Evidence for MaxFeature constraints from Japanese* January 1998

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1.Introduction

In some situations in Japanese, there is a parallelism between voiceless geminates and homorganic nasal-voiced stop clusters. For example, in the second column below we see intensified abverbs that have been argued to be derived from the indicated bases (compare to the reduplicated forms in the last column, for example):

(1)

a. /uka/	ukkari 'thoughtlessly'	ukauka 'thoughtlessly'
b. /zabu/	zamburi 'with a splash'	zabuzabu 'splashingly'

Intensification is indicated by gemination of a voiceless stop, as we see in (1a). But in the parallel example in (1b), which has a voiced stop, we see a nasal-consonant cluster. This is clearly related to the fact that voiced geminates are prohibited in Japanese: the only possible clusters are voiceless geminates and homorganic NC.

In autosegmental theory, this alternation is rather troubling. Previous analyses (McCawley 1968, Kuroda 1965) have suggested that there is first gemination of the voiced stop, and then the first half of the geminate changes to a nasal. But the latter operation seems totally stipulative. Delinking and spreading are the mechanisms that autosegmental theory employs to analyze feature-changing alternations, and there is no way to derive the nasal consonant by spreading from anything in the context; nor can we argue that some kind of delinking would give coda nasals in any straightforward way. Thus the nasalization operation requires an otherwise unattested kind of rule that inserts the feature [nasal].

Further, although perhaps we could just recognize such a feature-insertion rule type, a bigger generalization is missed by this type of analysis. The nasal insertion rule is clearly part of a conspiracy to enforce the syllable structure constraints, such as the ban on voiced geminates. This rule-based analysis does not capture the connection between the syllable structure constraints of Japanese and the rules enforcing them.

The latter problem is one that OT is designed to answer, and thus the OT approach will be adopted here. I will show that these alternations can be derived from the interaction of well-attested basic constraints. The additional theoretical interest of this analysis will be to show that this alternation provides additional support for the existence of MaxFeature constraints (Lombardi 1995a, Causely 1996, LaMontagne and Rice 1995, Walker 1997) withing Correspondence Theory (McCarthy and Prince 1995). Data throughout, unless otherwise specified, is from Aoki 1981, McCawley 1968, Kuroda 1965, and checked with a native speaker.

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2.Background

Ito (1986) argues that Japanese is subject to a Coda Condition on Place:

(2)

$*C]_{\sigma}$

|

Place

This accounts for the fact that the only possible Coda consonants in Japanese are those that are Place-linked to a following onset consonant: that is, Place-agreeing nasal-obstruent clusters and certain kinds of geminate. Ito demonstrates this with the following examples of Japanese words in (3a), and the rearrangement of these syllables in (3b). This shows for example that /p/ can only close a syllable when it is linked to a following onset /p/:

(3)

a.		b.	
kam.pai	'cheers'	*kap.toot	
sek.kan	'soap'	*sek.pa	
gak.koo	'school'	*kap.sek	
kap.pa	'legendary being'	*te.gak	
tos.sa	'impulsively'		
toot.te	'passing'		

Much subsequent work has adopted some version of this constraint, including work in OT; for the latter see especially Ito and Mester 1994, and Lombardi 1995, which demonstrates that an explicit Coda Condition constraint on Place must exist but that coda effects on Voice have a different analysis.

I will thus assume this constraint in the following. I will also assume without further discussion that there are constraints on what doubly linked structures are permissible. For example, we will see that Japanese allows voiceless obstruents and nasals to be geminate, but not voiced obstruents or sonorants. I assume that these are separate rerankable constraints, as I know of no clear evidence on a relationship among these requirements aside from the fact that voiceless obstruents are less marked than voiced obstruents, as we would expect from the fact that single voiceless obstruents are less marked than voiced. (See Taylor 1985, Jaeger 1978 for some statistics, not entirely consistent with one another, on the cross-linguistic distribution of different geminates.) It is also clear that a nasal that shares Place with a following consonant, usually a stop, is an unmarked type of consonant cluster (see Padgett 1991, 1994 for some discussion); I will assume without further detail that whatever constraint ranking makes this linking possible, and indeed the only possible linking aside from geminates, is part of the grammar of Japanese.

Japanese is also well known to have several strata of vocabulary, similar to the Germanic/Latinate division in English, which have different phonological properties (see Ito and Mester 1995, Fuzakawa 1997 for OT treatments). Both the intensive abverbs and the verbal morphology which are the subject of this paper are part of the native or Yamato stratum, so that these differences will not be relevant. A few minor details of Yamato phonology that will be also be seen in the data are the following:

1. Single /p/ is forbidden in the native stratum; this results in [h~pp] alternations as we see with

the following ma- prefix, which induces gemination:

hadaka ‘naked’ mappadaka

2. Postnasal obstruents must be voiced.

3. Finally, both geminate /r/ and /nr/ clusters are forbidden; thus /r/ will show no change in gemination environments.

I will be assuming privative Voice in this analysis; see Lombardi (1995a) for an argument within OT for privative Voice (as well as additional evidence for MaxVoice). I will of course also be assuming Correspondence Theory (McCarthy and Prince 1995).

3. Intensified adverbs

Intensified adverbs show a suffix -ri and modification of the medial consonant of the base. Note that not all intensified adverbs have attested reduplicated or plain adverb forms, but enough do that the general assumption is that they are derived from a base like that in the final column.

(4)

Intensified	Reduplicated	Adverb	Base
Voiceless			
batttari ‘with a bang’	batabata ‘noisily’	batari	bata
kotteri ‘densely’	kotekote ‘thickly’		kote
kossori ‘steathily’	kosokoso ‘sneakingly’		koso
kiccˇiri ‘tightly’	kičikiči ‘closely packed’		kiči
bisˇsˇiri ‘closely’	bišibiši ‘rigorously’		biši
hukkuri ‘plump,puffy’	hukuhuku ‘bulging’		huku
gakkuru ‘collapsingly’	gakugaku ‘wobbly’		gaku
ukkari ‘thoughtlessly’	ukauka ‘thoughtlessly’		uka
yappari/yahari ‘nevertheless’			
Voiced			
zamburi ‘with a splash’	zabuzabu ‘splashingly’	zaburi	zabu
šombori ‘sadly’	šobošobo ‘blearily’		šobo
manjiri ‘a wink of sleep’	majimaji ‘blinkingly’		maji
koŋgari ‘brown’			koga
Sonorants			
bonyari ‘absently’	boyaboya ‘dreamily’		boya
yamwari ‘gently’	yawayawa ‘softly’		yawa
gennari ‘fed up’			gena
simmiri ‘softly’			simi
furari ‘swaying’			fura

(Note also that koŋgari goes to koŋŋari by later rules affecting medial angma in at least some circumstances. See Mester and Ito 1996 for an OT analysis.)

In this section I will deal only with the behavior of obstruents; sonorants present additional

issues which will be dealt with in section 5.

As we saw above, the only possible clusters in Japanese are voiceless geminate, nasal geminate, and Place-linked nasal-obstruent. As previous analysts have pointed out, the intensified adverbs show clearly that there is a parallel between the geminates and the NC clusters; we need an analysis that will derive adverbs with geminates from voiceless or nasal, and adverbs with NC from voiced obstruents:

(5)

bata+ri -> battari
zabu+ri -> zamburi

The exact form of the constraint enforcing morphological gemination in these adverbs, which I will call Intens, is beyond the scope of this analysis. I assume that it either requires the syllable to be heavy or else calls for gemination directly; the only difference this will make is whether we must give a ranking that will rule out candidates that attempt to make the syllable heavy by vowel lengthening, and to be conservative I will do so. Intens must outrank Dep Mora, since all the optimal candidates add a mora:

(6) Intens: The first syllable of an intensified adverb must be heavy.
(7) DepMora: Penalizes adding a mora.

(8) Intens >> DepMora

/basa+ri/	Intens	DepMora
basari	*!	
☞baCsari		*

Intens must also outrank DepSeg, since voiced-consonant cases add both a mora and a consonantal root node:

(9) DepSeg: Penalizes adding a segment.

(10) Intens >> DepMora, DepSeg

/nobi+ri/	Intens	Dep, DepMora
nobiri	*!	
☞nombiri		* *

If Intens is a syllable weight requirement rather than a consonant gemination requirement, we must also ensure that faithfulness to vowel length is ranked above DepSeg:

(11) FaithVLength>>DepSeg

/nobi+ri/	FaithVLength	DepSeg
noobiri	*!	
☞nombiri		*

So far then, the inserted segment that satsifies Intens must be a consonant. CodaCond ensures that it will be a Place-linked consonant:

(12) (CodaCond unviolated)

/basa+ri/	CodaCond
bat.sari, bap.sari, bam.sari....	*!
banzari	
bassari	

As this tableau shows, a NC cluster would also satsify CodaCond. (The cluster has to be voiced, since in this stratum the constraint requiring postnasal voicing is unviolated.) But it would require insertion of additional features, which will violate faithfulness. I will assume that the constraint DepNas is what is crucial, although other features change as well:

(13) DepNas: Penalizes adding the feature [nasal]

In some cases DepNasal will be violated in optimal candidates, but not in an example like the following where the underlying consonant is voiceless. Here we can satisfy all the high-ranked constraints without inserting additional features:

(14) Intens, FaithVLength,CodaCond >> DepNas, Dep

/basa+ri/	Intens	FaithVLength	CodaCond	DpNas	Dep
basari	*!				
bap.sari,etc			*!		
baasari		*!			
banzari				*!	*
☞bassari					*

Only (d) and (e) satisfy the high-ranked constraints. (d) with the NC cluster violated DepNas, and (e) with gemination does not. Thus, no matter how we rank the lower-ranked constraints,

gemination will be optimal for this input.[1]

If we examine a form with a voiced obstruent, however, additional constraints come into play which force violation of DepNas. The geminated candidate is ruled out by an unviolated constraint against voiced obstruents in Japanese. Thus, nasalizing the coda consonant is the optimal choice.

(15) NoVoicedGem unviolated

/nobi+ri/	NoVoicedGem	DepNas
nobbiri	*!	
nombiri		*

But we need to consider additional candidates as well. Since voiceless obstruents can be geminate, why not geminate and devoice?

(16)

/nobi+ri/	NoVoiced Gem	DepNas
a. nobbiri	*!	
b. nombiri		*!
☹c. noppiri		

As we see, so far the constraint ranking gives the incorrect result that candidate (c) is optimal, so something must be missing. What this shows is that faithfulness to voicing is critical. It is more important to preserve the underlying voicing distinction than to avoid nasalization. Thus, MaxVoice must outrank DepNas.

(17) MaxVoice: A Voice autosegment in the input must be present in the output

(18) MaxVoice >> DepNas

/nobi+ri/	NoVoicedGem	MaxVoice	DepNas
a. nobbiri	*!		
☞b. nombiri			*
c. noppiri		*!	

[1](d) also has an additional violation of DepSeg. However, comparison to the verbs shows that it is the ranking of DepNas that is crucial; see tableau (27) for /yob+ta/ below, where neither candidate has a DepSeg violation.

With this additional ranking, we get the correct effect: (b) is now optimal instead of (c). Thus, we have achieved the desired analysis: in the intensified adverb, voiceless obstruents geminate and voiced obstruents have NC counterparts.

A couple of final points. First, recall that the intensified adverbs are in the Native/Yamato vocabulary and are thus subject to the unviolated postnasal voicing constraint. This means that whenever the coda is nasal, the following obstruent must be voiced. Nevertheless, the postnasal voicing requirement (PNV below) cannot do the work of MaxVoice in this analysis. By itself it would not allow the correct choice between voiceless obstruent and NC, as we see from the incorrect outcome in the following tableau:

(19)

/nobi+ri/	NoVoiced Gem	PNV	DepNas
nobbiri	*!		
nombiri			*!
nompiri		*!	
☹noppiri			

Second, note that although I use the constraint MaxVoice above, it appears in this case that an Ident constraint would have the same effect, as the reader can confirm. However, the behavior of verbs in the following section will show that MaxFeature formulation is neccesary.

(20)

Final ranking: Intens, FaithVLength, CodaCond, NoVoicedGem >> DepNas, DepSeg, DepMora
MaxVoice >> DepNas

3. Verbal paradigms

The verbal paradigm also shows the action of most of the constraints proposed for the intensified adverbs, as I will show, and some additional points of interest. I give the present and part tense morphemes as representative. The present tense /u/ allows us to see the underlying final consonant of the root in unmodified form. The first two examples, which are vowel-final roots, allow us to see the underlying form /ta/ of the past tense ending, which shows a surface alternation ta~da.

(21)

Root	present	past	
a. mi	miru	mita	look at
tabe	taberu	tabeta	eat
b. kam	kam	kanda	chew
yom	yomu	yonda	read
sin	sinu	sinda	die
c. tob	tobu	tonda	fly

yob	yobu	yonda	call
ukab	ukabu	ukanda	float
d. kag	kagu	kaida	sniff
tog	togu	toida	sharpen
e. kak	kaku	kaita	write
tok	toku	toita	solve
f. kas	kasu	kasita	lend
g. kat	katsu	katta	win
mat	matsu	matta	wait
h. agar	agaru	agatta	rise
hair	hairu	haitta	enter
kar	karu	katta	cut
i. nuw	nuu	nutta	sew
kaw	kau	katta	buy

As we see from this data, the verb paradigm also shows a relationship between voiceless geminate and voiced NC. In this case, though, the clusters arise through morpheme concatention, rather than through a constraint like Intens that has the effect of adding an additional consonant position. Thus the clusters undergo assimilation, and the disposition of their underlying features must be dealt with. I will deal first with the labials and coronals, and then turn to the additional complication of the velars. The rankings already proposed, with a few additions, will account for these data, and give additional evidence for the importance of MaxVoice.

First, we see both place assimilation and postnasal voicing in these data, in (21b). The PNV constraint is never violated in this stratum, showing the constraint ranking PNV >> DepVoice.

(22) PNV: Postnasal obstruents must be voiced.
(23) DepVoice: A Voice autosegment in the output has a correspondent Voice in the input.

(24) PNV >> DepVoice

/sin+ta/	PNV	DepVoice
sinta	*!	
sinda		*

Place assimilation is regressive, as it usually is cross-linguistically. I assume that this is due to differential faithfulness for consonant features in onset and elsewhere (Padgett 1995, see also Beckman 1997, Lombardi 1995b. Note that although Padgett argues that we need a constraint specifically enforcing nasal place assimilation, I see no evidence for it in these data - the Coda Constraint appears to ensure assimilation on its own.) In this tableau I consider only candidates that obey unviolated PNV.

(25)

/yom+ta/	CondCond	MaxOnsPlace	MaxPlace
yomda	*!		
yonda			*
yomba		*!	*

Note also that MaxSeg and DepSeg must outrank faithfulness to Place and to Voice, as we do not see consonant deletion or vowel epenthesis to eliminate CodaCond or PNV violations. With these rankings, cases that show PNV and/or Place assimilation only are accounted for.

The most interesting cases for the present purpose are the voiced obstruent -final roots, as here we see a somewhat unusual case of faithfulness to voicing. The alternation tob+ta -> tonda looks rather unusual, but the rankings established so far will give this as the optimal output. (I deal first with the labials as the velars have additional complications.)

First, recall that CodaCond is unviolated. Thus the optimal candidate must have some kind of doubly linked cluster:

(26) yob+ta: CodaCond-obeying candidates:
yotta, yobba, yodda, yonda, yomba, yompa, yonta

We can rule out several candidates strightforwardly. Candidates yompa, yonta are eliminated by unviolated PNV; yobba and yodda are eliminated by unviolated NoVoiced Geminate. If there is going to be a change of Place in the cluster, we know that it must be done by regressive assimilation, due to the ranking of Place faithfulness; this eliminates yomba from the competition:

(27)

/yob+ta/	MaxOnsPlace	MaxPlace
yomba	*!	*
yotta		*
yonda		*

The interesting choice, then, must be made between yonda and yotta. The choice is made in favor of yonda due to the ranking MaxVoice >>Dep Nasal that was already established for the intensive adverbs.[2]

[2]Note that although (b) has an additional MaxSeg violation, high ranking of MaxSeg cannot be the solution. It would not make the correct choice for the adverbs, and in any case sonorant-final verbs show that DepNas must outrank MaxSeg (see tableau (42) below.)

(28)

/yob+ta/	MaxVoice	Dep Nas
a. yotta	*!	
☞b. yonda		*

This ranking was established above to ensure the preservation of voicing in the "gemination" process required by intensive adverbs. As we see here, it is also necessary to account for the alternations in the verb paradigm. The [voice] of the underlying /b/ is preserved in the cluster, despite the fact that the segment corresponding to /b/ is changed almost beyond recognition.

With this example we can begin to make the argument for MaxVoice over IdentVoice in this analysis. Ident constraints require that correspondent segments agree in features:

(29) Ident Voice: Correspondent segments must agree in their voicing specification.

This means that if a voiced segment has no output correspondent, there is no pressure from the Ident constraint to preserve the underlying Voice feature. This will not allow the correct optimal output for Japanese, as we see in the following tableau:

(30)

/yob$_1$+t$_2$a/	IdentVoice	Dep Nas
a.☹yotta μ σ \/ y o t$_2$ a		
b. yon$_1$d$_2$a	*	*

Recall that the first candidate must be a true geminate, due to high ranked CodaCond. So in candidate (a) the root-final /b/ has no output correspondent: its mora position has been filled by spreading from the /t/. Thus there is no violation of faithfulness to voicing for any consonant in that candidate. The second candidate, on the other hand, violates both IdentVoice (since /t/ has changed to /d/) and DepNas (since /b/ has changed to /n/.) There is no way to rank these constraints to make the candidate (b) optimal, since (b) violates both and (a) violates neither; this is unfortunate, since (b) is the correct surface form.

Thus, the comparison between tableaus (28) and (30) shows that only MaxVoice, not Ident Voice, allows the analysis to work.[3] MaxVoice is violated by (28a) because there is an

[3]The reader may note that due to unviolated PostNasalVoicing, there may be a way to make Ident work in labial-final cases, if the [voice] of /tob/ is realized on the /n/ of [tonda]. But the velar cases show this cannot be correct: there is no Post-[i]-Voicing constraint to enforce voicing in [kaida]. (Also see section 5 on sonorants and voicing.)

input Voice that does not appear in the output; thus high ranking of MaxVoice allows us to construct the correct grammar for Japanese.

Preservation of voicing is also seen with velar-final roots. The velar is replaced by a vowel, and the voicing of the velar is reflected in the verb ending:

(31) a. kak+ta -> kaita
b. kag+ta -> kagda

What exactly happens to the velar consonant to change to to or replace it with a vowel is somewhat beside the point of the present paper. Whatever it is, it is highly specific to the verbal paradigm. Poser (1986) gives evidence that velar gliding is not a general process of the language. As seen above, it does not occur in intensified adverbs, which are part of the same vocabulary stratum. Poser shows that verb compounds also do not show velar gliding. In verb compounds, some occur either with or without epenthetic /i/. As we see below, there is no velar gliding in what Poser calls the reduced forms, i.e. those without the epenthetic vowel.

(32)

Compound		Verb components of compound		Reduced compound
fukitobasu	'blow away'	fuk 'blow'	tobas 'fly'	futtobu
hikitateru	'support'	hik 'pull'	tate 'stand'	hittateru
tsukidasu	'thrust out'	tsuk 'stab'	das 'put out'	tsundasu

Here, rather than velar gliding, we see the regular gemination/NC phenomena. Note that since these are also verbs, the velar gliding phenomenon can't be accounted for simply by saying something special about the representation of verbs; if for example the final velar is some kind of ghost segment, we still have to treat that segment specially in the verbal paradigm. [4]

The precise analysis of velar gliding, then, has to contend with issues of phonology-morphology interface that are clearly outside the scope of this paper. All that is relevant here is that, whatever enforces velar gliding, the choice between the following two candidates must be made, and MaxVoice will make it:

(33)

/kag+ta/	MaxVoice
a. kaita	*!
b. kaida	

[4] Poser 1986 points that in the dialect of Hachijoojima, there is no velar gliding even in verb conjugation: we see gemination instead. (Also note that voiced geminates are permissible, so there is no nasal insertion.)

watta 'boiled' standard waita
tsudda 'poured' standard tsuida

Note that no rule ordering is needed: we do not need to spread [voice] from the velar prior to deleting it. Rather, faithfulness to the underlying [voice] autosegment allows a nonderivational analysis.

Again, this example allows us to see that due to the way in which Ident constraints are defined, a MaxFeature constraint is required here. Recall that the IdentVoice constraint demands that a surface segment have the same value of [voice] as its underlying correspondent. The obvious correspondence relationships for this form would not allow an Ident constraint to preserve the voicing:

(34) /kag$_1$t$_2$a/ kai$_1$d$_2$a (if /g/ -> [i])
kaid$_2$a (if [i] epenthetic)

The suffix-initial coronal is not in correspondence with the underlying voiced segment in these two candidates, so IdentVoice would not require it to be voiced. An Ident constraint could only begin to do the job if we could somehow force the consonant of the suffix to be correspondent with the verb-final consonant. Presumably what we need is some kind of fusion candidate, since the ending retains most of the features of /t/ as well as the voicing of /g/; so it would have the correspondence relation in (35):

(35) /kag$_1$ t$_2$a/ kaid$_{1,2}$a

It's not clear how to force this to work across all the data, but imagine for a moment that this were somehow the correct structure of the surface form. It turns out that even so, we would need use MaxVoice.

If the ranking were such that fusion of the consonants were optimal, we would still need to choose among candidates that fused the consonants but made different choices about which features to preserve from which underlying segment. In particular we'd need to choose between the two candidates in (36): Both have fused the two consonants, but (a) preserves the voicing of the underlying /g/ while (b) matches with the voicing of the underying /t/. As we see from the violations incurred by these two candidates, if we use IdentVoice, the incorrect voiceless candidate (b) would still be optimal due to markedness:

(36)

	IdentVoice	*Lar
a. kaid$_{1,2}$a	*	*
b. kait$_{1,2}$a	*	

Each candidate violates Ident Voice once: (a) is not faithful to the voicing of the underlying /t/, and (b) is not faithful to the voicing of the underling /g/. Markedness (*Lar) will then decide in favor of the voiceless candidate no matter where it is ranked. We can't rerank the constraints to

get the correct output, since the candidate we want to have win violates both.[5]

Thus, we see that if we use the constraint MaxVoice, as in tableaus (28) and (33), we get the correct result. But if instead we use IdentVoice it is impossible to construct the grammar where [kaida] is optimal. Thus, the Japanese data show that MaxVoice is essential.
It seems that the only thing that could force the fused candidate to win would be the need to be faithful to the [voice] autosegment; the MaxVoice constraint does this directly.[6]

This analysis so far accounts for the behavior of obstruents in both intesified abverbs and the verbal paradigm.[7] I now turn to the behavior of sonorants, which differs in the two cases.

5. Sonorants

A final important question for the MaxVoice constraint is raised by the behavior of sonorants. Geminate non-nasal sonorants are prohibited. But the behavior of sonorants in gemination contexts is different in the intensified adverbs and in the verb paradigm. In the adverbs, sonorants act similarly to voiced obstruents: you get NC clusters (37a). But in the verb paradigm, sonorants (except /r/) undergo total assimilation and result in voiceless geminates (37b):

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[5] Similarly, a fusion candidate and IdentVoice will not allow the correct result for /yob+ta/. Both the fused candidate and (28b) violate IdentVoice. So the additional DepNas violation, whereever it were ranked, would be fatal; there would still be no way to rank to get the correct output (b):

	IdentVoice	DepNas
b. yonda	*	*

m σ
\/
c. yo $t_{1,2}$a *

[6] The reader may note that due to unviolated PostNasalVoicing, there may be a way to make Ident work in labial-final cases, if the [voice] of /tob/ is realized on the /n/ of [tonda]. But the velar cases show this cannot be correct: there is no Post-[i]-Voicing constraint to enforce voicing in [kaida]. (Also see section 5 below on sonorants and voicing.)

[7] For completeness we must consider one last type of form, with a root-final fricative. Unlike all other cases, these undergo epenthesis:

das+ta -> dasita

Clearly faithfulness to some feature of /s/ that it does not share with the other root-final segments must be higher ranked than Dep. It is not Place, as we have seen that Place of obstruents changes. It is unlikely to be [+cont] assuming that /r/ is also [+cont], and /r/ undergoes totally assimilation instead of epenthesis. We can assume that it is [+strident]:

Max[+strident] >> Dep

(/z/ does not occur verb-finally, so we cannot test its behavior.)

(37) a. nuwari -> numbari
b. nuw+ta -> nutta

The occurence of NC clusters in the gemination context was analyzed in section 3 as an effect of MaxVoice. If MaxVoice also applies to sonorant voicing, the ranking already established gives the correct results for adverbs. For example, candidate (38a) below preserves the Place of the onset consonant, which we have seen above is crucial in this language. MaxVoice applying to sonorant voicing would serve to correctly rule it out:

(38) MaxVoice and sonorants:adverbs (To be revised)

/nuwa/	MaxVoice	DepNas
a. nuppari	*!	
b.numwari		*

However, if MaxVoice applies to sonorant voicing in this way we get the wrong result in the verb paradigm. Recall that the verb ending always shows voicing when the final obstruent of the underlying root is voiced. That final stem consonant never appears unaltered, but its voicing is preserved on the suffix consonant:

(39) /tob/ tonda
/kag/ kaida

When the final consonant of the stem is a sonorant, however, its voicing is not preserved: that is, rather than an NC cluster, we see a voiceless geminate:

(40) /nuw/ nutta
/yor/ yotta

If MaxVoice applies to sonorant voicing, we get the wrong result in these cases; sonorant voicing will be preserved by appearing on the verb ending:

(41) MaxVoice and sonorants: verbs (To be revised)

/nuw+ta/	MaxVoice	DepNas
☹nunda		*
nutta	*!	

Comparing tableaus (38) and (41), we appear to have a ranking paradox. We need MaxVoice>>DepNas for obstruents in both verbs and adverbs and for sonorants in the adverbs, but DepNas>>MaxVoice for sonorants in the verb paradigm.

The fact that obstruents always need the same ranking, but sonorants differ in the two

situations, suggests the direction for a solution. Clearly we must retain the ranking needed for obstruents, and consider various aspects of the behavior of sonorants to solve the problem. I suggest that the solution is twofold:

First, MaxVoice does not apply to sonorant voicing. There are various ways we could execute this, but a difference seems reasonable given the difference in the status of voicing for obstruents and sonorants: it is distinctive for the former and not for the latter. We could of course invoke underspecification, but much recent OT work has argued against underspecification as an explanation for markedness phenomena (see Smolensky 1993, Lombardi 1997 for example).[8] Instead, then, I assume either that MaxVoiceObs outranks MaxVoiceSon universally, or that only MaxVoiceObs exists; the current data shed no light as far as I can see on the choice among these implementations. This gives the correct results for tableau (41), modified here:

(42)

/nuw+ta/	MaxVoiceObs	DepNas	MaxSeg
nunda		*!	
☞nutta			*

Second, once we have taken this step, we must account for why we see NC instead of voiceless geminates in the adverbs: what makes the choice between the candidates from tableau (38), repeated here with modification:

(43)

/nuwa/	MaxVoiceObs	DepNas
☹a. nuppari		
b.numwari		*!

Simply removing the MaxVoice violations from this tableau gives the wrong results for adverbs. It is clear that additional constraints must be involved, and this directs our attention to other differences between the verbs and adverbs. The crucial difference is the syllabic placement of the sonorant in question. In verbs it is in the coda, while in adverbs it is in the onset:

(44) verb /nuw.ta/ vs. adverb num.wari

Thus, I suggest that the NC clusters in adverbs with sonorants are a result of the need to be

[8] Another possibility, suggested by Steriade 1995, is that sonorant and obstruent voicing are different features, but this presents complications in analyzing sonorant-obstruent voicing interactions such as the postnasal voicing we have seen here - we can't spread the same voicing feature from nasal to obstruent - so I will not adopt this approach.

faithful to the sonorant-obstruent distinction in the onset, in contrast to the coda, where there is no sonorant-obstruent distinction. If this constraint outanks DepNas, the sonorant consonant must be preserved under adverb intensification (recall that given the syllable structure constraints, these are still the only candidates that will be under consideration):

(45)

/nu.wa/	faithOnsetSon	DepNas
a. nup.pari	*!	
b.num.wari		*

This will produce the correct result for adverbs, but verbs will be unaffected. CodaCond is unviolated in Japanese: there is nothing that is sufficiently high ranked to allow a /w/ to be maintained in coda position. Thus, although IdentOnsSon can maintain /w/ in the onset of intensified abverbs, CodaCond will make it impossible to maintain coda /w/ in the output for past tense /nuw+ta/ regardless of the ranking of lower constraints. It must change to obey CodaCond, and as we have seen above the optimal change is total assimilation.

6. Conclusion and directions for further research

I have shown that the parallel between voiceless geminates and NC clusters in Japanese morphology can be accounted for within Optimality Theory using well-attested constraints. In addition, I have shown that these alternations present evidence that a MaxFeature family of constraints must exist, since the constraint MaxVoice is needed to account for the relationship between voiced obstruents and NC clusters in gemination contexts, and for certain voiced realizations of verb endings.

If MaxFeature constraints are necessary, then there are a number of questions that arise for the theory of featural faithfulness in OT. Ident constraints have two apparent benefits that make our lives easier in many cases. First, a change of a feature in either direction is an equal violation. This is often necessary; e.g., in most languages where you assimilate voice, you change in both directions: as we see in (46a) where voiced becomes voiceless, and (46b) where voiceless becomes voiced:

(46) a. briv+treger -> briftreger Yiddish “mailman”
b. bak+beyn -> bagbeyn “cheekbone”

Both of these changes violate Ident Voice. Both violations seem to be equivalently ranked in this kind of language, so the single constraint IdentVoice that is violated by both changes gives the correct effect.

However, there are also cases where those two changes must be ranked differently. In fact his is true in Japanese. Tableau. (33) is somewhat oversimplified: what it really needs to show is that preserving the voicing of the underlying /g/ is more important than leaving alone the voicelessness of the suffix /t/. Certainly some constraint must penalize changing the voiceless consonant:

(47)

/kag+ta/	MaxVoice	DepOnsVoice?IdentVoice?
a.kaita	*!	
b.kaida		*

Here, the fact that we must separately rank the violations voiced -> voiceless and voiceless -> voiced argues that they must violated separate constraints like MaxVoice and DepVoice. But if this is correct, how to we handle the many languages where the change in both directions is equivalent, as in (46)? Do we need to allow tied rankings, and are such rankings the unmarked option, since this seems to be a common pattern of violations?

Further, we must ask exactly what constraint we need in a case like (47). It's clear that (a), where voiced goes to voiceless, violates MaxVoice. But (b), where voiceless becomes voiced, doesn't exactly violate DepVoice - it only adds a link, not a new Voice autosegment. Does this show that we need both families of constraints, Ident and Max/Dep, for features? Or can some refinement of Max/Dep, with added faithfulness to associations, get the right effect? This is something future research in featural faithfulness in OT must address.

The second apparent benefit of Ident constraints is that they don't allow features to move around, since violations are mediated through segments. This appears to be an advantage since in n the vast majority of segmental phonology, features are not moved to another segment to preserve them. Nonetheless, my analysis of the Japanese verb paradigm requires just such movement, arguing that an absolute prohibition on feature movement, as predicted by Ident constraints, is too strong. There are a few other cases that seem to show featural faithfulness independent of segments. (Note that single-feature floating morphemes are probably not an example, since are presumably regulated by faithfulness to morphemes.) For example, Sanskrit aspiration can be seen as such a case; assuming an analysis of Grassmann's law where each root has only one underlying voiced aspirate, we see aspiration on the initial consonant when it is forbidden from the second:

(48) /budh/ 'to know'
bodhati 3rd sg pres ind
bhut nom sg noun

Movement of features also seems to occur in some Salish languages. For example, in Shuswap, (Kuipers 1974) glottalization of sonorants seems to be mobile, being attracted to the post-tonic sonorant in some cases:

(49) x-pl-em' vs. x-plel'm-kn

So since such movement does happen, the prediction of Ident constraints is too strong. But the prediction of MaxFeature constraints alone is that all features would be expected to be mobile, and in all kinds of situations. This is clearly not true, so the interesting question is first of all,

what are the empirical situations in which such movement does and does not happen; and then, of course, what constraints must Universal Grammar contain to correctly account for those patterns.

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