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Junko Ito and Armin Mester

A characteristic and well-known feature of Tokyo Japanese is the opaque interaction of a morphophonemic process of compound voicing with a general allophonic process of *g*-nasalization. The immediate goal of this paper is to demonstrate that this interaction represents a certain kind of opacity that cannot be understood as arising out of Sympathy, which has been suggested as a general theoretical tool to deal with all types of opacity in strictly parallelist OT (McCarthy 1998). Rather, we argue that it arises naturally out of the serial interaction of the lexical and the postlexical module of phonology. Construed more broadly, this result constitutes an additional argument for the weakly parallel architecture of Optimality Theory argued for in Ito & Mester (to appear a,b) and reveals that one of the arguments originally put forth for Sympathy in our own earlier work—namely in Ito & Mester 1997b, where the interaction is given a sympathy treatment—turns out to be invalid upon closer inspection.

1. The Masking Interaction: compound voicing and *g*-nasalization

The interaction in question involves two well-known processes. The first is *Rendaku* (1), a process replacing voiceless obstruents by their voiced counterparts at the juncture of word-word compounds (specifically, at the beginning of second members that belong to the native core of the lexicon, see Ito & Mester 1999). A general phonological characteristic of Rendaku is the fact that it is systematically blocked in second members that already contain a voiced obstruent (2).

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(1) Compound Voicing (*Rendaku*): C → [+voi] /]+[__ X]

ta**m**a	'ball'	teppoo+**d**ama	'bullet'
so**n**o	'garden'	hana+**z**ono	'flower garden'

(2) Condition (*"Lyman's Law"*): X does not contain [+voi, -son]

(OCP on [+voice, -son], i.e. $[*VoiObs^2]_{Stem}$, following Ito & Mester 1998):

ta**b**a	'bundle'	satsu+**t**aba	'wad of bills'	*satsu-**d**aba
so**d**e	'sleeves'	furi+ **s**ode	'long-sleeved kimono'	*furi-**z**ode

Compound voicing interacts with *g*-nasalization (3), an allophonic process replacing word-medial /g/ by [ŋ] (/kagi/→*kaŋi* 'key', vs. word-initial ***g**eta* 'clogs').

(3) *g*-nasalization: /g /→ [ŋ] / $_{PrWd}$[... ___ (where ...≠ Ø)

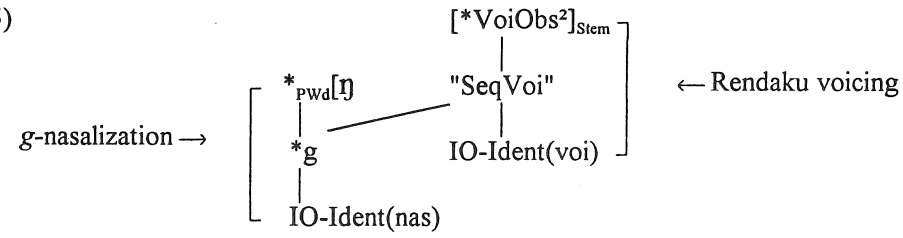
a. $_{PrWd}$[**g**.....]		b. $_{PrWd}$[..... ŋ ..]	
geta	'clogs'	kaŋi	'key'
go	'(game of) Go'	tokaŋe	'lizard'
gai+ŽiN	'foreigner'	koku+ŋai	'abroad'
guu+zeN	'accidental occurrence'	soo+ŋuu	'meet accidentally'

In rule terms, compound voicing feeds *g*-nasalization in the focus (4a) (i.e., *k*→*g*→*ŋ*), and is itself counterfed by it in the environment, i.e., when the sonorant [ŋ] replacing the obstruent /g/ appears inside the second compound member (4b).

(4)	a. *feeding:*	b. *counterfeeding:*
	/ori + **k**ami/ 'paper folding'	/saka+toge/ 'reverse thorn'
compound voicing:	ori **g**ami	—blocked by ...g...—
g-nasalization:	ori **ŋ**ami	saka toŋe
	ori **ŋ**ami]	[saka toŋe]

A preliminary analysis of the two interacting alternations distilled from previous work appears in (5).[1]

(5)



The sub-hierarchy responsible for compound voicing is illustrated in tableau (6).

(6) a. $[*VoiObs^2]_{Stem}$ ≫ SeqVoi

/satsu-taba/	$[*VoiObs^2]_{Stem}$	SeqVoi	IO-Ident(voi)
satsu-daba	*!		*
☞ satsu-taba		*	

b. SeqVoi ≫ IO-Ident(voi)

/hana-sono/	$[*VoiObs^2]_{Stem}$	SeqVoi	IO-Ident(voi)
☞ hana-zono			*
hana-sono		*!	

The sub-hierarchy responsible for *g*-nasalization is shown in (7) and (8), where the only difference between the input variants lies in violations of low-ranking IDENT(NAS). This brings out a detail important for the argument to be developed later in this paper: It concerns the freedom of specification of voiced velar segments as either nasal or oral in the input. Since the two segments do not stand in contrast and their distribution is allophonically

[1] The lefthand part of this ranking configuration (labeled "*g*-nasalization") appears first in McCarthy and Prince 1995 and is taken up in Ito and Mester (1997a,b), see below for an alternative and arguably superior approach. A detailed treatment of the Rendaku-related phonology of Japanese is given in Ito and Mester 1998. Note that "SeqVoi" is used here and throughout as a stand-in for the constraints resulting in the appearance of compound voicing. For concreteness, we can assume that the input for word-word compounds contains a linking morpheme carrying the specification [+voiced], whose realization is regulated by REALIZEMORPHEME (in this conception, the latter constraint takes the position of "SeqVoi").

determined,[2] Richness-of-the-Base (see Prince & Smolensky 1993) dictates that either of them is a viable input.

(7) /g/ as input:

/geta/ 'clogs'	*$_{PWd}$[ŋ	*g	IO-Ident(nas)
☞ a. geta		*	
b. ŋeta	*!		*

/kagi/ 'key'	*$_{PWd}$[ŋ	*g	IO-Ident(nas)
c. kagi		*!	
☞ d. kaŋi			*

(8) /ŋ/ as input:

/ŋeta/ 'clogs'	*$_{PWd}$[ŋ	*g	IO-Ident(nas)
☞ a. geta		*	*
b. ŋeta	*!		

/kaŋi/ 'key'	*$_{PWd}$[ŋ	*g	IO-Ident(nas)
c. kagi		*!	*
☞ d. kaŋi			

Ito & Mester 1997b bring out the expected result in (9b), where the transparent constraint ranking (5) fails for the counterfeeding interaction in (4b).

(9) a. Feeding relationship – correct result

/ori-kami/ 'paper folding'	*$_{PWd}$[ŋ	*VoiObs[2]	SeqVoi	*g	IO-Id(nas)	IO-Id(voi)
ori-kami			*!			
ori-gami				*!		*
☞ ori-ŋami					*	*

[2] See Ito & Mester 1997a for further details, with a treatment of the OO-based variability associated with *g*-nasalization in certain derived environments—these complicating factors have no bearing on the core cases under discussion here.

b. Counterfeeding relationship —wrong result:

/saka-toge/ 'reverse thorn'	*$_{PWd}$[ŋ	*VoiObs^2	SeqVoi	*g	IO-Id(nas)	IO-Id(voi)
saka-toge			*!	*		
saka-doge		*!		*		*
☹ saka-toŋe			*!		*	
☞!! saka-doŋe					*	*

2. Sympathy and Richness of the Base

The sympathy-based alternative to the failed transparent analysis developed in Ito & Mester 1997b appears in (10). The gist of the approach is to force the grammar to select *saka-toge* (10a) as the sympathy-candidate (marked by "❀"), in virtue of being the optimal member of the set of *non-nasalizing co-candidates*. (10a) can then serve as a role model for the overall winner, as far as the non-application of compound voicing is concerned. Technically, this is implemented by setting the selector constraint as IO-IDENT(NAS)$^{❀}$, and the sympathetic faithfulness constraint as ❀O-IDENT(VOI), which, ranked above SEQVOI, forces the winner to echo the ❀-candidate's voiceless [t].

(10)

/saka-toge/	*$_{PWd}$[ŋ	*Voi Obs^2	❀O-Id(voi)	Seq Voi	*g	IO-Id(nas)$^{❀}$	IO-Id(voi)
a. ❀ saka-toge				*	*!		
b. saka-doge		*!	*		*		*
c. ☞ saka-toŋe				*		*	
d. saka-doŋe			*!			*	*

The ❀O-IDENT(VOI) constraint column in (10) shows that the winning candidate (10c), with its voiceless [t], is sympathetically faithful to the ❀-candidate, whereas the competing candidate (10d) (the erstwhile problematic winner in (9)) is now excluded because of its unsympathetic [d]. The ❀-candidate itself (10a), while trivially fulfilling ❀O-IDENT(VOI), loses to (10c) on the *g*-constraint.

A serious liability of this analysis is already recognized in Ito & Mester 1997b:[3] It tacitly presupposes that the input is in some way or other fixed as /saka-toge/ (as opposed to /saka-toŋe/)—only then can faithfulness to a non-nasal input /g/ trigger the desired chain of sympathy effects. However, this crucial prerequisite of Sympathy Theory seems difficult to reconcile with core tenets of OT. The segments [g] and [ŋ] do not stand in contrast, and the surface distribution of the two variants is fully predicted by the constraint system. Familiar Richness-of-the-Base considerations require, therefore, as already explained earlier in connection with (7) and (8), that the ranking of output constraints alone be responsible for the derivation of the distribution of the two variants. No specific requirement for inputs to contain /g/ as against /ŋ/ in certain positions is necessary (or even possible). In other words, the grammar must be able to deal with input variants like /saka-toŋe/[4]—this is what it means in OT for an alternation to be allophonic. Here the sympathy-based approach to opacity strays off course: in the same way that sympathetic faithfulness to input nasality leads to the right winner in (10), it homes in on the wrong winner (namely **saka-doŋe*) in (11).

(11)

/saka-toŋe/	$*_{PWd}$[ŋ	*Voi Obs[2]	❀O-Id(voi)	Seq Voi	*g	IO-Id(nas)❀	IO-Id(voi)
saka-toge			*!	*	*	*	
saka-doge		*!			*	*	*
☹ saka-toŋe			*!	*			
☞!!❀ saka-doŋe							*

Just as with the examples from German phonology discussed in Ito & Mester (to appear b), where this argument is developed in greater detail and in a broader theoretical context, the general result is that Sympathy cannot cope with the rich inputs demanded by Richness of the Base whenever the masking process of an opaque interaction is allophonic.

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[3] See note 4, which expands on an observation by Kurisu and Spaelti.

[4] If Lexicon Optimization (Prince & Smolensky 1993, Ito, Mester & Padgett 1995) is accepted as a principle, /toŋe/ is in fact the best input for the output [toŋe].

3. Weak Parallelism

The strategy advocated here is in some respects the opposite of the Sympathy approach. It begins with the observation that the masking of certain phonological generalizations on the surface (dubbed "opacity" in Kiparsky 1973) is not—or at least, not necessarily—a unified phenomenon calling for a single device that would be responsible for bringing it about.[5] In our view, opacity arises rather as a by-product of the fact that OT-grammars have a particular kind of internal architecture, which includes both parallel and serial elements of structure. Specifically, a certain type of constraint conjunction (markedness & faithfulness, see Lubowicz 1998) results in faithfulness-enhanced markedness effects ('parallel opacity effects', Ito & Mester to appear a), whereas the separation of lexical and postlexical phonology as distinct and serially connected systems leads to the situation that word-level generalization can be masked by phrase-level effects ('serial opacity'). The resulting picture of the grammar is worked out in greater detail in Ito & Mester to appear b; here we focus on serial OT-opacity.

Lexical phonology and postlexical phonology are characterized by the three essential properties listed in (12).

(12) a. The lexical and the postlexical module constitute separate, but related, constraint systems.
b. They share many (not necessarily all)[6] constraints, but rankings can differ; consequently, many allophonic alternations are only active in the postlexical module.
c. Their interaction is serial, with the output of the lexical module serving as the input to the postlexical module.

This distinction between the two kinds of modules is well-known from the theory of Lexical Phonology (see also Kiparsky 1998), and it is unsurprising that this two-stage aspect of the grammar results in opacity.

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[5] This is in fact implicitly admitted by Sympathy Theory insofar as it excludes the 'chain shift' type of opacity from its own purview, see Ito & Mester to appear b for discussion.

[6] Thus it is at least conceivable that certain types of strongly phonetically constraints, calling for quantitative modes of evaluation, are literally not part of the lexical module.

3.1 Reanalyzing g-nasalization

For the Japanese case under discussion, it is useful to start out by scrutinizing the treatment of [g~ŋ] allophony seen so far on its own merits, irrespective of its involvement in opaque alternations. The crucial part of the approach adopted so far appears in (13),[7] now expanded to include the presupposed ranking of basic segmental markedness constraints as *g ≫*ŋ. (Note that, assuming total ranking, this must hold in order for *g to be the operative force resulting in /g/→[ŋ] replacements since the opposite ranking would never permit [ŋ] to appear as a way of resolving a *g violation.)

(13)	$*_{PWd}$[ŋ	"Velar nasals are prohibited PrWd-initially"	*(contextual markedness)*
	|		
	*g	"Voiced dorsal obstruents are prohibited"	} *(contextfree markedness)*
	|		
	*ŋ	"Velar nasals are prohibited"	}
	|		
	Ident(nas)	"No change in nasality"	*(faithfulness)*

The constraint hierarchy in (13) has three questionable aspects. First, a survey of the underlying segment inventories of familiar languages with /g/ and without /ŋ/ as systematic phonemes might suggest that the correct ranking should be [*ŋ ≫*g] rather than [*ŋ ≫*g]. This kind of intuition is not an infallible guide and is in this case not borne out by surface inventories, as Ito & Mester (1997a, 449-451) show in some detail, with cross-linguistic occurrence statistics based on Maddieson 1984. However, since such statistics are based on taxonomic-phonemic inventories—where English, for example, has phonemic /ŋ/ (as in /sɪŋ/)—, they do not provide a direct window on underlying inventories in the sense of generative phonology.

Second, as Bruce Hayes and Patricia Keating have reminded us (personal communication), explaining the replacement of intervocalic [g] by [ŋ] directly as an aerodynamic effect (with *g as a "phonologization" of Boyle's law, which formulates the inverse relation between volume and pressure in gases) is not as straightforward in terms of the underlying physics as one might wish, given the expandability of the walls of the supraglottal cavity. The aerodynamic difficulties connected with [g] are certainly negligible

[7] By a general M≫F default ranking in the absence of evidence for F-activity (see Smolensky 1995 and Ito & Mester 1999, to appear a for arguments), *ŋ≫IDENT(NAS) holds by default.

in intervocalic position, where [g] is often found to replace [k], along with the other voiced stops (e.g., in most of the native languages of Australia, which lack an underlying voicing contrast, see Dixon 1980).

While the first two points constitute food for thought, they have less weight than a third point one: As a markedness constraint against word-initial [ŋ], $*_{PWd}$[ŋ is puzzling in the light of positional faithfulness (Beckman 1997, and work cited there). While it is of course true that there can be constraints with antagonistic demands (OT is founded upon this very idea), it remains baffling that [ŋ] should be singled out by a special proscription in word-initial position, but not [g]—in spite of the fact that, under the basic assumptions of the analysis under discussion, *g ≫*ŋ must hold in the grammar of the *g*-replacing language (see above). Upon reflection, $*_{PWd}$[ŋ begins to look like an instance of one of the pitfalls of OT-analysis, namely, the quasi-automatic conversion of cross-linguistic generalizations into constraints of Universal Grammar. While it is tempting to interpret the *cross-linguistic observation* that many languages lack word-initial [ŋ] as direct evidence for a *universal constraint* against word-initial [ŋ], this conclusion remains a fallacy: Nothing within Optimality Theory (or outside it) guarantees the existence of such a position-specific markedness constraint. In the absence of solid (minimally, non-circular) reasons why word-initial [ŋ] should attract Universal Grammar's special wrath, it seems wise to pursue a reductionist strategy, which makes the absence of initial [ŋ] instead follow from a general prohibition against dorsal nasals. What needs explaining, then, is the emergence of non-initial [ŋ]—but here we are on familiar territory: [ŋ] arises in certain non-initial environments because the ban against [ŋ] is overridden by well-understood phonology, including the following factors: (i) place assimilation constraints affecting nasals, (ii) lenition constraints affecting intervocalic stops, and (iii) clustering constraints affecting [ŋg], coupled with the necessity to preserve a sufficient number of place contrasts in outputs (implemented by MaxPlace constraints (Lombardi 1998) or by direct regulation of contrasts, as in the work of Flemming 1995 and Padgett 1997).

We have at this point arrived at an arguably superior conception of [g~ ŋ] allophony: The basic segmental markedness ranking is *ŋ ≫*g, and the contextual effect concerns word-medial [g] rather than word-initial [ŋ].

(14) *VgV "Intersonorant g is prohibited." *(contextual markedness)*
|
*ŋ "Velar nasals are prohibited"
|
*g "Voiced dorsal obstruents are prohibited" } *(contextfree markedness)*
|
Ident(nas) "Changes in nasality are prohibited." *(faithfulness)*

This basic analysis is illustrated in (15) and (16), using examples familiar from above.

(15) input /g/:

/geta/ 'clogs'	*VgV	* ŋ	*g	Ident(nas)
☞ geta			*	
ŋeta		*!		*

/kagi/ 'key'	*VgV	* ŋ	*g	Ident(nas)
kagi	*!		*	
☞ kaŋi		*		*

(16) input /ŋ/:

/ŋeta/ 'clogs'	*VgV	* ŋ	*g	Ident(nas)
☞ geta			*	*
ŋeta		*!		

/kaŋi/ 'key'	*VgV	* ŋ	*g	Ident(nas)
kagi	*!		*	*
☞ kaŋi		*		

3.2 The lexical and poslexical modules of phonology

We are now ready for the decisive move which resolves the opacity of the interaction of *g*-nasalization with compound voicing. In weakly parallel OT, as developed in Ito &Mester to appear a, b, the traditional distinction between word phonology (or "lexical") and phrase phonology (or "postlexical") persists as a serial interface between two separate modules of grammar. As an allophonic alternation given to variation (see the references cited earlier), *g*-nasalization is certainly a candidate for the postlexical module. This means that the ranking that we have so far seen (given in (14)) is the postlexical one. The ranking in the

lexical module differs in one crucial respect, as shown in (17): *ŋ is undominated, in particular, it is not dominated by *VŋV.

(17) Lexical ranking: no ŋ's anywhere (including intersonorant position)

*ŋ
|
*g
|
Ident(nas)
|
*VgV

This is a type of ranking that serves to restrict the lexical segment inventory, in particular, as far as the admissibility of positional variants of segments (here, [ŋ]) is concerned (cf. the lexical-phonological notion of "structure preservation" see Ito & Mester to appear b). It should be noted that the Richness of the Base Hypothesis is not at issue here: the base input can have *ŋ* or *g*, but as shown in (18), because of high-ranking *ŋ, the scandidate with *ŋ* will not be the word-level winner.[8]

(18) input: /g/

/kagi/ 'key'	* ŋ	*g	Ident(nas)	*VgV
☞ kagi		*		*!
kaŋi	*		*	

input /ŋ/

/kaŋi/ 'key'	* ŋ	*g	Ident(nas)	*VgV
☞ kagi		*	*	*!
kaŋi	*			

In accordance with the basic premises of OT, the lexical segment inventory, like any phonological inventory, is not defined separately, but is derived from the constraints and their ranking in (17). The traditional lexical-phonological principle of structure preservation,

[8] This is not to say that underspecified inputs are impossible in OT. On the contrary, Richness of the Base demands that in cases like (18) representations such as /kaGi/, unspecified for [nasal], are in principle viable inputs. Because faithfulness is low-ranking, the correct output will be chosen (see Ito & Mester 1997a, 425-426 for discussion)

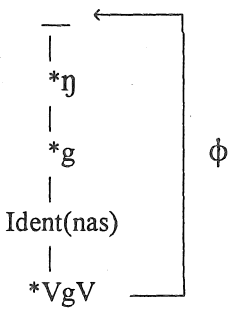
cast in a strongly underspecificationist mode (see Kiparsky 1985, 92), demands that the lexical output never contain any segments whose specifications are not possible in lexical inputs (and vice versa). In OT, the problematic link to underspecification is gone (for example, prosodic shape restrictions cannot be subsumed under underspecificationist structure preservation, as already recognized in Kenstowicz & Kisseberth 1979, 434), and structure preservation ceases to be a separate principle of the grammar, but all structure preservation effects flow directly from the lexical (word-level) constraint hierarchy. As the tableau des tableaux in (19) shows, the /ŋ/-input is occulted by the /g/-input in the familiar way.

(19)

input	output	* ŋ	*g	Ident(nas)	*VgV
☞ /kagi/	☞ kagi		*		*!
/kaŋi/	☞ kagi		*	*	*!

The postlexical module admits outputs containing [ŋ] under the pressure of the high-ranking contextual markedness constraint *VgV, which disallows voiced velar plosives in intersonorant position. In comparison with the lexical module (17), *VgV has moved up in the ranking (indicated by "ϕ" in (20)).

(20) Postlexical module: no g's word-medially in intersonorant position (instead: [ŋ])



For two modules to interface serially means that the output of the first module is the input to the second module. Here, the lexical module has a filtering function in that lexical outputs contain no ŋ. As we have seen, the lexical constraint ranking ensures that lexical outputs are broadly speaking phonemic. The postlexical inputs are crucially no longer *rich*

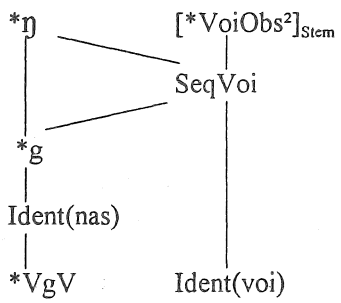
and *free* , since lexical outputs, in virtue of having already run through the lexical constraint gauntlet, are ŋ-free., whereas postlexical outputs show medial [ŋ], as seen in (21). As we will see, this removes the Richness-of-the-Base problem created by opaque interactions whose masking process is allophonic.

(21) postlexical input: always /g/

/kagi/	*VgV	* ŋ	*g	Ident(nas)
kagi	*!		*	*
☞ kaŋi		*		

We are now in a position to combine the new analysis of *g*-nasalization with the subpart of grammar responsible for Rendaku voicing. The overall ranking of the lexical module combining all the relevant constraints is given in (22).

(22)



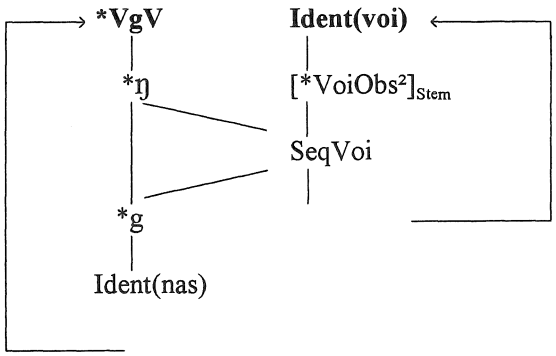
The diagonal lines in the ranking will be explained below (the line between *ŋ and *g is redundant, but is left for perspicuity). Sequential Voicing has all the properties of a lexical phenomenon, being morphologically conditioned, and immune to variation (i.e., no dialect has *ori-kami*, or *ike-hana*) whereas velar nasalization is not only allophonic, but also subject to significant dialectal variation (many dialects have [kagi], etc. with [g]). Tableau (23) shows how the 'structure-preserving' lexical module selects outputs with Rendaku voicing while eschewing *ŋ*.

(23) Lexical:

/ori-kami/	*ŋ	*Voi Obs²	Seq Voi	*g	Id (nas)	***VgV**	**Id (voi)**
ori-**k**ami			*!				
☞ ori-**g**ami				*		*	*
ori-**ŋ**ami	*!				*		*

The overall ranking of the postlexical module is given in (24).

(24)



Besides the promotion of *VgV already discussed, (24) also shows that a second constraint has been promoted: the faithfulness constraint Ident(voi).[9] Such promotion of faithfulness has, in traditional rule parlance, the effect of 'turning off a process'. Overall, then, lexical Rendaku has been turned off by promoting Ident(voi) and 'structure preservation' has been turned off by promoting the contextual markedness constraint *VgV. Ident(voi) crucially dominates *ŋ, as shown in (25).

[9] If Ident(+voi) and Ident(−voi) are separated as distinct constraints, there is no postlexical promotion of Ident(voi), but the ranking is fixed as Ident(+voi) ≫ SeqVoi ≫ Ident(-voi) (which is also supported by the fact that *saka-toge* wins over **saka-doke*) .

(25) Postlexical

/ori-gami/	***VgV**	**Id (voi)**	*ŋ	*Voi Obs²	Seq Voi	*g	Id (nas)
ori-kami		*!			*!		
ori-gami	*!					*!	
☞ ori-ŋami			*				*

Finally, we return to the opaque interaction that was problematic for Sympathy. As (26) shows, the case is straightforward under the conception of the grammar developed here. (26a) (which shows that *ŋ ≫ SeqVoi) illustrates how ŋ-less lexical outputs have no problem with overapplication of Rendaku: Since they contain medial *g*, voicing is blocked in the familiar way. Postlexically (26b), nasalization is enforced through high-ranking VgV, and at the same time the lexical voicing pattern is frozen in place by high-ranking Ident(voi): Hence no postlexical reshuffling of Rendaku voicing patterns is possible, and *sake-toŋe* emerges as the ultimate winner.

(26)

a. Lexical:

/saka-toge/	*ŋ	*Voi Obs²	Seq Voi	*g	Id (nas)	***VgV**	**Id (voi)**
☞ saka-toge			*	*		*	
saka-doge		*!		*		*	*
saka-toŋe	*!		*!		*		
saka-doŋe	*!						*

b. Postlexical:

/saka-toge/	***VgV**	**Id (voi)**	*ŋ	*Voi Obs²	Seq Voi	*g	Id (nas)
saka-toge	*!				*!	*	
saka-doge	*!	*				*	
☞ saka-toŋe			*		*		*
saka-doŋe		*!	*				*

In conclusion, Weak Parallelism recaptures the insights behind the lexical/postlexical distinction, and does not run into the difficulties that Sympathy faces. The Richness of the Base hypothesis is maintained, and the problem posed by opaque interactions whose

masking process is allophonic disappears because the lexical module exerts a filtering function in such cases, by crucially restricting lexical outputs to a limited inventory ('structure preservation').

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