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Two notes on laryngeal licensing: Hungarian and Arabic*

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In traditional grammar, Final Devoicing and Voicing Assimilation in obstruent clusters are treated as separate phonological processes (albeit with a possible implicational relation). With the development of Autosegmental and Prosodic representation, licensing constraints on where phonological features may appear in phonological structure have come to play a crucial role in phonological analysis. In research over the past decade Lombardi (1991, 1995, 1999) has proposed a simple and elegant typology for laryngeal features such as [voice] in which licensing constraints figure prominently. Subtle differences among six different language types are shown to follow from reranking of a simple and plausible set of constraints. In this paper after reviewing the Lombardi typology we discuss data from Hungarian and various Arabic dialects that do not fit into the typology. We propose recasting Lombardi's Laryngeal Licensing Constraint in terms of the contexts in which the phonetic cues for [voice] are more or less salient. The analysis accommodates the problematic Hungarian and Arabic data as well as the data from German, Polish, Swedish, and Yiddish that motivated the original analysis. The paper closes with speculative analysis of remaining problematic data from Ukrainian.

1. Introduction

In traditional grammar final devoicing and voicing assimilation in obstruent clusters are viewed as separate phonological processes. With the development of autosegmental and prosodic phonology, licensing constraints on where features may appear in the representation (as opposed to where they may not appear and so must be changed or deleted) have come to play a major role (e.g., Itô 1986; Kaye 1990). As a result, there is no one-to-one correspondence between traditional phonological processes and phonological constraints. In research over the past decade Lombardi (1991, 1995, 1999) has proposed a simple and elegant typology for laryngeal features — in particular [voice] — in which licensing constraints figure prominently. In this paper we attempt to extend Lombardi's typology in order to capture two languages which do not fit comfortably. The

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key proposal involves expressing laryngeal licensing not in terms of syllable structure but rather in terms of the contexts in which the phonetic correlates for [voice] are more easily perceived. See Steriade (1999a, 1999b) for discussion of this general approach, known as "licensing by cue".

The rest of this note is organised as follows. In the first section we review Lombardi's typology and the optimality theoretic constraint rankings that it reflects. We then discuss data from Hungarian that fall outside the system. We suggest a modification in the Laryngeal Licensing Constraint based on the function that release of a consonantal stricture serves in Hungarian phonology and phonetics. We then look at two Arabic dialects that have regressive voicing assimilation in obstruent clusters. Arabic is particularly relevant because the syllable structure can be determined independently by principles of prosodic structure. We see that the voicing data are problematic for the original onset-driven version of Laryngeal Licensing but fall under the scope of the proposed revision. The final section offers a speculative analysis of problematic data from Ukrainian. The paper closes with a brief summary.

2. Lombardi's typology of voicing assimilation and neutralisation

Lombardi (1999) recasts her (1991, 1995) typology of voicing assimilation and neutralisation in terms of Optimality Theory (Prince and Smolensky 1993; McCarthy and Prince 1995). We recall the essential tenets of her earlier theory. First, at least in the lexical phonology, the voicing opposition is privative: only voiced obstruents are marked by the feature [voice]. Second, an obstruent that precedes a tautosyllabic sonorant (effectively, an onset) is a favoured licensing site for [voice] (and other laryngeal features). Lombardi's typology comprises the five major language types seen in (1).

(1) Lombardi's voicing typology

Finnish:	no voiced obstruents.
Standard Arabic:	contrast of voiced and voiceless obstruents initially, medially, finally and in clusters: *zakab*, *ya-zkub* 'fill, perfect, imperfect', *sabaṭ*, *ya-sbaṭ* 'swim, perfect, imperfect'.
Standard German:	devoicing word finally and in certain clusters: *lö*/z/: *lö*[z]*en* 'to loosen', *lo*[s] 'loose', *lö*[s]*bar* 'solvable', *lö*[s]*lich* 'soluble', *lö*[s]*t* 'loosens'
Dutch:	devoicing word-finally but regressive assimilation in obstruent clusters: *hui*/z/: *hui*[s] 'house', *hui*[z]*en* 'houses', *hui*[s]*kamer* 'living room', *hui*[z]*baas* 'landlord'; /zɪt/: *zitten* 'sit', *zi*[d]*bad* 'hip bath'
Yiddish:	regressive assimilation in obstruent clusters but no final devoicing: *re*[d] 'I speak', *re*[t]-*st* 'you speak'; *ba*[k] 'cheek', *ba*[g]-*beyn* 'cheekbone'

Lombardi (1999) translates her (1991, 1995) Onset Licensing constraint into an optimality-theoretic positional faithfulness constraint that demands identity for voicing

between a tautosyllabic presonorant obstruent in the output and its input correspondent. Changes in either direction (from voiced to voiceless or voiceless to voiced) are counted as violations of this constraint. Violations are assessed to individual segments (even if they are associated to the same [voice] autosegment). She shows how the typology of (1) emerges from reranking the positional faithfulness constraint with a general faithfulness constraint on [voice] and two structural constraints: a markedness constraint penalising [voice] in obstruents and a uniformity constraint requiring obstruent clusters to agree in voicing. We state these constraints in (2).

(2) Universal Grammar constraints

Positional Faithfulness:	ID-[VOICE]$_{onset}$: there is identity in voicing between input and output correspondents of obstruents that immediately precede a tautosyllabic sonorant.
Context-free Faithfulness:	ID-[VOICE]: there is identity in voicing for corresponding input and output obstruents.
Markedness:	*[VOICE]: penalize voiced obstruents.
Uniformity:	obstruent clusters agree in voicing.

The basic intuition underlying this approach is that the cross-linguistic prevalence of regressive (as opposed to progressive) voice assimilation is a consequence of positional licensing of [voice] in the syllable onset. It is part of a family of faithfulness constraints for each feature that reflect differences in the relative salience of phonetic distinctions in different positions (see Steriade 1999a, 1999b for further development of this general point of view).

Let us see how the typology of (1) arises under constraint reranking. A language that lacks voiced obstruents in its output entirely (e.g., Finnish) ranks the markedness constraint *[VOICE] over both of the faithfulness constraints for [voice]. Thus, even if a voiced obstruent were posited for some input, it could never surface given the top ranking *[VOICE]. At the opposite extreme are languages in which voiced segments of the input surface in all contexts: initially, medially, and finally as well as in clusters. Various dialects of Arabic are possible exemplars of this type. Here the context-free faithfulness constraint ID-[VOICE] is ranked highest and the grammar thus rejects any candidates whose obstruents change their voicing specification between the input and the output.

German allows voiced obstruents in the syllable onset to surface phonetically while obstruents in the coda or in the appendix are obligatorily voiceless. This voicing pattern arises from top-ranking of the positional faithfulness constraint ID-[VOICE]$_{onset}$ dominating *[VOICE]. Such a ranking allows voiced obstruents to emerge in the syllable onset: *da* 'there' (3a). *[VOICE] in turn dominates context-free faithfulness ID-[VOICE] and UNIFORMITY. The former ranking ensures devoicing in positions outside the onset *lo*[s] 'loose' (3b) and the latter allows for clusters that disagree in voicing, such as the [sb] in *lö*[s]*bar* 'solvable' (3c).

(3) German devoicing, part 1

a. /d/*a*	ID-[VOICE]$_{onset}$	*[VOICE]	ID-[VOICE]	UNIFORMITY
☞ [d]		*		
[t]	*!		*	
b. *lo*/z/	**ID-[VOICE]$_{onset}$**	***[VOICE]**	**ID-[VOICE]**	**UNIFORMITY**
[z]		*!		
☞ [s]			*	
c. *lö*/z+b/*ar*	**ID-[VOICE]$_{onset}$**	***[VOICE]**	**ID-[VOICE]**	**UNIFORMITY**
[zb]		**!		
☞ [sb]		*	*	*
[sp]	*!		*	

In order to better appreciate how this grammar works, let us consider the derivations (input–output mappings) in (4) of three obstruent clusters: 1. the underlying /g+t/ of *sa*/g+t/*e* 'said', 2. the /t+g/ of *Ra*/t+g/*eber* 'advisor', and 3. the /d+g/ of *Run*/d+g/*ang* 'circuit'. All three must surface with the initial consonant voiceless. This will happen automatically in virtue of *[VOICE]. Given that the second consonant in the cluster occupies an onset, its voicing remains unchanged since ID-[VOICE]$_{onset}$ dominates *[VOICE] and thus nullifies any devoicing effect *[VOICE] might induce. Similarly, since *[VOICE] dominates the context-free faithfulness constraint ID-[VOICE], it calls for devoicing outside the onset. The result of these two rankings is that clusters of heterosyllabic obstruents such as in the [tg] of *Run*[tg]*ang* may disagree in voicing and thus violate the UNIFORMITY constraint. We can ensure that these voiceless–voiced clusters are maintained in the face of the UNIFORMITY violation by ranking UNIFORMITY below the point where the competing [dg] and [tk] candidates lose out to the [tg] of *Run*[tg]*ang*. Hence, both ID-[VOICE]$_{onset}$ and *[VOICE] dominate UNIFORMITY.

(4) German devoicing, part 2

a. *sa*/g+t/*e*	ID-[VOICE]$_{onset}$	*[VOICE]	ID-[VOICE]	UNIFORMITY
[gt]		*!		*
☞ [kt]			*	
[gd]	*!	**	*	
b. Ra/t+g/eber	**ID-[VOICE]$_{onset}$**	***[VOICE]**	**ID-[VOICE]**	**UNIFORMITY**
☞ [tg]		*		*
[dg]		**!	*	
[tk]	*!		*	
c. Run/d+g/ang	**ID-[VOICE]$_{onset}$**	***[VOICE]**	**ID-[VOICE]**	**UNIFORMITY**
[dg]		**!		
☞ [tg]		*	*	*
[tk]	*!		**	

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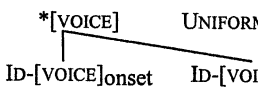
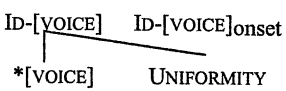
The table in (5) summarises the crucial constraint rankings in the form of inverted Hasse diagrams for the grammars considered so far. An unconnected constraint will be treated as undominated.

(5) Inverted Hasse diagrams for Finnish, Arabic, and German

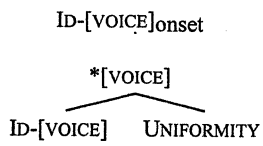
a. Finnish



b. Arabic



c. German



Polish, Dutch, and Yiddish obstruent clusters are minimally different from German in that the first obstruent assimilates the voicing of the second in order to satisfy UNIFORMITY. We illustrate with examples from Polish: *za*/b+k/*a* 'frog' dimin., *pro*/s'+b/*a* 'request', and *ni*/g+d/*y* 'never'. This ranking entails both the insertion of voicing on an underlying voiceless obstruent (6b) as well as the devoicing of an underlying voiced obstruent (6a). The result is thus a two-way departure from faithfulness. Hence, the UNIFORMITY constraint must dominate ID-[VOICE]. But Positional Faithfulness ID-[VOICE]$_{onset}$ remains top-ranked since an onset consonant does not change its voicing value. The upshot is regressive rather than progressive assimilation. As shown in (6c), an underlying cluster of voiced obstruents remains unchanged in the output in contrast to German *Run*[tg]*ang* (4c).

(6) Polish voicing and devoicing

a. *za*/b+k/*a*	ID-[VOICE]$_{onset}$	UNIFORMITY	*[VOICE]	ID-[VOICE]
[bk]		*!	*	
☞ [pk]				*
[bg]	*!		**	*
b. *pro*/s'+b/*a*	ID-[VOICE]$_{onset}$	UNIFORMITY	*[VOICE]	ID-[VOICE]
[s'b]		*!	*	
☞ [z'b]			**	*
[s'p]	*!			*
c. *ni*/g+d/*y*	ID-[VOICE]$_{onset}$	UNIFORMITY	*[VOICE]	ID-[VOICE]
☞ [gd]			**	
[kd]		*!	*	*
[kt]	*!			**

Finally, since these languages voice an underlying voiceless consonant in an obstruent cluster whose final term is voiced (6b), UNIFORMITY must dominate the *[VOICE] constraint that militates against voiced obstruents. It is this constraint ranking that differentiates Polish from German.

In her original (1991, 1995) typology, Lombardi stipulated the independence of final devoicing from regressive voicing assimilation by treating the final voiced obstruents of Yiddish and Serbo-Croatian as "extrametrical". Optimality Theory provides a more satisfying explanation by calling on its basic analytic tool: constraint ranking. Since the UNIFORMITY constraint drives assimilation in clusters, the treatment of word-final obstruents can be divorced from the assimilation in clusters. Languages like Yiddish and Serbo-Croatian that preserve underlying voicing on a final obstruent have faithfulness dominating *[VOICE] (7a) while final devoicing languages like German and Polish have the opposite ranking (7b).

(7) Final devoicing in Yiddish and Polish

a. *klu*/b/	ID-[VOICE]	*[VOICE]
☞ [b]		*
[p]	*!	
b. *klu*/b/	***[VOICE]**	**ID-[VOICE]**
[b]	*!	
☞ [p]		*

Constraint ranking explains another feature of Lombardi's original typology. There are languages such as Yiddish and Serbo-Croatian that neutralize voicing distinctions in obstruent clusters but maintain a voicing contrast word-finally. But there do not seem to be languages that neutralize voicing distinctions word-finally but maintain them in obstruent clusters. For Lombardi (1999) final devoicing implies the constraint ranking *[VOICE] >> ID-[VOICE]. This effectively devoices everywhere. By ranking the positional faithfulness constraint ID-$[\text{VOICE}]_{\text{onset}}$ above *[VOICE], a change in the onset consonant is blocked. Given that the constraint repertoire of Universal Grammar lacks any faithfulness constraint that singles out the coda, there is no way to specifically prevent the devoicing of a coda consonant. Consequently, other things being equal, final devoicing implies neutralization in obstruent clusters but not vice versa.

Lombardi also discusses Swedish where UNIFORMITY is satisfied in obstruent clusters by devoicing a voiced obstruent next to a voiceless one regardless of linear order: i.e., both progressive and regressive assimilation occurs.

(8) Bidirectional devoicing in Swedish obstruent clusters, part 1

hög	'high'	hög-tid	'festival'	[kt]
dag	'day'	tis-dag	'Tuesday'	[st]
syl-de	'covered'	läs-te	'read'	[st]
äg-a	'to own'	äg-de	'owned'	[gd]

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Rather than seeing this as the spread of [–voice] (inconsistent with the thesis of privative voicing), it is now treated as the context-free deletion of underlying [voice] specifications under the pressure of UNIFORMITY and *[VOICE]. Outside of obstruent clusters, voicing is faithfully retained. Lombardi (1999) derives this voicing pattern by demoting the positional faithfulness constraint ID-[VOICE]$_{onset}$ below context-free faithfulness ID-[VOICE] so that onset obstruents can be devoiced (9c). UNIFORMITY dominates ID-[VOICE] forcing clusters to agree in voicing and *[VOICE] enforces devoicing (9b,c). But ID-[VOICE] ranks above *[VOICE] to block devoicing outside a cluster (9a) as well as in clusters that satisfy UNIFORMITY at the outset (9d).

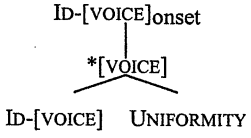
(9) Bidirectional devoicing in Swedish obstruent clusters, part 2

a. *hö*/g/	UNIFORMITY	ID-[VOICE]	*[VOICE]	ID-[VOICE]$_{onset}$
☞ [g]			*	
[k]		*!		
b. *hö*/g+t/*id*	UNIFORMITY	ID-[VOICE]	*[VOICE]	ID-[VOICE]$_{onset}$
[gt]	*!		*	
☞ [kt]		*		
[gd]		*	*!*	*
c. *lä*/s+d/*e*	UNIFORMITY	ID-[VOICE]	*[VOICE]	ID-[VOICE]$_{onset}$
[sd]	*!		*	
[zd]		*	*!*	
☞ [st]		*		*
d. *ä*/g+d/*e*	UNIFORMITY	ID-[VOICE]	*[VOICE]	ID-[VOICE]$_{onset}$
☞ [gd]			**	
[kd]	*!	*	*	
[kt]		*!*		*

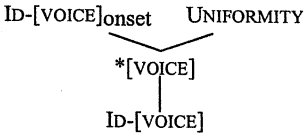
The Hasse diagrams in (10) show the constraint rankings that generate the German, Polish, Yiddish, and Swedish voicing patterns. Touring them in order, Polish differs from German by promoting UNIFORMITY above *[VOICE]. Yiddish differs from Polish by inverting the ranking between *[VOICE] and ID-[VOICE]. And Swedish differs from Yiddish by demoting faithfulness to onset voicing to the bottom of the hierarchy.

(10) Hasse diagrams for German, Polish, Yiddish, and Swedish

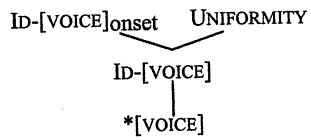
a. German



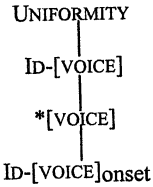
b. Polish



c. Yiddish



d. Swedish



Finally, Lombardi (1995, 1999) mentions Ukrainian (Bethin 1987) where UNIFORMITY in obstruent clusters is satisfied by (regressive) voicing but not by devoicing (11). Furthermore, this language has no final devoicing: *rot* 'mouth' *versus rod* 'kind'; *vas* 'you' accusative plural *versus vaz* 'vase' genitive plural.

(11) Voicing in Ukrainian, part 1

ri/dk/*o*	*ri*[dk]*o*	'seldom'		
ve/z+t/*y*	*ve*[zt]*y*	'to drive'		
pro/s'+b/*a*	*pro*[z'b]*a*	'request'	cf. pros-y-ty	'to request'
boro/t'+b/*a*	*boro*[d'b]*a*	'fight'		
ne/s+t/*y*	*ne*[st]*y*	'to carry'		
xo/d'+b/*a*	*xo*[d'b]*a*	'walking'		

Given the limited number of constraints at play, the analytic options are quite restricted — an obviously desirable state of affairs. Since there is no final devoicing, ID-[VOICE] must dominate *[VOICE]. This ranking also preserves a cluster of two voiced obstruents. But in mixed clusters we must introduce voicing in /s'+b/ → [z'b] yet block devoicing in /z+t/ → [zt]. It looks like the faithfulness constraint for voicing (i.e., ID-[VOICE]) must be in two places at the same time (an obvious contradiction). For /s'+b/ → [z'b] UNIFORMITY dominates ID-[VOICE] while for /z+t/ → [zt] ID-[VOICE] dominates UNIFORMITY.

A possible solution to this dilemma is to capitalise on the privative status of [voice]. The mapping we must allow (/s'+b/ → [z'b]) adds [voice] while the one we must block (/z+t/ → [st]) deletes [voice]. If McCarthy and Prince's (1995) correspondence constraints are extended from segments to features, then these two departures from faithfulness can be distinguished in terms of MAX (don't remove an element from the input) and DEP (don't insert an element into the output). The relevant constraint ranking for Ukrainian then is the same as Yiddish except that ID-[VOICE] is decomposed into MAX- and DEP-variants with UNIFORMITY ranked between them: MAX-[VOICE] >> UNIFORMITY >> DEP-[VOICE]. In other words, UNIFORMITY can be satisfied by insertion of [VOICE] (UNIFORMITY >> DEP-[VOICE]) but not by the deletion of [VOICE] (MAX-[VOICE] >> UNIFORMITY). In essence, this is also the analysis proposed by Gnanadesikan (1997).

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(12) Voicing in Ukrainian, part 2

a.	*/pro/s'+b/a*	MAX-[VOICE]	UNIFORMITY	DEP-[VOICE]
	[s'b]		*!	
☞	[z'b]			*
b.	*/ve/z+t/y*	**MAX-[VOICE]**	**UNIFORMITY**	**DEP-[VOICE]**
☞	[zt]		*	
	[st]	*!		

This completes our survey of Lombardi (1999). It is a simple and elegant theory with considerable descriptive coverage. It derives the cross-linguistic predominance of regressive (as opposed to progressive) voicing assimilation from the positional licensing of [voice] in the onset of the syllable. We now turn to some problems we have encountered in extending the theory.

3. Hungarian

As the paradigms in (13) demonstrate, Hungarian is a language which preserves the contrast between word-final voiced and voiceless obstruents. It also has regressive voicing assimilation in obstruent clusters with the outcome of assimilation determined by the final member of the cluster. This process is obligatory.[1]

(13) Regressive voicing assimilation in Hungarian, part 1

kap	'catches'	ka[b]-dos	'catches repeatedly'
dob	'throws'	do[p]-tam	'I threw'
jég	'ice (nominative)'	jé[k]-tó'l	'ice (ablative)'
csók	'kiss'	csó[g]-ból	'kiss (elative)'

Hungarian thus occupies the same slot in the Lombardi typology as Yiddish. The ranking of (10c) derives these alternations, as shown in (14).

(14) Regressive voicing assimilation in Hungarian, part 2

a. */do/b/*	ID-[VOICE]$_{onset}$	UNIFORMITY	ID-[VOICE]	*[VOICE]
☞ [b]				*
[p]			*!	
b. */do/b+t/am*	**ID-[VOICE]$_{onset}$**	**UNIFORMITY**	**ID-[VOICE]**	***[VOICE]**
[bt]		*!		*
☞ [pt]			*	
[bd]	*!		*	**

[1] Based on remarks in Vago (1980), Lombardi (1991, 1995) interpreted the process as optional. As pointed out in Lombardi (1999: 284), this disagrees with the judgement of most other Hungarian linguists, for whom the process is obligatory. See Szigetvári (1997: 223) and Siptár and Törkenczy (2000: 201).

(14) continued.

c. *ka*/p+d/*os*	ID-[VOICE]onset	UNIFORMITY	ID-[VOICE]	*[VOICE]
[pd]		*!		*
☞ [bd]			*	**
[pt]	*!		*	

Hungarian is of special interest because obstruents may cluster at the end of the word. Moreoever, the clusters can be formed by monoconsonantal suffixes which contrast in voicing. The definite imperative suffix /-d/ and the second singular present tense indefinite /-s/ (spelled *sz*) are two examples. These suffixes give rise to the partial paradigms illustrated in (15). They indicate that word-final clusters behave the same as the medial clusters in (13): the final consonant determines the voicing character of the entire cluster.

(15) Regressive voicing assimilation in Hungarian, part 3

1 sg. pres.	Imperative	2 sg. pres.	
kap-ok	ka[b]-d	kap-sz	'catch'
dob-ok	dob-d	do[p]-sz	'throw'
vág-ok	vág-d	vá[k]-sz	'cut'
rak-ok	ra[g]-d	rak-sz	'put'

In traditional grammar, where final devoicing and voicing assimilation are separate processes, these data can be derived straightforwardly: the grammar of Hungarian has the latter process but lacks the former. But in an optimality theoretic grammar, there is no one-to-one correspondence between phonological processes and constraints. As we have seen, in Lombardi's model the direction of assimilation (as progressive or regressive) is determined by the privileged status of onsets. When onset position is not at play then the outcome of assimilation is determined by the *[VOICE] markedness constraint. While this correctly predicts devoicing in *do*/b+s/ → do[ps], it also incorrectly predicts devoicing in the derivation of *ka*/p+d/.

(16) Regressive voicing assimilation in Hungarian, part 4
(to be revised)

a. *do*/b+s/	ID-[VOICE]onset	UNIFORMITY	ID-[VOICE]	*[VOICE]
[bs]		*!		*
☞ [ps]			*	
[bz]			*	**!
b. *ka*/p+d/	ID-[VOICE]onset	UNIFORMITY	ID-[VOICE]	*[VOICE]
[pd]		*!		*
☞ [pt]			*	
[bd]			*	**!

In these *tableaux* the candidates that satisfy UNIFORMITY tie for ID-[VOICE] with one violation each. The lower ranked *[VOICE] markedness constraint then converges on

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devoicing. While this is correct for clusters with a final voiceless consonant *do*[p]*sz* (16a), it yields the wrong result **ka*[p]*t* for the imperative *ka*[b]*d* (16b), which has a final voiced obstruent in the input (15). Furthermore, decomposing the ID-[VOICE] constraint into MAX-[VOICE] and DEP-[VOICE] will not help either: *do*/b+s/ → *do*[ps] is a MAX-[VOICE] violation while *ka*/p-d/ → *ka*[bd] is a DEP-[VOICE] violation. Both must rank below UNIFORMITY, so distinguishing between these two aspects of faithfulness for [voice] is of no avail.

In her interesting discussion of directional assimilation, Borowsky (2000) invokes a constraint that blocks change of a monoconsonantal affix in order to ensure regressive assimilation in English *fif-th* (cf. *five*). Whatever the merits of this move for English, it is of no help in the case of Hungarian because the suffixes /-d/ and /-s/ cease to determine the outcome of assimilation whenever they in turn are followed by an obstruent: *ka*/p+d+k/*i* → *ka*[ptk]*i* 'get out of'. Thus, it is the fact that /-d/ and /-s/ are the rightmost elements in the obstruent clusters of *ka*/p+d/ and *do*/b+s/ that determines the outcome of assimilation — not their monoconsonantal character. But they are clearly not in a syllable onset (under "standard" senses of this term) and so their special status in determining regressive assimilation remains to be accounted for.[2]

Our suggestion is that Lombardi's Onset Licensing constraint for [voice] (ID-[VOICE]$_{onset}$) is a subcase of a more general notion of phonological/phonetic "salience" that can have other manifestations besides privileging syllable onset position. In particular, Hungarian stops in prepausal position are saliently released. These releases carry information as to the voicing character of the consonant. As is well known, voice onset time is a primary cue to the contrast in obstruent voicing (Kingston and Diehl 1994). In languages with salient release a cue of this nature is present even in the absence of a following sonorant. In view of this point, we propose to recast the ID-[VOICE]$_{onset}$ constraint as Laryngeal Licensing in (17):

(17) The feature [voice] is licensed in contexts of salient release.

This formulation subsumes presonorant position (where the voicing contrast is cued by voice onset time) but extends as well to a prepausal position of salient release. According to (17), [voice] is licensed on word-final consonants in Hungarian. With Laryngeal Licensing (17) now substituting for ID-[VOICE]$_{onset}$ the devoicing derivation (16b) of **ka*/p+d/ → *ka*[pt] is correctly excluded. This input-output mapping is defeated at the first constraint evaluation in (16).

Hungarian stops may also be optionally released within an obstruent cluster yet here regressive voicing assmilation is still obligatory. Therefore, we follow Steriade (1999a) and assume a hierarchy of contexts that are canonically associated with release

[2] This behavior of final obstruent clusters in Hungarian and its implications for the Lombardi typology were independently discovered by Zsigri 1998. See also Petrova et. al. 2001 for relevant discussion.

cues that allow the voicing contrast to be recovered. The hierarchy minimally includes the following contexts: presonorant > word-final > preobstruent. Presonorant cues to voicing include burst duration and amplitude as well as F0 and F1 of the sonorant itself. In word-final prepausal position just burst duration and complexity are present; and in preobstruent position none of these cues is typically available. This phonetic scale of salience projects a corresponding hierarchy of markedness constraints (18) into the OT grammar. These constraints ban a paradigmatic voicing contrast *[±voice] in the contexts just described. The hierarchy is arranged from worst to best (cf. Prince & Smolensky 1993 for the first use of such scales in Optimality Theory).

(18) Hierarchy of contexts for an obstruent voicing contrast
*[±voice] / __ [-sonorant] >> *[±voice] / __ # >> *[±voice] / __ [+sonorant]

Most of the languages discussed previously are straightforwardly generated by simply embedding faithfulness for voicing (Lombardi's ID-[VOICE]) at different points in the hierarchy of contexts, as shown in (19a). (19b) illustrates *tableaux* for the crucial forms from Hungarian.

(19) a. Voicing typology in terms of (18)

Classical Arabic:
ID-[VOICE] >> *[±voice] / __ [-son] >> *[±voice] / __ # >> *[±voice/ __ [+son]

Hungarian, Yiddish:
*[±voice] / __ [-son] >> ID-[VOICE] >> *[±voice] / __ # >> *[±voice/ __ [+son]

Polish:
*[±voice] / __ [-son] >> *[±voice] / __ # >> ID-[VOICE] >> *[±voice/ __ [+son]

Finnish:
*[±voice] / __ [-son] >> *[±voice] / __ # >> *[±voice/ __ [+son] >> ID-[VOICE]

b.

ka/p+d/	*[±voice] / __ [-sonor]	ID-[VOICE]	*[±voice] / __ #
[pd]	*!		*
☞ [bd]		*	*
[pt]	*!	*	
do/b+s/	*[±voice] / __ [-sonor]	ID-[VOICE]	*[±voice] / __ #
[bs]	*!		*
☞ [ps]		*	*
[bz]	*!	*	

The faithful candidates [kapd] < /kap+d/ and [dobs] < /dob+s/ are rejected since they express a voicing contrast (inherited from the input) in pre-obstruent position. For exactly the same reason the candidates [kapt] < /kap+d/ and [dobz] < /dob+s/ are rejected: they

express a paradigmatic voicing contrast (inherited from the input) in pre-obstruent position. The winning candidates satisfy the constraint because they correctly fail to express a voicing contrast in pre-obstruent position. The value for the voicing feature in the stem-final consonant depends on the value of the following obstruent and hence is no longer independent of the context. In other words, the lexical contrast has been neutralized.

The constraints in (19a) are expressed in terms of a binary [±voice] opposition. The segment that realises the archiphoneme is either determined by the context (as in Hungarian) or is the unmarked member of the opposition (reflecting an inherent *[+voice] >> *[-voice] ranking, as in German and Swedish). In Polish word final obstruents assimilate the voicing of a following obstruent in the same phonological phrase. Before a sonorant there is dialectal variation with the Warsaw dialect having a uniformly voiceless realisation while for the Krakow dialect the outcome is determined by the context and thus appears voiced before a sonorant. See Rubach (1996) for recent discussion; he provides the following illustrations: *samochód ojca* 'father's car' and *brat ojca* 'father's brother' are both [t#o] in Warsaw but [d#o] in Cracow. In Hungarian regressive assimilation in obstruent clusters also applies across word boundaries: *Matyas, dobj* [z#d] 'Matyas, throw!' and *ad pitet* [t#p] 'gives pie'. Following Steriade (1999a), we assume these patterns arise from the relative ranking of an Output-Output constraint that analogises the phrase internal form of the word to its isolation form. In Hungarian and Warsaw Polish this constraint falls between *[±voice] / __ [-sonorant] and *[±voice] / __ [+sonorant] and so blocks voicing before a sonorant while in Krakow it is demoted below *[±voice] / __ [+sonorant] and so effectively plays no role in choosing a winning candidate.

The salient release of Hungarian word-final stops not only helps to foster regressive voicing assimilation in final obstruent clusters. It is also crucial in the maintenance of word-final, prepausal geminates. Another noteworthy feature of Hungarian is that it contrasts long and short vowels and single *versus* geminate consonants. These contrasts freely combine within the syllable, as the following paradigms show. (The accent marks a long vowel.)

(20) Salient release of Hungarian word-final stops

fed	'covers'	fed-d	'cover (imperative)'
véd	'defends'	véd-d	'defend (imperative)'
has	'stomach'	has-s	'influence (imperative)'
ás	'digs'	ás-s	'dig (imperative)'
sok	'many'	sokk	'shock'

Without salient release — particularly for a voiceless stop— there would be no demarcation of its termination and hence no way to reliably distinguish long *versus* short voiceless stops. It is interesting that Turkish (Clements and Keyser 1983) degeminates in preconsonantal and word-final position and also devoices in these contexts.

Based on the description in Nádasdy (1985), Morén (1999) calls attention to word-final degemination in the colloquial speech of educated Hungarians. It affects both vowels and consonants. With regard to consonants, final sonorants are degeminated while obstruents are not: *váll* 'shoulder' → *vá*[l] but *sokk* 'shock' → *so*[kk]. As Morén notes, this discrepancy runs contrary to the cross-linguistic preference for length to coincide with increased sonority. If word-final stops in Hungarian have salient release, then their otherwise aberrant behaviour begins to make some sense.

We close this section by observing that we have dropped reference to syllabic affiliation in our formulation of the Laryngeal Licensing Constraint (17) and have restated it in exclusively segmental terms. The motivation for this move can be seen in various dialects of Arabic, to which we now turn.

4. Arabic

It is well known that Arabic prosody depends on the contrast between light and heavy syllables (Mitchell 1993). Syllable weight is relevant for stress, minimality, and templating processes. Word-final single consonants are non-moraic while the VC-substring in VCC# and VCCV sequences is uniformly bimoraic and hence, under standard assumptions, tautosyllabic. We can bring this aspect of the prosody to bear on the onset/coda status of consonants with respect to the positional licensing of [voice]. The general upshot is that the two phenomena (syllable weight and voicing) are largely independent. We consider here two of the Arabic dialects that figure prominently in Abu-Mansour's (1996) discussion of voicing.

4.1 Daragözü

Daragözü is an Arabic dialect spoken in Turkey (Jastrow 1973). Its stress rule distinguishes closed from open syllables in the expected way (cf. below). Similar to Turkish, Daragözü devoices word-final obstruents. Daragözü also regressively assimilates voicing in obstruent clusters and thus has the constraint ranking of Polish seen in (10). According to Jastrow (1973: 31), "[v]iewed from the end of the word, stress is on the word-internal first long vowel or the first VCC sequence, otherwise on the first syllable of the word". At the end of the word before pause all voiced consonants are realised as voiceless (Jastrow 1973: 19). Final devoicing is not reflected in Jastrow's transcriptions, except for the pharyngeal /ʕ/, which takes the voiceless variant / / word-finally and before a voiceless consonant. For voicing assimilation Jastrow (1973: 24) states: "If a voiced and voiceless consonant come in contact, then the group is uniquely voiced or voiceless such that the first consonant assimilates to the second". These principles of Daragözü phonology are reflected in the following paradigm for the verb /qaTaʕ/ 'cut'. ([T] denotes an emphatic (pharyngealized) consonant).

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(21) Daragözü regressive voicing assimilation

	1st person	2nd person	3rd person
Singular masculine	[q^{a}Tá -tu]	[q^{a}Tá -t]	[qáTa]
Singular feminine	[q^{a}Tá -tu]	[q^{a}Tá -te]	[qáTʔ-et]
Plural	[q^{a}Táʔ-na]	[q^{a}Tá -to]	[qáTʔ-o]

The form of particular interest here is the first plural [q^{a}Táʔ-na]. It must have a closed penultimate syllable in order to attract the stress and so the /ʔ/ must occupy the coda. Nevertheless, /ʔ/ is not devoiced. This makes perfect sense according to the revised licensing principle in (17) which preserves [voice] on presonorant segments regardless of syllabic affiliation. See Rubach (1996) and Steriade (1999a) for similar critiques of syllabic licensing for [voice], based on data from Polish and Lithuanian. In our terms Daragözü has the same ranking as Polish in (19a) with faithfulness for voicing slipped between neutralization in word-final and presonorant position: *[±voice] / __ [-sonorant] >> *[±voice] / __ # >> ID-[VOICE] >> *[±voice/ __ [+sonorant].

4.2 Makkan

Abu-Mansour (1996) also discusses voicing assimilation in the Saudi-Arabian dialect of Makkah. It differs from Daragözü in retaining the contrast between voiced *versus* voiceless obstruents word-finally as well as before a voiced obstruent. Before voiceless obstruents there is devoicing of underlying voiced obstruents.

(22) Devoicing in Makkan Arabic, part 1

/yi+ktub/	[yiktub]	'writes'	[katab]	'wrote'
/yi+dba /	[yidba]	'slaughters'	[daba]	'slaughtered'
/yi+tbaʔ/	[yitbaʔ]	'follows'	[tabaʔ]	'followed'
/yi+dfin/	[yitfin]	'buries'	[dafan]	'buried'

Viewed formally, Makkan Arabic is the DEP-[VOICE]>> UNIFORMITY >> MAX-[VOICE] counterpart to Ukrainian (Gnanadesikan 1997).

(23) Devoicing in Makkan Arabic, part 2 (to be revised)

a. /yi+tbaʔ/	DEP-[VOICE]	UNIFORMITY	MAX-[VOICE]
☞ [tb]		*	
[db]	*!		
b. /yi+dfin/	**DEP-[VOICE]**	**UNIFORMITY**	**MAX-[VOICE]**
[df]		*!	
☞ [tf]			*

While this analysis works, we suggest an alternative more in keeping with the notion of phonological and phonetic salience. Presonorant position is an optimal context in which

to preserve a voicing distinction in obstruents because sonorants typically do not themselves contrast in voicing and so allow voice onset time to serve as an effective cue to the voicing distinction. What is special about Makkan Arabic, we suggest, is that the context for licensing the voicing contrast is extended from sonorants to voiced obstruents. On this view, just as a sonorant such as the nasal in [yikniz] 'accumulates' *versus* [yigni] 'owns' licenses the voicing contrast in the preceding stops so does the /b/ in [yitbaʔ] 'follows' *versus* [yidba] 'slaughters'. From the perspective of phonological salience, the Makkan pattern can be captured by dividing the *[±voice] / __ [-sonorant] constraint into voiceless and voiced contextual variants, with faithfulness for [voice] ranked between them.

(24) Devoicing in Makkan Arabic, part 3

a. /yi+tbaʔ/	*[±voice]/__[-son, -voice]	ID-[VOICE]	*[±voice]/__ [-son, +voice]
☞ [tb]			*
[db]		*!	*
b. /yi+dba /	*[±voice]/__[-son, -voice]	ID-[VOICE]	*[±voice]/__[-son, +voice]
☞ [db]			*
[tb]		*!	*
c. /yi+dfin/	*[±voice]/__[-son, -voice]	ID-[VOICE]	*[±voice]/__[-son, +voice]
[df]	*!		
☞ [tf]		*	

One final observation. Makkan *masdars* (nominalisations) in the CaCC-template break up rising sonority clusters with epenthesis: /ʔakl/ → [ʔakil] 'food'. But obstruent clusters generally surface without any vocalic support. The range of consonants composing the final cluster in the input freely combines all four possible combinations of voiced and voiceless obstruents. The remarkable fact is that these clusters are resolved in essentially the same way as medial ones: there is devoicing but no voicing.

(25) Devoicing in Makkan Arabic, part 4

/fatk/	fatk	'destruction'
/ʕabd/	ʕabd	'slave'
/rabk/	rapk	'confusion'
/rakb/	rakb	'caravan'

In a preliminary phonetic study of such clusters with two speakers, the following generalisations emerged. When the second consonant in the cluster is voiceless then the first obstruent neutralises to voiceless: /rabk/ → [rapk]. When the second consonant in the cluster is a voiced obstruent then a voicing contrast in the first obstruent is maintained: a /g/ is fully voiced in C_1 position ([fagd] 'losing') while voicing ceases at some point after the onset of /d/ ([nadb] 'appointment') and /b/ ([xabz] 'baking') in this position. When the second member of the cluster is a stop, then closure voicing consistently disappears in this consonant. Nevertheless, a voicing contrast is still

maintained—phonologically in the effect on the preceding obstruent and phonetically in the release: in voiceless stops (e.g. [fatk] 'destruction') energy is diffused through the spectrum (aspiration) while in voiced stops (e.g. [fatg] 'opening') it is weaker and more confined. This suggests that even though closure voicing is absent in C_2 because the constriction in the oral cavity blocks airflow through the glottis, the voicing contrast is still maintained articulatorily at the larynx and becomes audible at release.

Makkan thus appears to counter-exemplify a generalisation Lombardi (1999), following Mester and Itô (1989), attributes to Harms (1973) concerning the devoicing that obtains in the analysis of the English plural that posits an underlying voiced consonant: *cats* /kæt+z/ → [kæts]. Harms' "Generalisation" states: "voiced obstruents must be closer than voiceless [ones] to the syllable nucleus" (Lombardi 1999: 288). Another point worth mentioning is that, as in Hungarian, Makkan contrasts prepausal single *versus* geminate stops, which have salient release. With salient release, the final consonant in a CVCC *masdar*-cluster will have the same status as a prevocalic one with respect to the Laryngeal Licensing Constraint (17), and hence the identical behaviour with regard to voicing assimilation is to be expected.

We suspect that the preservation of voicing and place contrasts in such clusters is connected with a more measured intersegmental timing pattern in comparison to that found in English or French. Our data often indicate brief moments (one or two pulses) of periodic vibration between the consonants. See Gafos (2002) for discussion of the importance of such timing factors in Moroccan Arabic.

5. Ukrainian

We close by returning to the Ukrainian data mentioned earlier. We recall that Ukrainian maintains a voicing contrast word-finally as well as before a voiceless consonant. Before voiced obstruents there is regressive assimilation and hence neutralization. While these data could be described by inverting the *[±voice] / __ [-sonorant, -voice] >> ID-[VOICE] >> *[±voice] / __ [-sonorant, +voice] Makkan ranking to *[±voice] / __ [-sonorant, +voice] >> ID-[VOICE] >> *[±voice] / __ [-sonorant, -voice], the former ranking is grounded in phonetic perception and hence should be irreversible.

A possible alternative explanation is suggested by certain remarks in Bethin (1987). She reports that Ukrainian speakers syllabify obstruent clusters by maximising onsets. This applies even if the resulting clusters are not found word initially: *xlo.pcyk* 'little boy', *ko.bzar* 'singer'. The one systematic exception is a cluster of a voiced obstruent followed by a voiceless one; it is perceived as heterosyllabic: *rid.ko* 'seldom'. However, for this to happen, a preceding vowel is required: /z=p/*ek-ty* 'to bake' is realised as [sp]*e.kty* with voicing assimilation. But if the preceding word ends in a vowel then underlying voicing is retained: *moloko z=silosja* 'the milk has curdled' (Andersen 1969:165). The regressive assimilation in /z=p/*ekty* → [sp]*e.kty* as well as in *pro*/s'+b/*a* → *pro*[z'b]*a* indicates that Ukrainian demotes ID-[VOICE] below the constraints that neutralize voicing distinctions before voiced as well as voiceless obstruents. Hence, some other mechanism must block devoicing in *ridko*.

Here we follow Bethin's (1987) suggestion that in Ukrainian the lack of voicing assimilation in *ridko* reflects a process of coda laxing that weakens (sonorizes?) postvocalic voiced obstruents. This weakening will override the devoicing that is otherwise expected from the perceptually motivated ranking. Following Steriade (1999b), we speculate that the syllabification judgements reflect at least in part the availability of a matching word-initial cluster. In other words, a word-medial V.CCV parse will be rejected if the cluster is systematically excluded word-initially (based on the isolation pronunciation). This explains why a voiced+voiceless cluster is judged heterosyllabic: *rid.ko*. And since there is no final devoicing in Ukrainian, the heterosyllabic parse *rid.ko* also matches the right edge of the word. The hypothesized laxing process may be the way the language avoids final devoicing as well. If so, then Ukrainian has the same constraint ranking as Polish and Russian with ID-[VOICE] below *[±voice] / __ #. This interpretation is supported by dialect variation. The Southwestern dialects have final devoicing; but they also have regressive assimilation in clusters so that voiced obstruents devoice before a voiceless obstruent: cf. *ni*[γ]*ot'* 'fingernail' and Southwestern *ni*[x]*ty* vs. Standard Ukrainian *ni*[γ]*ty* plural. Clearly, these suggestions are highly speculative; a thorough study of the phonology and phonetics of Ukrainian obstruents is required to substantiate the hypothetical laxing process.

6. Summary and Conclusion

In this paper we have reviewed the positional licensing of laryngeal features as proposed in Lombardi (1991, 1995, 1999). In order to extend the model to Hungarian we have recast the constraint in more phonetic terms that refer to the contexts which are favourable to the realisation of cues to voicing contrasts: in particular voice onset time and release of stop closure. Dispensing with reference to the syllable also allowed us to come to terms with conflicting evidence in Arabic dialects.

Features like release are often regarded as insignificant details added in the phonetic component. The evidence reviewed here suggests that such factors can have an impact on phonological structure. Obviously, systematic study and experimentation is needed to substantiate the notion of saliency that underlies this approach.

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