may apply at the end of the prosodic word in languages that have no word-internal devoicing, we expect to find languages like the variety of Yiddish described by Birnbaum that devoices obstruents at the end of some higher prosodic domain, such as, at the end of an intonational phrase, as in the case at hand.[17] The possible devoicing environments seem to mirror the prosodic hierarchy in a way one would expect, as exemplified in Table 9, where each layer of checkmarks is expected to represent a possible devoicing environment within the devoicing typology (ω, Φ, I, U stand for phonological word, phonological phrase, intonational phrase and utterance, respectively).[18] As Table 9 shows, devoicing at the end of a higher prosodic domain implies devoicing at the end of a lower domain, but not inversely.

Syllable-final devoicing may apply without assimilation, as in German, or with assimilation, as in Dutch; assimilation may apply without syllable-final devoicing, as in Yiddish, Serbo-Croatian, and Rumanian. Since cluster devoicing without assimilation

[17] A case of utterance-final devoicing, which also applies to liquids and nasal consonants, is reported by Burquest (1998:68–70) for Angas, a Chadic language spoken in the central area of Nigeria. Standard European Spanish has a rule that devoices and laxes voiced obstruents prepausally (Navarro Tomás 1961): *se*[ð̥] 'thirst', but *se*[ðo]*rrible* 'terrible thirst'.

[18] We will leave out the foot domain, which does not seem relevant, either as a domain for devoicing, or for voice spreading.

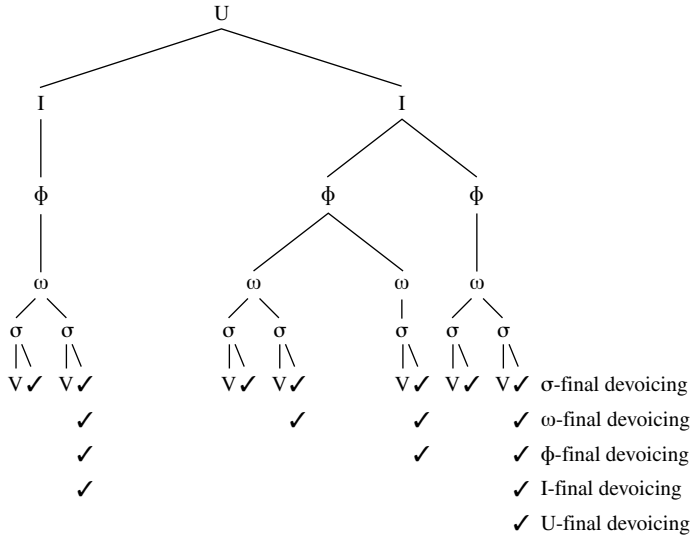


TABLE 9. Possible devoicing environments.

does not seem to occur in the world's languages, we will dismiss cluster devoicing as a possible phonological process or parameter, pace Cho (see §2.1). Instead, we will treat languages that have been classified as undergoing both cluster devoicing and assimilation as assimilation-only languages. Therefore, we need to assume only that syllable-final devoicing and assimilation are mutually independent processes: one may occur, or both, or none. Adding to this the fact that assimilation may involve [− voice] only, [+ voice] only, or both, the typology of (de)voicing effects in Table 10 is predicted (we omit devoicing above the word-level).[19]

σ-FINAL DEVOICING	ω-FINAL DEVOICING	ASSIMILATION	LANGUAGE	/az + laz + tas + dad/
yes	(yes)	yes ([α voice])	Dutch	[as + las + taz + dat]
yes	(yes)	no	German	[as + las + tas + dat]
yes	no	no	impossible	
yes	no	yes	impossible	
(no)	no	no	Berber	[az + laz + tas + dad]
no	yes	yes ([α voice])	Walloon	[az + las + taz + dat]
(no)	no	yes ([+ voice])	Ukrainian	[az + laz + taz + dad]
(no)	no	yes ([− voice])	Ya:thê	[az + las + tas + dad]
(no)	no	yes ([α voice])	Yiddish	[az + las + taz + dad]
no	yes	no	?	[az + laz + tas + dat]

TABLE 10. Possible combinations of relevant (de)voicing parameters.

Abstracting away from the fact that languages may choose a final devoicing rule conditioned by a prosodic category higher than the word, Table 10 contains all possible combinations of the relevant (de)voicing parameters.[20] Because of the implicational relation that holds between syllable-final and word-final devoicing, some languages are predicted not to exist. We think these predictions are correct. One language

[19] The facts of Ya:thê will be discussed in §4.3.

[20] A quite different approach is taken by Steriade (1997), who argues that OT constraints must make reference to phonetic cues and that prosodic factors do not determine voicing alternations. The clearest case

type that we predict to exist, illustrated in the last row of Table 10, was not encountered in the literature. This language would be like English, but with word-final devoicing. We suppose that its rareness is due to the relative rareness of the no-assimilation languages. Otherwise, all predicted combinations are attested. Notice that for syllable-final devoicing languages it is structurally impossible to show the three types of [voice] spreading that we have distinguished for assimilation-only languages. This is because syllable-final devoicing reduces the possible clusters that are inputs to assimilation to [−voice][+voice] or [−voice][−voice]. If assimilation applies in a [−voice][−voice] sequence, the effect of [−voice] spreading is invisible, or, put differently, [−voice]-spreading-only remains indistinguishable from no-spreading. Furthermore, when [+voice] spreads in a [−voice] [+voice] cluster, the process is indistinguishable from the spreading of [±voice]. To be able to show the relevance of single feature spreading combined with syllable-final devoicing, we need to find languages that also possess, for example, consonantal prefixes with different lexical voice specifications, hypothetically /f + [C . . . / and /z + [C . . . /, of which only one, but not the other adapts to the voice value of the root-initial consonant. We have not found such languages.

We have shown that the assimilation of voicelessness in the languages considered in §§3.1–3 cannot be explained properly by privative voice as integrated in a theory of devoicing as conceived by Cho and Lombardi. In the next two sections we will directly address the issue of the privativity of the voice feature, and show that [−voice] may function independently of [+voice].

4. ARGUMENTS AGAINST PRIVATIVE VOICE: POSTLEXICAL VOICELESSNESS. It is commonly agreed that the feature [−voice] is relatively 'unmarked' compared to [+voice], or equivalently, that it represents the default value for [voice]. Some phonologists have drawn the conclusion that [voice] is a privative feature. Consequently, one does not expect to find a language where the feature [−voice] is specified phonologically at any level of representation, or participates in phonological processes of any kind, including rules of assimilation and dissimilation. One of the most compelling arguments for the privativity hypothesis is the existence of a language like Ukrainian, which spreads only the positive value of [voice]: compare *ča*[s] 'time' ~ *ča*/s-d/*ijaty* → *ča*[z-d]*ijaty* 'time to act', *žyra*[f] 'giraffe' ~ *žyra*[v#b]*ižyt* 'the giraffe is running' with *xo*[bt]*y* 'trunk-GEN.SG', *be*[ʒ-tʃ]*estia* 'dishonor' (from Danyenko & Vakulenko 1995). If [−voice] does not exist, and since Ukrainian has no syllable-final devoicing, spreading can only apply to the only existing (positive) value, i.e. [+voice], creating clusters that

we know that shows the relevance of syllable structure comes from Catalan, where obstruents assimilate in voicing to both obstruent and sonorant consonants. Consider the prefixes *des* and *sub*.

(i)	de[s.p]entinar	'to uncomb'	su[p.t]ítol	'subtitle'
	de[z.ɣ]laçar	'to defrost'	su[b.ʒ]ènere	'subgenus'
	de[z.ʎ]igar	'to untie'	su[b.l]ímit	'sublimit'
	de[z.r]atizar	'to clear of rats'	su[b.r]utina	'subroutine'

The final consonant of a prefix is never syllabified as the onset of otherwise permissible tautosyllabic clusters. In onset clusters, the contrast between voiced and voiceless is systematically maintained.

(ii)	sem[.pr]e	'always'	de[s.pl]egar	'to unfold'
	sem[.br]a	'sows'	de[s.tr]iar	'to separate'

It is not clear to us whether and, if so, how prosodic factors might interfere with the different phonetic cues distinguished by Steriade in the process of grammaticalization of devoicing and voice assimilation. Further research on this question might show that the phonetic and the prosodic approaches are to a certain extent complementary.

are homorganically voiced, whereas [+voice] [−voice] obstruent sequences remain heterorganic.

We will discuss languages that show the opposite of the Ukrainian situation, in that only [−voice] assimilates, whereas [+voice] remains inert or behaves in a way that is different from [+voice].

4.1. YORKSHIRE ENGLISH. As is turns out, cases that represent the reverse Ukrainian situation are not difficult to find. The examples in 18, taken from Wells (1982:367), come from the Yorkshire English dialect.[21]

(18)		
	bed-time	be[tt]ime
	subcommittee	su[pk]ommittee
	headquarters	hea[tk]uarters
	frogspawn	fro[ks]pawn
	a big piece	a bi[kp]iece
	live performance	li[fp]erformance
	wide trousers	wi[tt]rousers (compare *white trousers*: *whi*[tt]*rousers*)
	white book	whi[tb]ook (not **whi*[db]*ook*)

In the Yorkshire dialect, all voiced obstruents become voiceless before a voiceless consonant across word boundaries (including compound boundaries). Under the same conditions, voiceless consonants are not regressively voiced. As in RP, syllable-final devoicing does not exist in Yorkshire English, so the homorganicity of these clusters cannot be explained by an independent rule of devoicing. Wells leaves no doubt about the neutralizing character of the process. 'This is not mere allophonic devoicing, such as is widespread in English: it involves the complete neutralisation of the voicing (fortis/lenis) opposition'. The neutralization of the voice opposition before voiceless obstruents is confirmed, moreover, by the fact that 'an underlying /d/, Yorkshire assimilated, can be realised as [ʔ] just as an underlying /t/ can be' (Wells 1982:367).

Some phonologists have proposed to distinguish between voiced and voiceless obstruents in Germanic languages other than Dutch with the feature [spread glottis] (see Iverson & Salmons 1995, for English). This, however, does not seem a plausible approach for a language like Dutch, or for all of the Romance languages, where there is no phonetic motivation for replacing [−voice] by [spread glottis]. We turn next to Parisian French, which also shows the necessity of a separate rule of [−voice] spreading.

4.2. PARISIAN FRENCH. In his study of the Parisian French syllable, Dell (1995) pays a great deal of attention to the behavior of voice in obstruent clusters. We follow his analysis closely. The words in 19 are taken from Dell 1995, and, where useful, completed with our own examples.

It is well known that Parisian French (henceforth French) has no rule of word-final devoicing. Word-internally, there is a voicing contrast in the syllable coda (19a); inside words there is obligatory regressive DEVOICING (19b) and optional regressive VOICING (19c). According to Dell, regressive devoicing is obligatory in all speech styles: 'however carefully pronounced, *gibecière* is homophonous with *gypsière*, and when schwa drops *la jeter* ([laʃte]) is homophonous with *l'acheter*' (1995:12).

[21] Thanks to Carlos Gussenhoven for drawing our attention to these facts. Spencer 1996:49 discusses a process of fricative devoicing for RP, which seems to apply under the same conditions as the more general devoicing process discussed here for Yorkshire English.

(19) a. internal contrast

admirer	a[d]mirer	'admire'	
cadenas	ca[d]nas	'padlock'	
acne	a[k]né	'acne'	
osmose	o[s]mose	'osmosis'	
atlas	a[t]las	'atlas'	
patelin	pa[t]lin	'village'	

b. obligatory regressive devoicing

distinctif	distin[kt]if	'distinctive'	(compare distin[g]uer)
subtropical	su[pt]ropical	'subtropical'	(compare su[b]alpin)
projeter	pro[ʃt]er	'throw'	(compare pro[ʒ]ette)
absorption	a[ps]or[ps]ion	'absorption'	(compare absor[b]er)
absorptif	a[ps]or[pt]if	'absorptive'	(compare absor[b]er)
là-dessus	la[ts]us	'on that'	(compare par-[də]ssus)

c. optional regressive voicing

anecdote	ane[g/kd]ote	'anecdote'	
aqueduc	a[g/kd]uc	'aqueduct'	
décevant	dé[z/sv]ant	'disappointing'	(comp. dé[s]oive)
défaisait	dé[v/fz]ait	'undo-IMPF.'	(compare dé[f]ais)
achever	a[*ʒ/ʃv]er	'finish'	(compare a[ʃ]ève)

Whereas the rule of regressive devoicing is obligatory, regressive voicing is optional.[22] In addition, the rule of optional voicing has an unexpected exception, represented by the cluster [ʃv], which never becomes homogeneous, although /ʒ/ exists as a phoneme in French. As it turns out, Parisian French comes close to the situation described for Yorkshire English: there is no final devoicing. Therefore, spreading of [−voice] can only be achieved if [−voice] is present in the representation. Moreover, Parisian French has morpheme-internal obstruent clusters of the type [−voice][−voice], [+voice][+voice], and [−voice][+voice], whereas the type [+voice][−voice] is lacking. This asymmetry is due to the presence in the grammar of obligatory spreading of the unmarked [−voice] feature to the left. But regressive assimilation of the marked [+voice] feature is only optional.[23]

A more spectacular case of postlexical [−voice] spreading occurs in Ya:thê, which has a lexical opposition between plain voiceless, voiceless aspirated, and voiced obstruents, as we will see next.

4.3. YA:THÊ. Ya:thê, the language of the Fulniô Indians, who live in northeastern Brazil in the state of Pernambuco,[24] is classified as an isolated language of the Macro-Jê linguistic stock (see Rodrigues 1986:47–56). Ya:thê uses the laryngeal features voiceless, voiced, and aspirated contrastively, although the complete range of laryngeal oppositions is exploited only in the coronal stop series, as is shown in Table 11, which represents the consonantal phonemes of the language.

[22] Although the speech style in which regressive voicing does not occur is a 'painstakingly careful' one (François Dell, p.c.).

[23] Notice that the optional pronunciation of *anecdote* with voiceless /k/ is not sufficiently explained by reference to the orthography. It cannot be dismissed as a 'spelling' pronunciation, because words like *subtropical* are always pronounced with a voiceless cluster.

[24] All examples are taken from Costa 1999. We are very grateful to the author for sending her thesis to us and for useful help in the interpretation of the data.

p	t	tʃ	k	
	d	dʒ		
	t^h	$tʃ^h$	k^h	h
f	s	ʃ		
m	n			
	l	ʎ		

TABLE 11. Ya:thê system of underlying consonants.

In Ya:thê, sequences of consonants exist lexically word-initially. Word-internally, they can arise as the result of a lexical rule of vowel deletion. The examples in 20 show the behavior of the contrastive laryngeal features when they become contiguous in the sequence. More particularly, voiceless obstruents regressively devoice voiced obstruents (20a), whereas the feature [+ voice] does not spread to a preceding voiceless obstruent (20b). The segments under focus are in italics; the symbol « represents a slight (optional) vocalic transition, which occurs between consonants that have different laryngeal specifications, or between heterosyllabic clusters derived from syncope.[25]

(20) a. /i - e - *d*a - *k*a/ [ie*t*k^ja]
1SG.SUBJ - 3SG.OBJ - let - IND 'I let him'
/fowa - *d*e*s*a/ [fowa*ts*a]
stone - ATTR 'of the stone'
Port. /mɛ*d*i*k*o/ > Ya:thê [mɛ*tk*o]
'physician'
/tʃtʃaia ne - do*d*e - *k*^{h}ia - ka/ [tʃtʃaja:do*tk*^{h}iaka]
day exist - NEG - IMPF - IND 'there was no day'

b. /i - kfa*f*a - *d*ode - mã/ [ikfa*f*$^{«}$*d*od$^{«}$mã]
1SG.SUBJ - sleep - NEG - TEMP SUBORD 'when I do not sleep'
/i - kfa*k*e - *d*o*d*e - *k*a/ [ikfa*k*$^{«}$*d*o*tk*^{j}a]
1SG.SUBJ- can - NEG - MOOD 'I cannot'
/ta - sama*k*^{h}e - *d*o*d*e - *k*a / [tasama*k*$^{h«}$*d*o*tk*^{j}a]
3SG - marry - NEG - MOOD 'he does not marry'
/i - t^{h}a*t*e - *d*e/ [t^{h}a*t*$^{«}$*d*e]
1SG - mouth - ORIGIN 'from my mouth'
/e - *t*^{h}o - *d*o*d*e - *k*a/ [e*t*$^{h«}$*d*o*tk*^{j}a]
3SG - die - NEG - IND 'he does not die'

Ya:thê has no syllable-final devoicing, as witnessed by forms like /a-ek^{h}de-dode-ma/ → [aek$^{h«}$do*d*$^{«}$ma] 'when you do not know', or /ja-e-da-dode-kane-ka/ → [jɛ:*d*dodekã:k^{j}a] 'we do not leave him yet', where the italicized *d* is in the coda. Costa (1999:63) observes that inside words, derived clusters are heterosyllabic. Also, complex onsets in stems become heterosyllabic when certain clitics are prefixed, as in [ik.fa.ya] 'my bed' from /i/ '1 clitic' and /kfa.ya/ 'bed'. Costa explicitly notes that the heterosyllabicity of the /kf/ cluster in this form contrasts with its tautosyllabicity when it occurs after a word-boundary, as in [ɔtska#kfa.ja] 'bed of the man', from [ɔtska] 'man' and

[25] Interestingly, a similar phenomenon occurs in Ukrainian, where, as we have seen, the heterorganic clusters are of the opposite type [+ voice][− voice]. Zilynśkyj remarks: 'When two non-homorganic stops come together, closure of the second consonant is produced immediately after the opening of the first, in both received pronunciation and in folk dialects. However, between the offset of the preceding stop and the onset of the following stop, a transitional sound of a vocalic nature is formed (the so-called off-glide)' (1979: 136).

[kfaja] 'bed'. The fact that syllable structure is not involved can be observed also in morpheme-initial consonant sequences that mimic the pattern observed in derived clusters: no sequences of [+voice][−voice] exist, whereas any other structurally possible combinations of laryngeal specifications is acceptable, as exemplified in 21.[26]

(21)	[ʃdia]	'bee'	[tʰkwa]	'to die'
	[tdia]	'road'	[tkʰa]	'head'
	[kʰde]	'to know'	[kfake]	'to can'
	[pdãneka]	'to slip'	[kfɛlneka]	'to play'
	[sdadaka]	'spider'	[ʃkʲa]	'to be'
	[fdesea]	'frog'	[ktsalene]	'message'

Ya:thê is a clear example of the reversed Ukrainian situation. The language is particularly interesting because the spreading element is demonstrably the feature voiceless, not spread glottis, because voiceless obstruents contrast with aspirated ones. If phonological activity can be taken as evidence for lexical contrastivity, as suggested by Iverson and Salmons (1995), we must assign lexical status to voicelessness in Ya:thê. Yet, [−voice] 'voiceless' is still the unmarked member within the class of laryngeal features. The consonant system of Ya:thê, which has eight voiceless obstruents, two voiced obstruents and three aspirated obstruents, is entirely consistent with this fact.

Notice, finally, that the last example in 20a shows that voiced consonants become voiceless before aspirated ones. This is what is predicted by the systems of laryngeal features proposed in SPE and by Halle and Stevens (1971:203). In the latter study, the SPE feature [−voice] is replaced by [+stiff vocal cords]. Aspirated consonants are specified for both [+stiff vocal cords] and for aspiration proper ([+spread glottis]), whereas voiced consonants are defined as [+slack vocal cords]. In Halle and Stevens's system of distinctive features, the assimilation pattern of Ya:thê could be formulated elegantly as regressive assimilation of the feature [+stiff vocal cords].

In §3, we examined languages like Yiddish, Serbo-Croatian, and Rumanian, which show that the spreading of both [+voice] and [−voice] may occur in languages that have no independent process of neutralization. From the perspective of Lombardi's derivational theory, one would expect these languages to spread [+voice] only, as in Ukrainian. In this section we added another language of this type, Parisian French, where [+voice] spreading does not act in a way identical to [−voice] spreading, suggesting that the two processes do not represent a uniform process of laryngeal assimilation, but two different processes. We have also given examples of languages where clusters agree exclusively in voicelessness, like Yorkshire English and Ya:thê.[27] These languages, and especially Ya:thê, clearly represent the opposite of the Ukrainian situation. Again, the existence of these languages cannot be explained if [voice] is a privative feature. More in general, there seems to be no real empirical difference in the phonological (postlexical) behavior of [−voice] as compared to [+voice]. In the

[26] Januacele Costa pointed out to us that, very probably, these clusters derive historically from CVC sequences through syncope.

[27] The languages we have discussed above are not the only ones that are known to spread [−voice] only. As Abu-Mansour reported (1996:217–19), Makkan Arabic has no word-final devoicing (cf. [ʕadʒuuz] 'old'), and no internal syllable-final devoicing (cf. [ʔibnu] 'his son'). Obstruents in internal position behave asymmetrically with respect to assimilation: they contrast in voicing when followed by a voiced obstruent (compare [ʔakbar] 'older' with [madbaħa] 'massacre') or a sonorant, but they assimilate when a following obstruent is voiceless, as in [ʔaksam], from /ʔagsam/ 'he made an oath'.

next sections we will show that the feature [− voice] is not only needed in the postlexical phonology, but also in the lexical phonology and at the level of lexical representation.

5. ARGUMENTS AGAINST PRIVATIVE VOICE: LEXICAL VOICELESSNESS. Lombardi (1996a) retreats from the extreme position that [− voice] has no role to play in the phonology of the world's languages. A number of processes involving [− voice] are discussed, and it is argued that they all represent postlexical processes. The author therefore proposes that the feature [voice] is a privative feature lexically, but a binary feature postlexically. Given that most of the evidence for spreading of [± voice] is postlexical in nature, we have the feeling that Lombardi's position amounts to saying that voice is binary in almost any language. Even for Dutch, which has word-internal, syllable-final devoicing, and where assimilation could therefore be analyzed with a privative [voice] feature, it now becomes unclear how these processes should be analyzed: since [voice] assimilation is postlexical, and since postlexically [− voice] is available, assimilation could be formulated as the spreading of a binary feature. Similarly, assimilation in Polish, Catalan, Yiddish, Rumanian, and Serbo-Croatian are demonstrably postlexical. The same idea is repeated in Lombardi's OT analysis of neutralization and voice assimilation (1999:299), where she claims that the analysis does not deal with postlexical voicing. To the extent that the phenomena discussed are postlexical (no evidence of their lexical status is given), her remark is surprising.[28]

To our knowledge, nobody has ever seriously reviewed the evidence for the inertness of [− voice] in the lexical phonology. One real argument for lexical assimilation of only [+ voice] would be a case that involves assimilated segments preserving their derived voice value after LEXICAL deletion of the trigger, e.g., /kas + ba/ → [kaza], but /mez + po/ → [mezo], next to underived [lozbi] and [nusko]. Such a grammar would show that assimilation is lexical (because it precedes a lexical rule of deletion), and, moreover, show the inactivity of the [− voice] feature in the lexicon. And given the structure-preserving nature of lexical rules, one should find rules of [voice]-assimilation that apply in lexically derived clusters only, and for which only segments contrasting in voice are targets. An instance of the latter would be a (nonexistent) dialect of Dutch with regular assimilation of obstruents to obstruents, but no assimilation of /k, x/, which do not contrast with /g, ɣ/, e.g. *verheu*[x]*en* 'to rejoice (at)' **vreu*[xd]*e* 'joy' (instead of attested *vreu* [ɣd]*e*) vs. *ze*[s]*en* 'six-PL.', *ze*[zd]*e* 'sixth', or a variety of Spanish with /p/, /t/, /k/, /b/, /d/, /g/ assimilating in voicing, as they do regularly, but in which /f/, /s/, /x/, which have no phonological voiced correlates, would not assimilate: *conce*[β]*ir* 'to conceive', *conce*[pθ]*ión* 'conception' *de*[s]*orden* 'disorder', **de*[s*d*]*icha* 'misfortune' (instead of attested *de*[z*d*]*icha*). To prove the lexical absence of voiceless one would have to find such languages and observe that regressive spreading of voicelessness does not occur. To our knowledge, no such varieties have been reported. Of course, one would not expect that a feature that is persistently present postlexically could not be present lexically. We will therefore turn to a number of languages that provide evidence for the lexical activity of the feature voiceless.

5.1. DUTCH PAST TENSE FORMS. It is well-known fact that Dutch stop-final and fricative-final obstruent clusters show different voice effects. Fricative-final clusters are always voiceless (o/p + v/allen [pf] 'strike'), whereas stop-final clusters can be either voiced or voiceless, predictable from the rightmost obstruent in the cluster (ka/s + b/oek

[28] It is not made explicit how lexical privativity and postlexical binarity translates in OT.

[zb] 'cash book', hui/z + k/amer [sk] 'living room'). Traditionally, the voicelessness of fricative-final clusters is explained as postlexical progressive assimilation of a [−voice] coda obstruent, which can be underlying, or derived by syllable-final devoicing. The process is postlexical because it also applies across word boundaries: *vij*/v/ /z/*onen* → *vij*[f] [s]*onen* 'five sons', *laa*/t/ /v/*rij* → *laa*[t] [f]*rij* 'set free'.

In verb forms, progressive assimilation applies lexically. Whereas progressive assimilation creates homogeneous VOICELESS clusters when the first member is an obstruent and the second member is a fricative, it creates homogeneous VOICED or VOICELESS clusters when the first member is a verbal root and the second member the past or the (prenominal inflected) participle suffix (/-də/), as in the examples in 22.

(22)

INFINITIVE	2/3 SG PRES IND	IMP SG/PL(N)	PAST PART	
ma/k/ + en	maa[k + t]	maa[k + t]e(n)	ge + maa[k + t]e	'make'
sto/p/ + en	sto[p + t]	sto[p + t]e(n)	ge + sto[p + t]e	'stop'
kra/b/ + en	kra[p + t]	kra[b + d]e(n)	ge + kra[b + d]e	'scratch'
ku/s/ + en	ku[s + t]	ku[s + t]e(n)	ge + ku[s + t]e	'kiss'
ra/z/ + en	raa[s + t]	raa[z + d]e(n)	ge + raa[z + d]e	'rage'
bo/f/ + en	bo[f + t]	bo[f + t]e(n)	ge + bo[f + t]e	'be lucky'
be/v/ + en	bee[f + t]	bee[v + d]e(n)	ge + bee[v + d]e	'tremble'
po/x/ + en	po[x + t]	po[x + t]e(n)	ge + po[x + t]e	'boast'
pla/ɣ/ + en	plaa[x + t]	plaa[ɣ + d]e(n)	ge + plaa[ɣ + d]e	'tease'
ha/l/ + en	haal + [t]	haal + [d]e(n)	ge + haal + [d]e	'get'
kno/r/ + en	knor + [t]	knor + [d]e(n)	ge + knor + [d]e	'grunt'
ka/m/ + en	kam + [t]	kam + [d]e(n)	ge + kam + [d]e	'comb'
kano + ën	kanoo + [t]	kano + [d]e(n)	ge + kano + [d]e	'canoe'

The most straightforward analysis posits a rule of progressive [−voice] assimilation which specifically targets the past tense suffix, lexically represented as /də/. From this perspective, the Dutch past tense provides prima facie evidence for lexical [−voice] spreading.[29]

Cases of progressive assimilation cannot follow naturally from the analysis in Lombardi 1995b, where a language-specific rule of progressive devoicing (delinking) is proposed that only applies to fricatives.[30]

[29] The past tense suffix also surfaces as [də] in the speech of those speakers who neutralize the voice opposition in fricatives word-initially and intervocalically: compare standard *vre*[z]*en*, *vree*[zd]*e* with nonstandard *vre*[s]*en*, *vree*[zd]*e* 'to fear INF/IMPF'. These speakers usually maintain the voice opposition after sonorants: *behel*[z]*en* 'to concern', *wal*[s]*en* 'to waltz', *aar*[z]*elen* 'to hesitate', *per*[s]*en* 'to press', *verslon*[z]*en* 'to neglect', *dan*[s]*en* 'to dance', *gol*[f]*en* 'to play golf', *gol*[v]*en* 'to undulate' *dur*[v]*en* 'to dare', *smur*[f]*en* 'to smurf', *verdel*[ɣ]*en* 'exterminate', *al*[x]*emist* 'alchemist', *ter*[ɣ]*en* 'to provoke', *or*[x]*idee* 'orchid'. Since the imperfect of *krassen* 'to scrape', *dansen*, *walsen*, etc. is *kra*[st]*e* (</kras/ + /də/), *dan*[st]*e* (</dans/ + /də/), wal[st]e (</wals/ + də/), etc., it is most likely that also in the neutralizing dialects *voiced* fricatives are underlying in the verbs like *vre*[s]*en* that select [də] as the imperfect allomorph.

[30] The rule must apply before spreading of [voice], and the ordering must be stipulated. It cannot be derived from the elsewhere condition, as claimed in Lombardi 1995b: 51, 56, because spreading, 'voice spreads to the left' satisfies part (i) of the elsewhere condition (the structural description of 23 properly includes [voice], the structural description of spreading, but fails to satisfy (ii), because the result of applying the effects of delinking of laryngeal and the result of rightward spreading are NOT distinct, i.e. contradictory (Kiparsky 1982:136–37, 160). We assume that the inclusion of [−son] to the left of the arrow is an error (it would mean deletion of [−son]), and that the rule should be understood as having /[−son]— to the right.

(23) Progressive neutralization

$$[-\text{son}]\ [-\text{son},\ +\text{cont}] \rightarrow [-\text{son},\ +\text{cont}]$$

$$\begin{array}{ccc} | & & \\ \text{Lar} & & \text{Lar} \\ | & & | \\ \text{[voice]} & & \text{[voice]} \end{array}$$

Rule 23 is marred with the same ad hoc status as the cluster devoicing parameter proposed by Cho, and, in Lombardi's derivational theory, the rule of regressive cluster devoicing needed to account for Yiddish, Rumanian, and Serbo-Croatian. The rule predicts languages that have obstruent clusters of which the leftmost member contrasts for voice, but of which the remaining obstruent(s) are voiceless. Since such languages are unattested, it must be stipulated that delinking must always be followed by spreading. Moreover, the analysis appears to be weakened by the role of the OCP, on which it relies to account for the assimilation in the Dutch past tense. The (legitimate) question is whether in words like *kaa*[z + b]*oot* from *kaa*/z + b/*oot* 'cheese boat' the obstruent /z/ needs to be devoiced by delinking and subsequently revoiced by spreading. Lombardi suggests that this is unnecessary because of the OCP, which creates a doubly linked structure (as a result of Fusion) in which delinking is blocked by the Linking Constraint. With this in mind, consider the derivations in Table 12, which follow Lombardi's analysis.

	kaa/z + b/oot	ka/s + b/oek	o/p + v/allen	kaa/z + v/orm	kra/b + ð/e
FUSION	⋁			⋁	⋁
	voice			voice	voice
DELINKING	inappl.			inappl.	inappl.
FRIC. NEUTRAL.			[pf]	inappl.	inappl.
SPREADING		[zb]			
	[zb]	[zb]	[pf]	*[zv]	[bð] (>[bd])
GLOSS	'cheese boat'	'cash book'	'strike'	'cheese mold'	'scratched'

TABLE 12. Assimilation in Dutch.

Lombardi's description of the progressive assimilation in the Dutch past tense closely follows Trommelen & Zonneveld 1979 by assuming that the past-tense suffix is fricative-initial underlyingly, although it surfaces with a stop. The surface form *maa*[kt]*e* 'made sing' is derived from underlying *maa*/kə + ð/*e* by successive application of THEME-VOWEL DELETION (*maa*/k + ð/*e*), PROGRESSIVE NEUTRALIZATION (*maa*/k + θ/*e*), and STOPPING (*maa*/k + t/*e*).[31] To account for the surface form *kra*[bd]*e* 'scratched' from underlying *kra*/bə + ð/*e*, after theme-vowel deletion derives *kra*/b + ð/*e*, the initial structure in Table 12, delinking (voice constraint 3a) and progressive neutralization 23 must be blocked from applying, otherwise *kra*[pt]*e* would be derived. This is where FUSION becomes crucial. Assuming that two successive privative [voice] autosegments fuse into one, neither progressive neutralization nor delinking can apply on account of the linking constraint. However, whereas Fusion is crucial to derive *kra*[bd]*e*, it also blocks delinking and progressive neutralization in words like *kaa*/z + v/*orm*

[31] Notice that, under this analysis, the segment /ð/ exists only in the morphemes of the past and past participle.

'cheese mold', the fourth example in Table 12, which erroneously predicts surface [zv] instead of the correct [sf] for this form. In Lombardi 1991:55, the voiceless cluster as in *kaa*[sf]*orm* 'cheese mold' is explained as the consequence of this word being a compound: '/z/ has already devoiced before the level of compounding'. Therefore, 'there is no point in the derivation . . . where the two voiced consonants come together, and so no Fusion'. Notice, however, that *kaa*[zb]*oot* is also a compound, hence, the OCP for [voice] is irrelevant for the derivation of *kaa*[zb]*oot*. But if fusion is not part of the phonological grammar of Dutch, a different account is necessary for past tense forms. It is therefore important to know what happens with derived words that are not compounds. The prediction is clear: in a case like /XdzY/, where d is a voiced consonant, z a voiced fricative, and /Xd/ and /zY/ are not both words, the form will surface as [XdzY]. But the prediction is incorrect: compare the suffixed word *hei*[l + z]*aam* 'beneficial', which demonstrates the voiced character of the suffix initial fricative, and *raa*[t + s]*aam* 'advisable' from *raa*/d + z/*aam*, with progressive devoicing. Similarly, the fact that morpheme-internal, obstruent-stop clusters can contrast in voicing, but only voiceless obstruent-fricative clusters exist (Trommelen & Zonneveld 1979), comes as a surprise if progressive devoicing applies only at the juncture of compounds *hoo*[vd]*en* 'head, chief- PL', *scho*[ft]*en* 'bastard- PL', etc., but only *a*[tf]*ocaat* 'lawyer', *A*[tf]*ent*, 'Advent', and so on. The latinate prefix /ad-/, even if very restricted, shows the same pattern: *a*[d]*optatie* (cf. *co* + *optatie* 'co-optation'), but *a*[tf]*erteren* 'advertise' (cf. *con* + *verteren* 'to convert'). It seems that fusion is not a rule of Dutch.

The Dutch past suffix presents the only exception to the generalization that in stop-final clusters the rightmost obstruent determines the voice value of a cluster. The vowel-final verb stems show that the past tense suffix starts with a voiced consonant underlyingly: *kano* + *de* 'canoed-SG'. The most straightforward way to account for the voiceless variants like *schraa*[pt]*e* in a derivational analysis is to assume that there is a process of progressive [−voice] spreading. This process, which is restricted to the morphological category 'past', or maybe just to inflection, is necessarily a lexical rule. Postlexically, syllable-final devoicing and regressive assimilation will apply regularly to *kra*/b + d/*e*, in order to yield *kra*[bd]*e*, perhaps via intermediate *kra*/pd/*e*.[32] If we assume that [−voice] exists lexically, we do not need to assume fusion, nor cluster delinking. Similarly, the relation between fricative devoicing and syllable-final devoicing would immediately appear: one does not expect the unrestricted devoicing of a cluster-final fricative in a language without syllable-final devoicing. In a derivational analysis, a rule of [−voice] spreading, fed by syllable-final devoicing, naturally establishes this relation. Of course, a theory with [−voice] predicts that progressive [−voice] spreading may occur in languages that do not have syllable-final devoicing. Exactly this happens in the variant of Yiddish described in Birnbaum 1979, where 'unvoicing through progressive assimilation is general with [z]', as in [nemtsi] from /nemt zi/ 'she is taking', or [voshertsiχ] from /vos hert ziχ/ 'what's new'. The claim that [voice] is a privative feature lexically, but a binary feature postlexically amounts to saying that [−voice] assimilation, as in Yiddish, could in no language be conditioned by a morphological category. Yet, the Dutch rule of progressive assimilation in past tensed verbs seems nothing more or less than a morphologized version of a rule of

[32] As shown in Wetzels 1985, devoicing and assimilation may apply in random order to yield the correct output forms. This is because assimilation itself creates the shared laryngeal node in clusters, to which access to devoicing is blocked by the linking constraint.

progressive [− voice] assimilation. An indigenous language of Brazil provides evidence for the presence of [− voice] at the level of lexical representation.

5.2. BAKAIRI. Bakairi, a language of the southern Carib family (Rodrigues 1986: 58–64) is spoken by approximately three-hundred fifty people in the state of Mato Grosso, southwest of the Upper Xingu river. The system of underlying consonants is given in table 13.[33]

p	t		k
b	d		g
	s	ʃ	x
	z	ʒ	ɣ
m	n		
	l		
	r		

TABLE 13. Bakairi system of underlying consonants.

The syllable structure of Bakairi is of the (C)V type, which means that consonants do not cluster and are allowed only in syllable-onset position. Bakairi has monosyllabic and polysyllabic roots. In polysyllabic roots, voiced and voiceless oral obstruents alternate in a way shown by the following monomorphemic words (for reasons that will be made clear below, we exclude for now from the discussion the root-initial consonants, such as /t/ in /tɔzekadɔ/ 'bench', etc.).

(24)

+ − +	+ − +	− +	+ −
/tɔzekadɔ/	/ədəpigɨ/	/pekɔdɔ/	/paʒika/
'bench'	'heat'	'woman'	'ant eater'

The usual distribution of voiced and voiceless consonants consists of an alternating sequence of [+ voice], [− voice], or [− voice], [+ voice], as in 24, although a small number of words exists that contain only voiced obstruents (*azage* 'two'). Moreover, those studying Bakairi have found no polysyllabic roots that show more than a single occurrence of the feature [− voice]. In Table 14 the impossible patterns are summarized in a and the corresponding minimally different grammatical sequences that are attested in b.

a. UNATTESTED	b. GRAMMATICAL
i. − + −	− + +
ii. + + −	+ + +
iii. + − −	+ − +
iv. − −	+ + or + −

TABLE 14. Distribution of [± voice] features in Bakairi.

The general pattern of voicing is the following: word-initially, only voiceless obstruents can appear; in other positions, i.e. intervocalically, only voiced obstruents occur, except for one single position, where obstruents may appear as voiceless. This position can be the first or the second intervocalic position in root initial words, as in 24 above, or the first or second position counting from the left edge of the root if there are prefixes, as in 25 (roots are italicized).

[33] All data are taken from de Souza 1991, 1995.

(25)	s-*eka*-dai	OBJ-ask-PAST	'asked'
	n-*eɣase*-agɪ	3-go-PAST	'went'
	n-*epi*-ge-agɨ	OBJ-pull-VERBLR-PAST	'he pushed'
	n-*ɨge*-aki	3-die-PAST	'died'
	n-*ɨke*-agi	3-sleep-PAST	'slept'
	ige-ke	sg-GER	'singing'
	n-ad-*aɷge*-aki	3-INTRANS-tear-PAST	'tore'

In a derivational analysis, the attested patterns can be made to follow from a difference in lexical specification of the first intervocalic consonant of the root: this consonant is supplied with a [+voice] specification (/tɔzekadɔ/), with a [−voice] specification (/pekɔdɔ/) or without any voice specification (/azage/). For all unspecified obstruents, the surface value for [±voice] is predictable by three rules. The first rule provides [+voice] intervocalically. The second rule fills in [−voice] word-initially. That these rules are necessary is shown by alternations like [tɔkɔ] 'bow' ~ [tɔ-dɔka-ge] 'have a bow'.[34] Third, as the examples in 25 show, a lexical [+voice] value determines the choice of the [−voice] value of the immediately following obstruent, including obstruents that are part of suffixes. The alternating voice pattern can be derived by an OCP-driven rule of voice dissimilation that inserts the opposite value after a lexically specified [voice] feature. Only on the assumption that both [+voice] and [−voice] are lexical values in Bakairi can we explain the alternations that occur in the suffix consonants in a straightforward and nonarbitrary fashion. We need at least one [+voice] specification as a conditioning environment for the rule that predicts the following [−voice] consonant. We need a lexical [−voice] specification when it occurs on the first intervocalic obstruent (the only position of contrast), to prevent it from surfacing as [+voice]. Independent evidence for the lexical presence of the [−voice] feature comes from words derived from disyllabic roots of the type (C)VSV, where S represents a sonorant consonant. Some examples are given in 26.

(26)	*paru*-da	cleared land-in	'in the cleared land'
	ila-dɨbe	wet-PART	'wet'
	n-*ema*-ke-agi	OBJ-hand-VERBLR-PAST	'won'
	m-*ema*-ke-agi	2-hand-VERBLR-PAST	'you won'
	s-*ema*-ke-Ø	OBJ-hand-VERBLR-PAST	'I won'
	n-*ema*-ge-aki	OBJ-hand-VERBLR-PAST	'stole'
	u-*di*-aki	l-go-PAST	'I went'

The (redundant) [+voice] feature of a sonorant consonant never triggers voice dissimilation. Consequently, the first two words of 26, which are derived from a root that does not contain intervocalic nonsonorant consonants, surface as expected. In contrast, the voiceless consonant of the verbalizing suffix *-ke* in the different forms of 'to win' may come as a surprise. It is not the case that the consonant in this suffix is lexically voiceless, as can be observed in a word like *t-ipini-ge-ba* 'he has no food'.[35] Moreover, in the last word of 26, the consonant of the past morpheme is voiceless, although the

[34] For a detailed account, see Wetzels 1997, where an analysis of voicing in Bakairi is proposed based on lexical floating features, which also crucially refers to the positive and negative values of [voice]. Another case of a language that has a three-way distinction between plosives that alternate for [voice], nonalternating voiceless plosives, and nonalternating voiced plosives is Turkish, discussed by Inkelas and Orgun (1995: 777), who also consider the three-way contrast as strong evidence for the binarity of the [voice] feature.

[35] According to de Souza (1991:330), the only suffix that always surfaces with a voiceless consonant is the causative suffix.

stem *di* does not even contain an intervocalic consonant (the reader may recall that the only consonant that can surface with a lexically specified [± voice] value is the leftmost C that is preceded by a root vowel). To account for the devoicing effect on the following suffix we must suppose that the roots *ema* 'win' and *di* 'go' are lexicalized with a floating [− voice] feature, which docks on the suffix consonant, the first segment capable of carrying a contrastive voice specification. Interestingly, the penultimate word in 26 shows that a (floating) [+ voice] feature must be lexically present in the root *ema* 'to steal', in order to explain the presence of the voiceless consonant in the suffix */-aKi/*, again on the assumption that voice dissimilation can only be triggered by a lexically contrastive [+ voice] feature. We conclude that Bakairi represents a language in which both [+ voice] and [− voice] function as lexical features.

6. PRIVATIVITY IN OPTIMALITY THEORY. Since all of the arguments presented in favor of privative voice come from derivational analyses, we have presented our counterarguments within the same theoretical paradigm. In the foregoing discussion we showed that the feature [− voice] may be present at any level in the phonological grammar of a language that contrasts voiced with voiceless consonants. To be sure, our main concern has been not only to show that the privativity hypothesis is highly problematical if integrated in a derivational framework but also that there is little in the BEHAVIOR of [− voice] in assimilation to suggest that it is fundamentally different from [+ voice]. Whereas Ukrainian represents a case of [+ voice]-only spreading, Ya:thê shows spreading of [− voice] only. Furthermore, where Japanese has a ban on more than one [+ voice] feature per word (Lyman's law), Bakairi imposes the same restriction on the occurrence of [− voice] (for Japanese see Itô & Mester 1986, 1998; Fukazawa & Kitahara 2001). We suspect that the ban on [− voice] will yield undesirable consequences for optimality theory precisely because the behavior of the features [+ voice] and [− voice] in phonological processes is to a large extent identical. It is however much harder to argue against privativity in optimality theory than it is in derivational phonology. This is due to the fact that with the IDENT and AGREE constraint families it is as easy to refer to the absence of a privative feature as it is to refer to the unmarked value of a binary feature. To see this, we turn back briefly to the facts of Ya:thê, Ukrainian, and Bakairi.

The reader will recall that in Ya:thê the distribution of [+ voice] and [− voice] in clusters is as in Table 15.

*	+	−
	−	−
	−	+
	+	+

TABLE 15. Possible [± voice] sequences in Ya:thê.

We could account for the facts in Table 15 by ranking the positional faithfulness constraint IDENTONSVO in the OT grammar of Ya:thê above a version of the AGREE constraint that selects the feature [− voice]. Similarly, one can account for regressive [+ voice] spreading in a language like Ukrainian with the same ranking but an AGREE constraint that selects the feature [+ voice]. Now, if [− voice] is not available as a feature, a CONDITIONAL AGREE constraint could be used to insure that the right candidate is selected as the optimal one in Ya:thê. The constraint could be as in 27.

(27) Given a consonant cluster C_1C_2, if C_1 is voiced, then C_2 must be.

The constraint above would give rise to the Ya:thê pattern without referring explicitly

to [− voice]. A similar conditional AGREE constraint is also necessary to account for the Ukrainian pattern, summarized in Table 16.

	+	−
	−	−
*	−	+
	+	+

TABLE 16. Possible [± voice] sequences in Ukrainian.

Since in a privative theory there is no formal difference between [voice] and [+ voice], the normal application of the AGREE constraint (see 4 above) would treat [− voice] [+ voice] and [+ voice] [− voice] sequences as equally undesirable. In order to avoid [− voice] [+ voice] but to allow [+ voice] [− voice] we need a constraint like the one in 28.

(28) Given a consonant cluster C_1C_2, if C_2 is voiced, then C_1 must be.

It seems then that the price one must pay for privative voice is to enlarge the class of constraints that account for homogeneously voiced clusters with a type of conditional AGREE constraint that would otherwise be unnecessary. In other words, a derivational theory with privativity (which is more restrictive than a theory with two- or three-valued voice) is equivalent to an OT theory with privative voice that does not allow conditional statements in the formulation of AGREE ([VOICE]). It seems then, that what constraints 27 and 28 really do is allow the privative [voice] feature to act as a de facto two-valued feature. But maintaining [− voice] in the universal set of phonological features enables one to keep to the standard interpretation of AGREE that can now select [+ voice], [− voice] or both (for example by way of a laryngeal node, or maybe a voice node).[36]

Let us next turn to Bakairi. It is clear that an attempt to mimic the derivational analysis based on floating features in an OT framework would presuppose an underlying ternary distinction between [+ voice], [− voice], and [Øvoice], which is inherently incompatible with the privativity hypothesis. And since part of the derivational analysis depends on the possibility of having access to lexical voice specifications (as opposed to surface voice specifications), we would have to engage in a discussion of derivational levels in OT, which would take us too far away from the objectives of our study. We will therefore concentrate on some crucial aspects of the Bakairi voicing patterns and show why these cannot be dealt with in a satisfactory way if privativity for voice is assumed. One concern is the desirability of using underspecification to account for the alternation in root-initial consonants, which surface as voiceless when word-initial, but as voiced when word-internal: /tɔkɔ/ 'bow' ~ /tɔ-dɔka-ge/ 'have a bow'. Another concern is that Bakairi words may contain only one instance of the feature [− voice], except when the root-initial consonant is also word-initial, in which case two voiceless obstruents may occur.

[36] The issue of the formal properties of constraints is a thorny one. Nevertheless, the question is nontrivial. Conditional markedness constraints like 'if [+ F], then [+ G]', unlike the more commonly used negative constraints like *[+ F, + G], are not satisfied by an underspecified segment [+ F, ØG]. As Nick Clements pointed out to us, the proposal to eliminate conditional constraints from the grammar implies that incomplete specification should always be an available option to avoid a feature cooccurrence constraint. On the opposite proposal, incomplete specification would not be an available option. To our knowledge, the question of how constraints are formulated and its empirical implications has never been systematically addressed. Obviously, a proper assessment of whether conditional constraints should be part of OT can be made only after such an evaluation has been carried out.

Inkelas 1994 explicitly deals with the issue of underspecification in OT and shows that LEXICON OPTIMIZATION could force speakers to set up underlyingly underspecified structures when these structures yield surface alternants all of which are predictable from context or grammatical defaults. Limiting the discussion to underived roots, if we were to apply Inkelas's conclusions to the facts of Bakairi, the obstruent that should remain underlyingly unspecified is the root-initial consonant, if present, because its surface alternants are fully predictable from their surface context. We will assume that all other features are lexically attached to the segments on which they surface.[37]

(29) a. (V+)CVCVCVCV
+ + +

b. (V+)CVCVCVCV
(−) + +

c. (V+)CVCVCVCV
+ (−) +

In the representations above, the negative voice specifications are put in parentheses. Obviously, these will be present in the lexical representation only when binary voice is assumed. The lexical structures in 29 should yield words that contain voiced segments only (in 29a), words in which the (only) voiceless segment is the first intervocalic segment of the root (in 29b), and words in which the (only) voiceless segment is the second intervocalic segment of the root (in 29c). Under a privative analysis, the correct surface structures for the given underlying structures would be selected by the set of (partially) ordered constraints in 30.

(30) a. word-initial obstruents may not be specified for [voice]
b. root-initial obstruents must be specified for [voice]
c. at most one intervocalic obstruent may not be specified for [voice] in a word
d. obstruents should be faithful to an underlying [voice] specification
e. intervocalic obstruents must be specified for [voice])

Constraints 30a and 30b account for the alternation between voiceless and voiced consonants in pairs like /*t*ɔkɔ/ 'bow' ~ /tɔ-*d*ɔka-ge/ 'have a bow' (the alternating segments are italicized). Recall that, if prefixes are attached to the root, the root-initial consonant surfaces as voiced. Constraint 30c is necessary to insure that a Bakairi word contains at most one word-internal voiceless obstruent. It must dominate the faithfulness constraint 30d, for example, to insure the proper bakairization of loan words, which may contain more than one word-internal voiceless obstruent in the language of origin. It is generally agreed that faithfulness constraints can be relativized for a specific domain within which they hold, in this case the root, more formally IDENTROOTVO (see Benua 1997, Urbanczyk 1996).[38]

In the OT grammar given above, the form and function of constraint 30b are disturbing. As a markedness constraint, it is not obvious what its phonetic motivation could be. Root-initial nonsonorant consonants that are not also word-initial are always intervo-

[37] Obviously, an analysis that does not rely on floating features must use a diacritic solution for a set of stems that cause alternations on suffixes (see the words in 26). As suggested in the text, we have not found an OT analysis for the Bakairi pattern that only involves constraints one could plausibly assume to be part of UG in the version of the theory that does not allow for an intermediate level at which not all segments are fully specified for the [±voice] feature. Nevertheless, we believe that the alternative discussed below is not a straw man, because the question of whether the root-initial consonant is underspecified remains relevant in any type of analysis, as well as the consequences this would have for a privative vs. a binary voice feature.

[38] We are assuming that in the privative analysis the IDENT constraint compares corresponding segments for presence/absence of a voice feature; for brief discussion see McCarthy & Prince 1995:319.

calic in Bakairi. Hence, constraint 30b duplicates the work of the constraint given in 30e, which is independently necessary to account for default [+ voice] in intervocalic prefix and suffix consonants. As a matter of fact, constraint 30b could be dispensed with, if root-initial consonants were underlyingly specified as voiced. This alternative shows the true nature of our problem: full lexical specification of the alternating root-initial consonant is necessary only under the hypothesis of privative voice. With binary voice, underspecification can be maintained and constraint 30b can still be dispensed with. The set of (partially) ordered constraints in 31, based on a binary feature [± voice], would select the appropriate surface structures for the input forms presented in 29.

(31) a. word-initial obstruents must be [− voice]
b. at most one intervocalic obstruent may be [− voice] in a word
c. obstruents should be faithful to an underlying voice specification
d. intervocalic obstruents may not be [− voice]

We assume that in a binary voice theory only contradictory specifications on corresponding input/output segments (*< [αvoice] → [− αvoice] >) will be marked as violations of the IDENTVOICE constraint 31c. Any surface value for the root-initial consonant will thus not violate 31c. The candidates containing [− voice] or [Øvoice] will be starred by constraint 31d. We conclude that, to account for the voicing pattern of Bakairi, the privativity hypothesis necessitates the formulation of a constraint that is not a probable candidate for UG membership.

The constraint necessary for formulating the restriction on the presence of [− voice] in Bakairi words (cf. 31b) is reminiscent of the OCP. Itô & Mester 1996 and Alderete 1997 proposed that OCP effects be formulated in OT as self-conjoined markedness constraints. The obvious candidate for self-conjunction in the constraint set in 31 is 31d, redefined below as 32d, where we have also reformulated the OCP constraint 31b as a case of local self-conjunction.

(32) a. word-initial obstruents must be [− voice]
b. *V[− voice]V^{2}word
c. obstruents should be faithful to an underlying voice specification
d. *V[− voice]V

In Bakairi, the presence of one word-internal (intervocalic) voiceless obstruent excludes the occurrence of another. This is captured by constraint 32b, which states that no word may contain two violations of the intervocalic voicing markedness constraint. Since Bakairi permits intervocalic voiceless consonants, the faithfulness constraint 32c must outrank the simple markedness constraint 32d. However, the fact that the intervocalic contrast is restricted to a single obstruent per word is guaranteed by the ranking of the conjoined markedness constraint above the faithfulness constraint.

If Itô and Mester and Alderete are correct in their insight that OCP restrictions in OT should be stated as self-conjoined markedness constraints, then without the feature [− voice] the parallel between Japanese and Bakairi cannot be captured.

As we have shown, the implementation of the privativity hypothesis in OT has undesirable consequences. First, we must enlarge the class of AGREE constraints with conditional constraints of the type 27–28. Further, privativity is incompatible with voicing patterns that necessitate a three-way contrast among [+ voice], [− voice], and [Øvoice] (for more discussion see Inkelas 1994). Finally, Similar OCP effects cannot be treated in a formally similar way. The important question then is whether one should give up binarity at such a price, especially since [+ voice] and [− voice] are both equally

active in the phonology as triggers of assimilation and in co-occurrence restrictions. We believe that there simply is no good reason to do so.

Considered from the perspective of phonetically neutral positions, it looks as if the realization of voiceless implies a departure from this position. It constitutes a phonetic target on its own and should not, therefore, be treated like [− aspirated] or [− glottalized], which do not seem to represent phonetic targets. From the point of view of markedness, in languages with a voice contrast, [− voice] seems to relate to the other laryngeal features much in the same way that the feature [coronal] relates to the other place features. These properties can be reflected in the formal characterization of constraint families in the usual way (for the encoding of markedness in optimality theory see Prince & Smolensky 1993, Kiparsky 1994, discussed in Inkelas 1994).

7. Conclusion. It is the normal case for languages to have homogeneous voice clusters, which are created by spreading both values of the [± voice] feature over the entire cluster, usually in a regressive pattern. Sometimes only a single value of [± voice] is spread. We showed that this happens in French, Ya:thê, and, perhaps, Yorkshire English. These languages testify to the fact that the feature [− voice] can be active in the phonology, while [+ voice] remains inert, or behaves in a different manner. While in these languages the independent activity of [− voice] occurred in the postlexical phonology, we have argued that the variation in the Dutch past morpheme is most plausibly expressed as a case of lexical [− voice] spreading, and that the voice pattern of Bakairi necessitates a lexically contrastive [− voice] feature. We have concluded that [voice] is a binary feature, against the by now widely accepted idea that only voicedness may function at the level of lexical representation and in lexical alternations. The hypothesis of binary [voice] predicts that languages can exist that use co-occurrence restrictions exclusively referring to [− voice], in a way that is exemplified by Lyman's law in Japanese for [+ voice]. Again, Bakairi turned out to be a language of this type. Given our conclusion that [+ voice] and [− voice] do not behave very differently from an empirical point of view, the privativity hypothesis leads to problems of explanatory adequacy in derivational theories as well as in constraint-based theories, such as optimality theory.

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