

Voicing alternations and underlying representations: The case of Breton[☆]

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Abstract

The alternations in obstruent voicing in the dialect of Breton found on the Île de Groix are particularly interesting, since three modes of neutralisation can be observed: (i) final devoicing, i.e., obstruents surface as voiceless in syllable- or word-final position; (ii) obstruent voicing, which is observed when a word-final obstruent is followed by a vowel- or sonorant-initial word, and (iii) regressive as well as progressive voicing assimilation, which is found in obstruent clusters. The respective patterns give evidence for the following claims: first, [voice] is a binary valued feature and underspecification is a third option in Breton. The Breton voicing phenomena will be accounted for within the Correspondence/Markedness version of Optimality Theory. Second, the analysis crucially relies on the devices of positional markedness and positional faithfulness. Neither can be rejected in favour of the other. The last finding of this paper is that voicing assimilation in Breton is a side effect of the interaction of positional faithfulness and positional markedness. There is no evidence to assume a specific assimilation constraint, as is usually done in the Optimality theoretic literature on voicing assimilation (e.g. Gnanadesikan, 1997; Lombardi, 1999). © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

It is a widespread assumption in Optimality-theoretic literature that underlying representations are fully specified. This follows from basic assumptions of this theory, such as Lexicon Optimization (Prince and Smolensky, 1993; Inkelas, 1994). Since output or surface forms are regarded as fully specified, every feature which is not specified in a given input incurs a DEPENDENCY-feature violation. The constraints of the DEP constraint family militate against the filling-in of features in surface representations which are not present in the underlying representation. Thus, full specification of underlying forms – even though it is uneconomical within the lexicon – is forced upon the lexicon for reasons of grammatical economy.

Inkelas (1994) and Inkelas et al. (1997) argue that predictable alternating structure should be regarded as underspecified. The alternative with regard to morpheme-specific alternations would be to assume either separate allomorphs in the lexicon, or morpheme-specific rerankings of the constraint component CON (or at least parts of it). Both allomorphy and morpheme-specific constraint ranking are highly undesirable for reasons of economy and theoretical plausibility. A theory, which potentially assumes a separate grammar for each morpheme in a given language is highly uneconomical in comparison to the assumption of one grammar for each language or dialect. The question also arises how children learn the different constraint rankings within one language. In her argumentation for archephonemic underspecification, Inkelas relies crucially on data from Turkish, where some root-final consonants are specified either as [+voice], or as [-voice], or they are underspecified for that feature. In connection with positional faithfulness (Beckman, 1997; Lombardi, 1995b, 1999) and positional markedness (Zoll, 1998; Grijzenhout and Krämer, 1998), which assume particular faithfulness constraints on onsets or initial positions and particular markedness constraints on word- or syllable-final positions, the impression emerges that morpheme-initial elements are always fully specified (not in the least because of their perceptual prominence), while morpheme-final elements show a tendency towards underspecification (because the choice of available elements in a language's inventory is more restricted for codas and word-final segments than for other positions). In this paper, I will provide evidence that (morpheme-)initial consonants may be underspecified, too. Thus, full specification of initial segments is only a tendency and not a (universal) rule. The language under discussion is the Breton dialect spoken on Île de Groix as reported by Ternes (1970). The analysis of the voicing alternations provided here, will crucially rely on the notions of positional faithfulness, give new arguments for positional markedness, and it will involve the grammatical tool of local conjunction (Smolensky, 1993, 1995) for two purposes: first to combine simple markedness to complex i.e. positional markedness constraints; and second in the sense of Lubowicz (1998) to explain derived environment effects (DEE) like final voicing.

The assumption of binary features, combined with the possibility of underspecification does not invoke a ternary phonemic contrast (such a ternary distinction could arise, e.g., when aspiration and voice interact in a system to constitute a contrast of voiceless aspirated, voiceless unaspirated and voiced obstruents). I will show that

demands of markedness regulate the emergence of the underspecified features in a principled way as either positively or negatively specified in surface representations.

The paper is organised as follows. Section 2 introduces the phenomenon of final devoicing and the theoretical analysis proposed by Lombardi (1995b, 1999). The understanding of the obstruent voicing pattern found in Île de Groix Breton (section 3) is crucial for the analysis of laryngeal assimilation, which is given in section 4. Section 5 concludes.

2. Final devoicing

As illustrated in (1), Breton displays final devoicing. Underlying final voiceless plosives always surface as voiceless, also in intervocalic position. See (1b) and (1d). In the first column, the respective obstruents are in final position, whereas they are in intervocalic position or between a sonorant and a vowel in the second column. Underlyingly voiced plosives in contrast are voiceless in syllable- or word-final position (see examples 1a,c, first column) and they are voiced in onset position, for example when a vowel-initial affix is attached to the root, as can be seen in the second column of the respective examples.

(1) Final devoicing in Île de Groix Breton (Ternes, 1970: 127):¹

	singular	plural	
a.	pout	poudeu	'pot'
b.	kurt	kurteu	'cour'
c.	korf	korveu	'corps'
d.	grek	grekeu	'cafetière'

Lombardi (1999) analyses similar data with the following set of constraints (2). The markedness constraint *[voice] militates against the surface occurrence of voiced obstruents in general. The faithfulness constraint IDENT[voice] prefers output forms of underlying obstruents which are identical to their underlying representation in the specification of [voice]. The constraint IDENTONSET[voice] is restricted to obstruents which are syllabified in onset position in surface representations. Since the last two constraints stand in a general ~ specific relation, IDENTONSET[voice] must rank above IDENT[voice] according to Paninian ranking (Prince and Smolensky, 1993).

(2) Constraints:

*[voice]:	Avoid voiced obstruents.
IDENT[voice]:	Obstruents in the output have the same [voice] specification as in the Input.

¹ The Île de Groix data will be given as transcribed by Ternes. For standard Breton data, the phonetic transcription is given in roman and the orthography in arial type letters. Note that even though stress is indicated in some examples, syllabification is never indicated by the authors cited.

IDENTONSET[voice]: Obstruents which are in onset position in the output have the same feature specification for [voice] as in the Input.

Final devoicing is the result of ranking the markedness constraint between the two faithfulness constraints. This is exemplified in tableau (3).

(3) Devoicing Grammar in the sense of Lombardi (1999):

IDENTONSET[voice] >> *[voice] >> IDENT[voice]

	IDENTONSET[voice]	*[voice]	IDENT[voice]
☞ a. /poud/ ~ pout			*
b. /poud/ ~ poud		*!	
c. /poud+ew/ ~ pou.tew	*!		*
☞ d. /poud+ew/ ~ pou.dew		*	
e. /grek/ ~ krek	*!		*
☞ f. /grek/ ~ grek		*	

Both surface candidates which are compared with regard the underlying form /poud/ incur one constraint violation. Candidate (a) violates IDENT[voice], because the final /d/ is voiceless on the surface. In this respect, this candidate satisfies *[voice]. Candidate (b) violates the latter constraint, because the final /d/ is mapped faithfully to the surface. In candidate (b) this /d/ is not in onset position, therefore it is only subject to IDENT[voice] while IDENTONSET[voice] is vacuous with regard to this segment. Since IDENT[voice] is ranked lower than *[voice], the candidate wins, which violates the faithfulness constraint by satisfying the markedness constraint, i.e. candidate (a), the one with final devoicing. The pair (c,d) shows the evaluation of the more faithful plural form of the same stem. The pair (e,f) illustrates how the high ranking of positional faithfulness prevents surface obstruents in onset position from appearing as voiceless in obedience of markedness.

It will be shown later in this paper that Lombardi's analysis has to be modified in two ways: The feature [voice] which she assumes to be privative, must be a binary one to account for the Breton data to be examined below. Second, the analysis of devoicing which relies on the markedness constraint *[voice] is not adequate. A positional markedness constraint on syllable codas is indispensable to give an adequate explanation of the Breton voicing phenomena.

After the introduction to final devoicing, I first proceed to the discussion of 'final voicing' in the next section. The last type of alternation to be examined will be assimilation (section 4).

3. Voicing

In case a word-final consonant is followed by a word beginning with a vowel or a sonorant, the consonant in question surfaces as voiced. Intervocalic voiceless obstruents in other environments are not realised as voiced (see the examples in 1b,d). Example (4a) shows the word *beleg* ‘priest’ in utterance-final position where its final consonant is voiceless. In (4b), the same word is found before a word beginning with a voiceless obstruent and the final consonant is also voiceless. In (4c), the word *beleg* ‘priest’ is placed before a vowel-initial word. Here, it surfaces with a voiced final consonant. The final consonant of *beleg* also surfaces as voiced in (4d), where a sonorant follows.

(4) Standard Breton

- | | |
|---|--|
| <p>a. 'sɛlid uz ar 'bɛ:lek
sellit ouzh ar beleg
'Look at the priest.'</p> | <p>b. 'sety 'āmā ar 'bɛ:lek 'ko:s
setu amañ ar beleg kozh
'here is the old priest'</p> |
| <p>c. 'bɛ:leg ar 'bares
beleg ar barrez
'the priest of the parish'</p> | <p>e. yr 'bɛ:leg 'ma:d eo / e:
ur beleg mat eo
'he is a good priest' (Hemon, 1995: 92)</p> |
| <p>d. yr 'bɛ:leg 'ma:t
ur beleg mat
'a good priest'</p> | |

Under the assumption that the final *g* of *beleg* is voiced underlyingly, an explanation of this voicing pattern could be quite straightforward. If the obstruent provides an onset for the following word it is in onset position and therefore surfaces faithfully to its underlying voice specification. The problem is not as easy to resolve, because voicing of word-final consonants before vowel-initial words does not only apply to underlyingly voiced final consonants. Underlyingly voiceless consonants are subject to this alternation, too (Ternes, 1970: 97). This is illustrated by the data in (5). In (5a), the verb root *šùk* ‘sit down’ appears in a suffixed form, exhibiting a root-final voiceless obstruent in a syllable onset. Thus, it can be concluded that it is underlyingly voiceless. In (5b) though, the same obstruent surfaces as voiced when followed by a vowel-initial word.

- | | |
|--|--|
| <p>(5) a. šùk-ed əzáj!
sit.down-imp.2.pl there
'Sit down (you.plural) there!'</p> | <p>b. šùg əzáj!
sit.down there
'Sit down there!' (Ternes, 1970: 45)</p> |
|--|--|

A summary of the voicing patterns discussed in this section is given in the table below.

(6) Realisations of morpheme-final obstruents:

	Absolute final position	Before vowel-initial affix	Before vowel- or sonorant-initial word
a. /d/	t	d	d
b. /t/	t	t	d

The solution to this mysterious phenomenon of final voicing lies in the syllabification of Breton segments and in the particular morphoprosodic context. If the final consonants are syllabified in the onset of the following word when a vowel- or sonorant-initial word follows, they are prosodified within another prosodic domain (i.e. word) than the rest of the morpheme they belong to lexically. In that case, onset voicing is triggered as a kind of marking of this misalignment of prosodic and morphological structure.² The patterns of syllabification in Île de Groix Breton will give support for this claim.

3.1. *Patterns of syllabification*

Breton allows monosyllabic words that consist of only one short vowel, for example *y* ‘egg’ (Ternes, 1970: 66f.). This means that constraints prohibiting epenthesis (DEPIO) are more important than those requiring an onset (ONSET) and more prominent than the minimal weight requirement on prosodic words (FOOTBINarity, see Prince, 1980; Prince and Smolensky, 1993; Hayes, 1995, and others).

(7) The minimal syllable/word in Île de Groix Breton

/y/ ‘egg’	DEP-IO	FOOTBIN	ONSET
a. □y	*!	*	*
b. □y:	*!*	*	*
c. y:	*!	*	*
☞ d. y		*	*

² A rather tentative explanation for a similar phenomenon, final voicing in Sanskrit, is given by Selkirk (1980). She proposes the following rule: [-son] → [+voice]/ [...[...]_o [[+voice] ...]_o ...]_U ‘A prosodic word-final obstruent becomes voiced when followed by a prosodic word starting with a voiced element within an utterance’. As will be shown in this paper, such an analysis would make the wrong predictions and would miss some crucial generalisations if applied to the Breton data.

Île de Groix Breton displays codaless syllables as well as syllables with a coda. The maximal coda contains two consonants. Onsets can be fairly complex, consisting of maximally three consonants. According to Ternes (1970: 66f.), consonants between vowels are syllabified in such a way that the boundary between the two syllables cannot be determined anymore, i.e. we assume ambisyllabicity here. In OT terms, this is an effect of the constraint ONSET (and probably of NoCODA). In cases where a final obstruent meets a vowel-initial or sonorant-initial syllable, it gets syllabified in the onset, regardless whether a word boundary intervenes or not. According to Ternes (1970: 70), in cases of a homophonous obstruent cluster, only a short stop can be perceived.

- (8) damp tə- gusk-et ta → damp tə- guske ta
 come.1PL 2 sleep-inf well ‘Well, let’s go to sleep!’ (Ternes, 1970: 73)

In (8), the homophonous obstruent cluster ($t+t$) degeminates and the remaining short t is syllabified in two syllables being in coda and in onset position at the same time.

In this language, MAX-IO must be ranked above NoCODA, because coda consonants may surface in Breton (maximally two in one coda). *GEMINATE is undominated, because there are no long consonants in the language, neither phonemically nor derived. With this ranking, candidate (9d) is the optimal output if the surfacing t is ambisyllabic *and* regarded as coalescence of both underlying t ’s, hence saving a MAX-IO violation. For the sake of explanatory transparency, I will regard candidate (9c) as optimal and proceed on this basis. If one counts this MAX-IO violation, candidates (9c) and (9d) tie on MAX-IO, but candidate (9d) loses for having a NoCODA violation which candidate (9c) lacks.

(9) Degemination and syllabification

/gusket] [ta/	*GEMINATE	ONSET	MAX-IO	NoCODA
a. et.ta	*!			*
b. et.a		*!	*	*
☞ c. e.ta			*	
(☞) d. e.ta			(*)	*(!)

With this analysis of Île de Groix Breton syllabification in mind, I will now return to the problems connected with voicing of word-final obstruents.

3.2. The analysis of voicing

Underlyingly voiceless final consonants, that are syllabified in onset position in affixation do not get voiced, as shown in (1a,c). This is the only diagnostic to estab-

lish their underlying voice specification. Furthermore, in word-initial position, we find voiceless obstruents, as illustrated by the data in (10) where some minimal pairs are shown (taken from Ternes, 1970: 4f.).

(10)	pout	‘pot’	bout	‘bunch of heather’
	tān	‘fire’	dān	‘profound’
	sej	‘bucket’	zej	‘silk’
	fej	‘faith’	vej	‘guard, take care’
	ka:r	‘(hand)cart’	ga:r	‘leg’

This tells us that a constraint which is responsible for onset voicing must be ranked under IDENTONSET[voice]. If it were ranked higher, the voiceless onsets in (10) would not occur. I will formalise this constraint as an Alignment constraint, requiring that the left edge of every syllable has to coincide with the left edge of a voicing span, as given in (11).³

- (11) ONSETVOICING (OV) {AlignL(σ , [+voice])}: The left edge of every syllable coincides with the left edge of a voiced segment.

Evidence for such a markedness constraint, and for the fact that the unmarked voice specification at the left syllable edge is [+voice] also comes from language acquisition. Children (at least German children) go through a phase where they may voice voiceless obstruents in onsets (see Grijzenhout and Joppen, 1998), whereas they never devoice voiced onsets. Another piece of evidence comes from languages which do not display a voicing contrast among obstruents (see e.g. Golston and Kehrein, 1999, for a discussion of possible laryngeal contrasts). Ladefoged and Madieson (1996) report that most languages with only one series of stops have voiceless stops phonetically. In most Australian languages, however, “the stops may be produced with no actual opening [of the vocal folds] required, with vibration ceasing due to lack of efforts to sustain it” (Ladefoged and Madieson, 1996: 53). This means that in these languages, onset stops are produced with initial voicing. This can be explained by an undominated constraint on onset voicing. We will now consider how the onset voicing constraint interacts with other constraints in Breton.

³ The same may also be expressed as a positive Markedness constraint, i.e. $\sigma_{\{ [+voice] \}}$, as was the choice of Grijzenhout and Joppen (1998).

(12) Initial voiceless plosives: IDENTONS[voice] >> ONSETVOICING >> *[+voice]

	IDENTONS[voice]	ONSETVOICING	*[+voice]
a. /poud/ ~ [bout]	*!		*
☞ b. /poud/ ~ [pout]		*	
c. /poud/ ~ [poud]		*	*!
☞ d. /bout/ ~ [bout]			*
e. /bout/ ~ [pout]	*!	*	

The ranking IDENTONSET[voice] >> ONSETVOICING which is established so far, rules out every onset voicing. The solution to the ranking paradox created here comes from a further observation: onset voicing happens only when a final consonant is syllabified into the onset of a following prosodic word. I outlined above that the syllable wellformedness constraints ONSET and/or NOCODA force this resyllabification. McCarthy and Prince (1993), Selkirk (1995), and Grijzenhout and Krämer (1998) use an alignment constraint which demands that the left edge of stems matches with the left edge of the prosodic word they are in. This constraint is given in (13).

(13) ALIGNL(stem, PWd): The left edge of every stem coincides with the left edge of a prosodic word.

In Breton words containing vowel-initial stems, all segments of a morpheme belong to one prosodic word except for the initial obstruent, which is taken from the preceding word (maybe it is ambisyllabic, see 9). The initial obstruent is placed between the left stem boundary and the left prosodic word boundary, in violation of ALIGNL(stem, PWd). Since onset voicing occurs in Breton only when this constraint is violated, I conclude that it is fatal in the grammar of Breton to violate both constraints, i.e., ALIGNL(stem, PWd) and ONSETVOICING at the same time. Formally, this can be achieved by locally conjoining the two constraints (on the device of Local Conjunction see Smolensky, 1993).

(14) A&OV Local Conjunction:⁴

{ALIGNL(stem, PWd) & ONSETVOICING} Domain: segment.

⁴ In the current formulation of the two constraints, this is a conjunction of two members of the Alignment family. According to Lubowicz (1998), derived environment effects (DEE) emerge as an effect of the local conjunction of faithfulness with markedness constraints. Since both constraints, which are involved in the analysis of the Breton voicing in derived environments, may also be formulated as ANCHORL(stem, PWd) (i.e., Faithfulness) and $\sigma_{\{+voice\}}$ (i.e., markedness), the approach presented here is fully compatible with Lubowicz' account of DEE.

Technically, two possibilities remain to escape violation of the local conjunction of ALIGNL(stem, PWd) and ONSETVOICING (henceforth A&OV): either violation of the ALIGN constraint, or violation of the ONSETVOICING constraint can be avoided. Avoidance of violating ALIGNL(stem, PWd) is made unacceptable by the obvious high ranking of syllable wellformedness constraints, because in this case the first syllable in the prosodic word in question would have no onset. A further possibility would be to epenthesise an obstruent to provide an onset. I found no instance of consonant epenthesis in Breton, so DEP-C must rank quite high. The only possibility which remains is satisfying the local conjunction A&OV by voicing the onset and ignoring therefore IDENT[voice]. IDENT[voice] must be ranked below locally conjoined A&OV.

In the following, another example of onset voicing is given (15), which will be analysed with the grammar developed so far in tableau (16).

- (15) tap + ar-ivi:n tab ar-ivi:n
 tap, hit PREP-trap/mouth
 ‘Hit him on the mouth!/Beat the shit out of him!’

- (16) Initial voicing: DEP >> ONSET, NoCODA, A&OV >> IDENTONS[voice] >> *[+voice]

/tap # arivi:n/	DEP	ONSET, NoCODA	A&OV	IDENT ONSET	ONSET VOICING	*[+voice]	ALIGNL
a. tab.(□#a...	*!	NoCoda	(*)		*(*)	*	*
b. tap.(#a...		*!*			*		
c. tab.(#a...		*!*			*	*	
d. ta.(p#a...			*!		**		*
e. da.(b#a...				**!		**	*
f. ta.(b#a...				*	*	*	*

In tableau (16), candidate (a) is out because of its violation of DEP by epenthesis of an onset for *arivi:n*. Violation marks for ONSETVOICING and A&OV are given in brackets, because only if the epenthesised consonant is voiced, a violation of the former occurs; and only in this case a violation of the latter can be counted, since only then both constraints are violated by the same segment. ALIGNL is violated anyway by candidate (16a), because the epenthetic consonant separates the left morphological edge of *arivi:n* (indicated by ‘#’) from its left prosodic edge (indicated by ‘(’). Candidates (16b,c) are ruled out for having a coda in the first syllable and no onset in the second, thus violating high ranking NoCODA and ONSET, respectively. Candi-

date (16d) is fine with regard to DEP, ONSET and NOCODA, since it syllabifies the final obstruent of the first morpheme in the onset of the second, satisfying all three constraints. The obstruent in question is faithful to its underlying voice specification in satisfaction of IDENT. It has a violation of ONSETVOICING, since the underlying specification is [-voice]. This obstruent separates the left morphological edge of *arivi:n* and the left prosodic edge, incurring an ALIGNL violation. Both violations together (i.e. that of ONSETVOICING and that of ALIGNL) committed by the same segment count as a violation of A&OV. The winning candidate (f) avoids the A&OV violation not at the expense of one of the higher ranked syllable wellformedness constraints. It violates IDENTONSET[voice] by voicing the /p/ in order to fulfil all higher ranked conditions. Note that candidates (16b,c) did not violate A&OV either but incurred violations of the important syllable wellformedness constraints. Finally, candidate (16e) has both onset consonants voiced. Because of this it gets one violation mark more for IDENTONSET than candidate (16f).

The ranking established so far is summarised below. Only the ranking of ALIGNL cannot be determined (except for the fact that it must be rather low in the hierarchy).

(17) Summary:

DEP >> ONSET, NOCODA, A&OV >> IDENTONS[voice] >> ONSETVOICING >> * [+voice]

The analysis of syllabification and voicing of obstruents before vowel-initial words must be regarded as provisional, since it will be subject to an important reformulation in the following section. ‘Resyllabification’ and voicing of obstruents before sonorant-initial words (starting with *m*, *n*, *r*, or *l*) will be discussed in the end of section 4. The assimilation patterns of obstruents discussed in this section will turn out as a problem for the ONSET/NOCODA based account of ‘resyllabification’ proposed here. A revision of this account which captures the obstruent patterns will be problematic for the analysis of presonorant voicing. This in turn leads us to a third and final modification of the analysis.

4. Assimilation

Press (1986) and Hemon (1995) state that homorganic clusters always surface as voiceless in Standard Modern Breton. This is illustrated by the data below.

(18) Standard Breton:

- | | | | |
|---------------|----------------|----------------|-----------------------------------|
| a. bloaz + zo | ['blwa(s) 'so] | b. dek + gwele | ['de:k 'kɥe:le] / ['de: 'k ɥe:le] |
| year + ago | ‘a year ago’ | ten + bed | ‘ten beds’ |
| c. addeskiñ | [at'teskĩ] | | |
| ‘relearn’ | | | |

(Hemon, 1995: 92)

However, for Île de Groix Breton this does not hold. In this dialect, some homorganic clusters turn out as voiced (19b) and some as voiceless (19a,c). For instance,

this means that some of the clusters consisting of a final voiceless obstruent and an initial voiced obstruent surface as voiceless (19c), some others as voiced (19b). This observation holds for all places of articulation.

- (19) a. /damp tə-gusket ta/ → [damp tə guske ta] ‘Well, let’s go to sleep!’
 b. /urxləwéāt dāžərys/ → [urxləwéā dāžərys] ‘a dangerous illness’
 c. /əndrijet daj/ → [əndrije taj] ‘the third day’

From the data available to me, I cannot judge whether this must be analysed as a case of dialectal variation, or whether the descriptions of the ‘standard’ are somewhat too economic. I will therefore restrict myself to the analysis of the Île de Groix degemination data. The point is that homorganic clusters are reduced to a single segment in Île de Groix while in the standard grammars two segments are transcribed. If there is a dialectal difference, it may be reduced to the fact that the standard does not allow voiced geminates, while the Île de Groix variety bans all geminates.

4.1. Assimilation and underspecification

The data in (20a–g) show heterorganic clusters with regressive assimilation. (20h,i) illustrate that assimilation may also be progressive. In the examples, I left out clusters with a voiceless second element, since these always surface as voiceless clusters due to final devoicing anyway.

(20) Breton heterorganic cluster assimilation:⁵

- | | | | | |
|----|----------------|------------|--------|---|
| a. | žu: žep | + guroŋ | → [bg] | proper name ‘Joseph Guron’ |
| b. | urpaka sigaret | + bamdaj | → [db] | ‘a packet of cigarettes a day’ |
| c. | ərzantəzet | + zo-nilis | → [dz] | ‘the saints of the church’ |
| d. | rok | + donet | → [gd] | ‘before coming’ |
| e. | rmemes | + byxej | → [zb] | ‘the same life’ |
| f. | mis | + dy | → [zd] | ‘the month of december’ |
| g. | ərwirijes | + va:ri | → [zv] | ‘the virgin Mary’ |
| h. | tra nəvaŋk | + demp | → [kt] | ‘we don’t miss anything’ |
| i. | ərbeis | + bijān | → [sp] | ‘the little finger’ (Ternes, 1970: 72ff.) |

To account for voicing assimilation of obstruent clusters, I will provisionally adopt a constraint demanding Identity in voicing specifications of adjacent obstru-

⁵ Note that coronals as the first part of a cluster are dropped sometimes instead of undergoing assimilation. One may conclude that coronals are the result of coda epenthesis to provide a consonantal right edge for each prosodic word, or that they be lexically underspecified for place, and that acquisition of the following place feature produces a geminate which is subject to antigemination. As I do not want to enter the discussion on the status of the feature coronal (see Hall, 1997, and references there), and this coronal skipping provides neither substantial insights nor problems for the discussion in this paper, I will ignore this phenomenon.

ents as proposed in Grijzenhout and Krämer (1998). The definition of this constraint is given in (21).

(21) SURFACE-IDENTITY[voice] (S-IDENT):⁶

Let α be an obstruent in a string and β be any adjacent obstruent in that string.

If α is [γ voice] then β is [γ voice], and vice versa.

(Adjacent obstruents are identical in voicing.)

This device alone does not suffice to explain the Breton assimilation data. This constraint interacts with the degemination and devoicing grammar established already. Regarding the data in (19a,b) one would assume a ranking where S-IDENTITY and *GEMINATE are undominated, since no clusters disagreeing in voicing and no geminates occur in the Île de Groix dialect. The ranking of IDENTONSET above *[+voice] has been adopted from the analysis of devoicing sketched so far.

(22) S-IDENT, *GEMINATE >> IDENTONSET[voice] >> *[+voice]

This perfectly describes the data (19a,b) and (20a–g), which exhibit regressive assimilation or a surface realisation of the voicing specification of the second element (i.e. the one in onset position) in a degeminated homorganic cluster, respectively. All data with a voiced onset becoming voiceless in a cluster, like (19c) and (20h,i), are not captured by this analysis. To find out what happens here, we must consider more data. In (23a,b) the final consonant *ʃ* is combined with a *b*, giving rise to a voiced cluster in (23a) and to a voiceless cluster in (23b). If one combines the word *bənak* of (23b) with another word, as in (23c), it again turns out as voiceless. These data can be explained if it is assumed that the initial voiced obstruents which surface as voiceless as the second member of a cluster must be underspecified for [\pm voice] underlyingly. In isolation, they receive their voicing in initial position through the requirement of onset voicing.

- | | | | | | | |
|---------|----------|---|-------|---|------------------------|-----------------------|
| (23) a. | unačypaš | + | ba:k | → | unačypa ʒ ba:k | |
| | luggage | | boat | | ‘boat luggage’ | |
| b. | unačypaš | + | bənak | → | unačypa ʃ pənak | |
| | luggage | | any | | ‘any luggage’ | |
| c. | urmi:s | + | bənak | → | urmi:spənak | |
| | a month | | any | | ‘any month’ | (Ternes, 1970: 70ff.) |

In (24a–d) more examples of the same pattern are given. The initial obstruent of the second word surfaces with the same voice specification as a preceding obstruent in (24a,b), and it retains its voicing specification in (24c,d). I will assume that the respective obstruent in (24a,b) /T/ is underspecified for voice underlyingly, and the

⁶ This constraint is nothing but a more technical version of Lombardi’s (1999 and elsewhere) AGREE constraint or Gnanadesikan’s (1997) ASSIM, incorporating these into the general faithfulness family and providing a unified source for assimilation phenomena in other domains as well.

(27) Voicing of underspecified obstruents

i.	/Pənak/	IDENTONSET[voice]	ONSETVOICING	*[+voice]
a.	pənak	(*)	*!	
☞ b.	bənak	(*)		*
ii.	/pen/			
☞ c.	pen		*	
d.	ben	*!		*

The question now arises whether the surface realizations of the underspecified segments incur IDENT[voice] violations or not. On the one hand, all output forms of an underspecified input have a voice specification. From this point of view, all outputs of underlying /P, T, K.../ violate the identity constraint. On the other hand, one could argue that if there is no specification in the input there is nothing to compare the output with; this means that surface forms of underspecified elements cannot violate the respective identity constraint. For an argumentation for the latter view see Krämer (1998). In this study it makes no difference whether these violations (if existing) are counted or not.

The basic idea to capture progressive devoicing in this account is that if an underspecified obstruent is preceded by another obstruent, the latter is devoiced due to final devoicing, and the second segment (the underspecified one) acquires the negative voice specification in satisfaction of S-IDENT, because it has no underlying voice specification to be maintained to satisfy IDENTONSET[voice], the constraint which is responsible for regressivity of assimilation elsewhere. This goal is not achieved yet. Under the analysis developed so far (given in 28), one still cannot account for the emergence of voiceless clusters, as illustrated in (29).

(28) S-IDENT >> IDENTONSET[voice] >> ONSETVOICING >> *[+voice]

(29) Assimilation combined with devoicing based on simple markedness
 unačypašpənak ‘any luggage’

/...š+P.../	S-IDENT	IDENTONSET *[+voice]	ONSET VOICING	*[+voice]
☉ a. ...ž.b...				**
☹ b. ...š.p...			*!	
c. ...ž.p...	*!		*	*
d. ...š.b...	*!			**

In this tableau, ☉ indicates the optimal output of this grammar and ☹ shows the candidate which is the form actually found in Breton. The undesired emergence of a voiced cluster in (29) is an effect of the ranking of ONSETVOICING above simple markedness, which was motivated above. If *[+voice] were ranked above OV, no onset voicing would ever be observed in Breton, so the ranking of OV above *[+voice] is essential. Unfortunately, the desired candidate loses because it violates ONSETVOICING, which is satisfied by the candidate with voiced obstruents.

The emergence of voiceless clusters in such cases was attributed to final devoicing. In derivational terms final devoicing feeds assimilation. Analysing final devoicing as the interaction of IDENTONSET[voice] and *[+voice] is not sufficient in this context. Another solution is that Final Devoicing occurs to satisfy a local conjunction of two constraints like NOCODA or ALIGNR(prosodic word, vowel) (which demands that every prosodic word ends in a vowel) and *[+voice].

(30) FINALDEVOICING (FD) Local Conjunction:
 {NOCODA & *[+voice]}; Domain: segment.

This complex markedness constraint is violated iff both simple markedness constraints of which it is conjoined are violated by the same segment, as was the case with the local conjunction of ONSETVOICING and ALIGNL in (14). The important point is now that this local conjunct can be ranked with respect to the constraint on onset voicing, which was not possible with the simple markedness/positional faithfulness account of final devoicing. An appropriate grammar for Breton voicing alternations, in which final devoicing is more important than onset voicing is formulated in (31), which is illustrated by tableaux (32) and (33).

(31) S-IDENT >> IDENTONS[voice] >> FINALDEVOICING >> ONSETVOICING >> *[+voice]

(32) Evaluating *unačypašpənak* ‘any luggage’

	/š+P/	S-IDENT	IDENTONS [voice]	FD	OV	*[+voice]
a.	žp	*!		*	*	*
b.	šb	*!				*
c.	žb			*!		**
☞ d.	šp				*	

(33) Evaluating *unaypazba:k* ‘boat luggage’

	/š+b/	S-IDENT	IDENTONS [voice]	FD	OV	*[+voice]
☞ a.	žb			*		**
b.	šp		*!		*	
c.	žp	*!		*	*	*
d.	šb	*!				*

As argued in 3.1, ONSETVOICING has to rank below IDENTONSET[voice] to avoid that all onsets surface as voiced. Furthermore, ONSETVOICING has to rank above *[+voice] to trigger onset voicing. The constraint responsible for final devoicing has to rank above ONSETVOICING. If this were not the case, onset voicing would apply to the underspecified onsets and all these clusters would surface as voiced. This is the most compelling reason why a positional markedness constraint for final devoicing in Breton has to be assumed at all. Thus, FINALDEVOICING ranks above ONSETVOICING, whereas *[+voice] ranks rather low in the hierarchy.⁷ Now, one could suspect that IDENTONSET[voice] is not necessary anymore. Why refer to both, onsets and codas? Unfortunately, the data cannot be analysed only with the simpler IDENT[voice] ranked between FINALDEVOICING (to account for final devoicing) and ONSETVOICING (to account for voiceless onsets). This ranking would lead to a pattern

⁷ Some forms in the tableaux incur violations for both *[+voice] and NOCODA without having a violation of the local conjunction of both constraints. This is because in these cases the two constraints are not violated by the same segment. Since the domain of this local conjunction is the segment the violations in the tableaux (32) and (33) are calculated correctly regarding this matter.

High ranking NoCODA would militate against such a syllabification and favour the candidates in (35f). To avoid this, NoCODA has to rank at least under ALIGNL which would induce a violation mark for the syllabification in (35f).

Such a grammar, however, has a problem with obstruent voicing in front of sonorant nasals and liquids. Breton, in contrast to its sister language Welsh, lacks voiceless sonorants like /t/ or /r/. Sonorants in final position do neither cause voicing assimilation in a following onset obstruent, nor are they devoiced in such environments:

(36) *ərmem + to:l* → *ərmem to:l* ‘the same hit’ (Ternes, 1970: 80)

Thus, the voicing of the final obstruent of *trizek* in (37) must be due to the reasons outlined above for the voicing of consonants preceding vowel-initial words, and it cannot be an effect of voicing assimilation.

(37) *trizek + mi:s* → *trizegmi:s* ‘thirteen month’ (Ternes, 1970: 79)

The tableau in (38) illustrates that the Breton grammar which has been set up so far does not account for the data in (36) and (37).

(38)

/trizek # mi:z/	ONSET	A&OV	IDENT ONS [voice]	FD	OV	ALIGNL	NoCODA
● a. <i>trizek.(#mi:s</i>							*
b. <i>trizeg.(#mi:s</i>				*!			*
c. <i>trize.(k #mi:s</i>		*!			*	*	*
⊗ d. <i>trize.(g #mi:s</i>			*!			*	*

We need a mechanism that ensures that the stem-final obstruent is syllabified as the onset of the following sonorant-initial item. Consider in this respect that Venne-mann (1988: 40) formulated the syllable ‘contact law’, as given in (39).

(39) Contact Law:⁸

A syllable contact A^sB is the more preferred, the less Consonantal Strength the offset A and the greater the Consonantal Strength of the onset B; more pre-

⁸ Zec (1995: 92) formulates nearly the same in her ‘constraint on moraic structure’. According to this constraint, a root node r_i is moraic only if it is more sonorous or equally sonorous than the following root node r_j .

(i) μ
|
 $r_i r_j$ Sonority (r_i) \geq Sonority (r_j)

cisely – the greater the characteristic difference CS(B)–CS(A) between the Consonantal Strength of B and that of A.

This means that the end of a syllable should be more sonorant than the beginning of the next. This contact law explains quite elegantly why in German, in which complex codas are allowed, a word like *Tatra* or the proper name *Petra* are syllabified as [ta.tra] and [pe.tra] respectively (and not **tat.ra*, **pet.ra*), in contrast to words like *Wartha* surfacing as [var.ta]. In Breton, this contact law or contact constraint causes syllabification of word-final obstruents into the onset of the next word. If the latter starts with a more sonorous segment, this syllabification avoids increase in sonority from one syllable to the next. An optimality-theoretic reformulation of (39) as a markedness constraint is given in (40).

(40) Syllable Contact Constraint (CoCo):

Given two adjacent segments Seg₁ and Seg₂ in different syllables, the sonority degree of Seg₁ should not be lower than the degree of sonority of Seg₂.
 ($\{\forall(\text{Seg}_1 . \text{Seg}_2) \rightarrow \text{sonority Seg}_1 \geq \text{sonority Seg}_2\}$)

The contact constraint (CoCo) is ranked above ALIGNL(stem, PWd) and below or equally high as the faithfulness constraint guarding the feature [\pm sonorant]. Otherwise no syllabification of word-final obstruents into following onsets would be observed and the obstruent would probably change into a sonorant, which is not the case either. Additionally, the contact constraint has to rank above IDENTONS[voice]. The voicing of stem-final obstruents in the onset of the following word which is induced by A&OV, is a violation of the positional faithfulness constraint, which seems to weigh less than having a wellformed syllable contact (compare candidates a and d in 41).

(41) IDENT[sonorant], A&OV, CoCo >> IDENTONS[voice], ALIGNL(stem, PWd)

/trizek # mi:z/	IDENT[son]	A&OV	CoCo	IDENTONS [voice]	ALIGNL
a. trizek.(#mi:s			*!		
b. trizeŋ.(#mi:s	*!				
c. trize.(k #mi:s		*!			*
☞ d. trize.(g #mi:s				*	*

The tableau in (41) illustrates the effect of the contact law in Île de Groix Breton. Candidate (a) is the most faithful one. Additionally, it perfectly aligns morphological and prosodic boundaries. It is ruled out for violating CoCo, because it has a less sonorous segment in the end of the second syllable (the *k*) than in the beginning of the third (the *m*). Candidate (b) avoids this by transforming the *k* into its sonorant

counterpart η , thus incurring a violation of IDENT[son]. Candidate (c) is out for violating A&OV, the local conjunction of ALIGNL(stem, PWd) and the constraint ONSETVOICING, which causes voicing of onsets in case of morpho-prosodic misalignment. Only candidate (d) remains, which obeys all high ranking constraints, but violates low ranking ALIGNL (and is unfaithful to [voice]).

According to the line of thought pursued here, the morpheme-final obstruents in Île de Groix Breton are syllabified into the following word (and surface as voiced in obedience of A&OV) in order to provide a better onset for that syllable with regard to the offset of the preceding one.

4.3. Consequences for the analysis of assimilation

Every sound segment of human language has a degree of sonority. On the sonority hierarchy, voiceless obstruents are less sonorous than voiced obstruents. Voiced obstruents in turn are less sonorous than sonorants (nasals and liquids). The latter are less sonorous than vowels. A voiceless obstruent in a syllable offset preceding a voiced obstruent in a syllable onset violates the syllable contact constraint, because sonority increases from the offset to the onset, while it should decrease or remain stable. The escape from this violation is an alternative violation of FINALDEVOICING. In this case, the obstruent in coda position raises its sonority to the sonority level of the following voiced obstruent by surfacing as voiced. This is exactly what happens in regressive assimilation. Canonic voicing assimilation is an effect of the syllable contact constraint. The necessity of this constraint was motivated in 4.2, and elsewhere in the literature (Vennemann, 1988; Zec, 1995). If this constraint also causes the effects which are generally attributed to a particular agreement or identity constraint on obstruents, we can abandon the latter in favour of the more general one. Tableau (42) evaluates canonical, i.e. regressive, assimilation with two prespecified segments involved. The grammar relies on the ranking motivated in the preceding sections. The tableau shows that the only task of the assimilation constraint is to rule out candidates (42a and 42f). These additionally violate the high ranking contact constraint (42a) and IDENTONS[voice] (42f). I conclude that to account for these data an assimilation constraint makes the grammar unnecessarily redundant.

(42) Regressive assimilation: CoCo >> IDENTONS[voice] >> FD

/ unačypaš # ba:k /	S-IDENT	A&OV	CoCo	IDENTONS [voice]	FD	OV	ALIGNL
a. ...paš (#ba:k)	*		*!			*	
b. ...paš (#pa:k)				*!		*	
c. ...pa.(š#pa:k)		*!				*	*
d. ...paž (#ba:k)					*	*	
e. ...pa.(ž#ba:k)				*!		*	*
f. ...paž (#pa:k)	*			*!	*	*	

The assimilation pattern where an underspecified onset and an underlyingly voiced coda are involved show that ALIGNL has to rank above ONSETVOICING. Otherwise candidate (43d) would be the winner in tableau (43). This candidate has syllabified the morpheme-final obstruent into the next prosodic word, where it can surface faithfully to its underlying specification and escapes final devoicing.

(43) FD feeds progressive assimilation: FD, ALIGNL >> ONSET VOICING

/mi:z # Pənak/	S-IDENT	A&OV	CoCo	IDENTONS	FD	ALIGNL	OV
a. mi:s(#bənak	*		*!				
b. mi:.(s#pənak		*!		*		*	*
☞ c. mi:s(#pənak							*
d. mi:.(z#bənak						*!	
e. mi:z(#bənak					*!		
f. mi:z(#pənak	*				*!		*

In the evaluation in (43), the task of excluding nonagreeing clusters is an effect of the contact constraint (43a) and the constraint on final devoicing (43f).

To account for morpheme-internal regressive assimilation, the additional constraint *COMPLEX, which militates against complex onsets and complex codas likewise has to be taken into consideration. This constraint ranks between the contact constraint and faithfulness to voicing specifications. This prevents syllabification of all members of a cluster into one syllabic position in order to escape violation of the syllable contact constraint and causes voicing of the first segment in a cluster if the second is voiced.

5. Conclusions

Advocates of privative features (Lombardi, 1995c; Steriade, 1995, among many others) could object that, due to the ternary distinction shown in this paper, the features active in Breton are something like the uni-valued [spread glottis] and [constricted glottis] which together constitute a ternary distinction in, e.g., Korean (Kim, 1970; Iverson and Salmons, 1995). First, it must be recognised that in such a case one would expect minimal pairs for [spread glottis], [constricted glottis] and no specification for either spread glottis nor constricted glottis. Such minimal pairs have not been found yet in Île de Groix Breton. In fact, the language distinguishes three

degrees of aspiration (Ternes, 1970: 11f.), unaspirated, slightly aspirated and aspirated among voiceless plosives, but these are not phonemic. They are predictable, with aspiration being the default case. Second, a phonetic difference between [spread glottis], [constricted glottis] and absence of either feature should be audible in the examined cases. This is not the case either. With a ternary distinction based on a binary feature as assumed here, the underspecified segments become either minus- or plus-valued on the surface to satisfy markedness constraints (i.e. *[+voice], and Final Devoicing), or other demands (i.e. Onset Voicing). Such a twofold surface distinction could be provided by one privative feature. If we assume that this feature is [voice], all voiceless plosives should be underspecified underlyingly (and on the surface), being then subject to Onset Voicing on the surface. Dispensing with the constraint on Onset Voicing would mean that the different behaviour of the different voiced onsets in clusters cannot be accounted for anymore. Why do some devoice in a cluster, while some impose their voice value on the whole cluster? On the other hand, if the relevant feature would be [spread glottis], all voiceless plosives would be specified underlyingly (and on the surface). In that case, the analysis would at least account for the emergence of voiceless plosives, but again the different behaviour of voiced obstruents could not be explained. How can the absence of a feature (the correlate of [+voice] in this analysis) be inherited by a cluster containing also a salient feature [spread glottis]? Furthermore, under such an analysis, the need would arise to explain Final Devoicing in this language in a different way than in all other languages which display this phenomenon, i.e. as ALIGNR(σ [spread glottis]) or something equivalent.

Within the framework of Optimality Theory, it has been shown here that the Breton data can be accounted for adequately with the assumption of complex markedness constraints, positional faithfulness and the anchoring/alignment of edges of phonological and morphological categories. A constraint whose sole purpose it is to demand assimilation is not required to account for the Breton data. Thus, a typology of voicing alternations must consider more variables than was previously assumed (see e.g. work by Lombardi).

The argument that both positional markedness as well as positional faithfulness are needed can be summarised as follows. If final devoicing in Breton were due to the interaction of positional faithfulness with simple markedness, all clusters with an underspecified second member would be predicted to surface as voiced. The constraint on onset voicing has to rank above simple markedness to show any effect at all. In such a grammar, one would have no reason to assume underspecification, because all assimilation patterns would be regressive. Dispensing with positional faithfulness in favour of positional markedness would predict progressive devoicing assimilation only, because in this scenario the final devoicing constraint has to be ranked above the simple identity requirement to capture final neutralisation. This is obviously not the case in Breton. Therefore, both types of positional constraints are indispensable.

The account given in this paper provides an explanation of a typological observation which Lombardi's (1999) onset-based account cannot capture: In languages without final devoicing like Mekkan Arabic (Gnanadesikan, 1997) or Ukrainian

(Butska, 1998), assimilation is regressive throughout (an exception is Swedish, see Lombardi, 1999: 285f.), whereas in languages displaying final devoicing, the direction of assimilation may be reversed under certain circumstances. The ranking of the constraint on final devoicing above IDENTONSET[voice] yields progressive devoicing. This pattern is found in Dutch clusters consisting of a stop plus a fricative or of two fricatives. Grijzenhout and Krämer (1998) attribute this to the relatively high ranking of the constraint on final devoicing and a splitting-up of faithfulness constraints into an identity constraint of stops in onset position and general faithfulness. A case where progressive devoicing is found consistently is Colloquial German (see Kleinhenz, 1998: 138, for a discussion within a rule-based account, or Kohler, 1977). In this variety of German, clusters of a voiceless or devoiced obstruent followed by an underlyingly voiced obstruent are entirely devoiced. This can be explained by the ranking of positional markedness above (positional) faithfulness.

What is most intriguing is the role of prosody and sonority in voicing alternations. The assumption that voicing assimilation is an effect of sonority requirements on syllable structure still has to be confirmed cross-linguistically. If further research shows that voicing assimilation in general is not triggered by an assimilation constraint, but by wellformedness constraints on adjacent syllables, then the question raised by Lombardi (1999: 299) is resolved. She asks why it is only the feature [voice] which is subject to assimilation, while assimilation of the other laryngeal features (aspiration and glottalisation) is rare or nonexistent. The latter do not contribute to the sonority degree of a segment or syllable position while the feature [voice] does. Therefore, only this feature can be subject to alternations in satisfaction of sonority constraints on syllabic structure.

References

- Beckman, J.N., 1997. Positional faithfulness, positional neutralisation and Shona vowel harmony. *Phonology* 14, 1–46.
- Butska, L., 1998. Faithfulness to [voice] in Ukrainian: An analysis of voicing alternations within Optimality Theory. *RuLing Papers* 1. Rutgers University, 59–73.
- Gnanadesikan, A.E., 1997. Phonology with ternary scales. Ph.D. dissertation, GLSA: University of Massachusetts, Amherst.
- Golston, C. and W. Kehrein, 1999. Laryngeal contrasts. Ms., California State University and Philipps University Marburg.
- Grijzenhout, J. and S. Joppen, 1998. First steps in the acquisition of German Phonology: A case study. Working papers Theorie des Lexikons 110, Heinrich-Heine-Universität Düsseldorf.
- Grijzenhout, J. and M. Krämer, 1998. Final devoicing and voicing assimilation in Dutch: The interaction of alignment and featural identity. Working papers Theorie des Lexikons 106, Heinrich-Heine-Universität Düsseldorf.
- Hall, T.A., 1997. The phonology of coronals. Amsterdam: Benjamins.
- Hayes, B., 1995. *Metrical Stress Theory: Principles and case studies*. Chicago, IL: University of Chicago Press.
- Hemon, R., 1995. *Breton grammar*, 10th edition. Translated and revised by Michael Everson. Dublin: Everson Gunn Teoranta.
- Inkelas, S., 1994. The consequences of optimization for underspecification. *NELS* 25, 287–302.

- Inkelas, S., O. Orgun and C. Zoll, 1997. The implications of lexical exceptions for the nature of grammar. In: Iggy Roca (ed.), *Derivations and constraints in phonology*, 393–418. Oxford: Clarendon.
- Iverson, G. and J. Salmons, 1995. Aspiration and laryngeal representation in Germanic. *Phonology* 12, 369–396.
- Kim, C., 1970. A theory of aspiration. *Phonetica* 21, 107–116. Reprinted 1988 in *Soujours in language I* (Collected papers by Chin-Wu Kim), 73–82. Seoul: Tower Press.
- Kleinhenz, Ursula, 1998. On words and phrases in phonology: A comparative study with focus on German. Ph.D. dissertation, Berlin.
- Kohler, K.J., 1977. *Einführung in die Phonetik des Deutschen*. Berlin: Schmidt.
- Krämer, M., 1998. A correspondence approach to vowel harmony and disharmony. Working papers Theorie des Lexikons 107, Heinrich-Heine-Universität Düsseldorf.
- Krämer, M., 1999. On the role of prosodic and morphological categories in vowel harmony and disharmony: A correspondence approach. In: Tina Cambier-Langeveld, Anikó Lipták, Michael Redford and Erik Jan van der Torre (eds.), *ConSOLE VII Proceedings*, 183–199. Leiden: SOLE.
- Ladefoged, P. and I. Maddieson, 1996. *The sounds of the world's languages*. Oxford: Blackwell.
- Lombardi, L., 1991. Laryngeal features and laryngeal neutralization. Ph.D. dissertation, University of Massachusetts, Amherst. Published in 1994 by Garland, New York.
- Lombardi, L., 1995a. Why place and voice are different: Constraint interaction and featural faithfulness in Optimality Theory. Ms., University of Maryland, College Park.
- Lombardi, L., 1995b. Restrictions on direction of voicing assimilation: An OT account. *University of Maryland Working Papers in Linguistics* 3, 89–115. (cit. op ms. version 1998)
- Lombardi, L., 1995c. Laryngeal features and privativity. *The Linguistic Review* 12, 35–59.
- Lombardi, L., 1999. Positional faithfulness and voicing assimilation in Optimality Theory. *Natural Language and Linguistic Theory* 17, 267–302.
- Lubowicz, A. 1998. Derived environment effects in OT. Ms., University of Massachusetts, Amherst.
- McCarthy, J. and A. Prince, 1993. Generalized alignment. In: G. Booij, J. van Marle (eds.), *Yearbook of morphology*, 79–153. Dordrecht: Kluwer.
- McCarthy, J. and A. Prince, 1995. Faithfulness and reduplicative identity. *University of Massachusetts Occasional Papers in Linguistics* 18, 249–384.
- Press, I., 1986. *A grammar of Modern Breton*. Berlin: Mouton de Gruyter. (First published in 1947.)
- Prince, A., 1980. A metrical theory for estonian quantity. *Linguistic Inquiry* 11, 511–562.
- Prince, A. and P. Smolensky, 1993. *Optimality theory: Constraint interaction in generative grammar*. Ms., Rutgers University, New Brunswick, NJ, and University of Boulder. Boulder, CO.
- Selkirk, E., 1980. Prosodic domains in phonology: Sanskrit revisited. In: M. Aronoff, M. Kean (eds.), *Juncture*, 107–129. Saratoga, CA: Anma Libri.
- Selkirk, E., 1995. The prosodic structure of function words. In: J. Beckman, L. Walsh Dickey S. Urbanczyk (eds.), *University of Massachusetts Occasional Papers 18: Papers in Optimality Theory*, 439–470. GLSA, University of Massachusetts, Amherst.
- Smolensky, P., 1993. Harmony, markedness, and phonological activity. Paper presented in October at Rutgers Optimality Workshop-1 at Rutgers University: New Brunswick, NJ.
- Smolensky, P., 1995. On the internal structure of the constraint component of UG. Colloquium presented at University of California: Los Angeles, April 7, 1995.
- Steriade, D., 1995. Underspecification and markedness. In: J. Goldsmith (ed.), *The Handbook of Phonological Theory*, 114–174. Cambridge, MA: Blackwell.
- Ternes, E., 1970. *Grammaire structurale du Breton de L'Île de Groix (dialecte occidental)*. Heidelberg: Carl Winter Universitätsverlag.
- Vennemann, T., 1988. Preference laws fore syllable structure and the explanation of sound change. Berlin: Mouton de Gruyter.
- Zec, D., 1995. Sonority constraints on syllable structure. *Phonology* 12, 85–129.
- Zoll, C., 1998. Positional asymmetries and licensing. Ms., Massachusetts Institute of Technology.