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Lexical and Postlexical Phonology in Optimality Theory: Evidence from Japanese*

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A characteristic feature of conservative varieties of Tokyo Japanese (Hibiya 1999) is the interaction of a morphophonemic process of compound voicing with a general allophonic process of g-weakening. Given the current interest in parallelist approaches to the masking of certain phonological generalizations on the surface (dubbed "opacity" in Kiparsky 1973), the immediate goal of this paper is to demonstrate that this interaction represents a type of opacity that cannot be described in an adequate way by means of Sympathy (McCarthy 1998), which has been suggested as a general and strictly parallelist tool to deal with all types of opacity in Optimality Theory (henceforth, OT; Prince and Smolensky 1993). Mistakenly put forth as an argument for Sympathy in our own earlier work (Ito & Mester 1997b) the case receives a superior understanding under familiar conservative assumptions, where the opacity arises naturally out of the serial interaction of the lexical and postlexical modules 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), which maintains lexical and postlexical phonology as different and serially connected systems, without necessarily embracing the entirely separate assumption of serially connected levels within the lexical phonology itself argued for by Kiparsky 1998.

1. The masking interaction: compound voicing and g-weakening

The interaction in question involves two well-known processes. The first is *Rendaku* (1) (literally, *sequential voicing*), a process replacing voiceless obstruents by their voiced counterparts at the juncture of word-word compounds (specifically, at the beginning of second members). 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], or $[*VoiObs^2]_{Stem}$, following Ito & Mester 1998):

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

As argued in detail in Ito and Mester 1986, compound voicing has all the properties of a lexical process listed in (3).

(3)
a. Essential reference to morphological structure (voicing appears only in a narrowly circumscribed class of compounds, see also Otsu 1980 and Haraguchi 2001)
b. Existence of numerous exceptions (see Rosen 2001 for the most exhaustive recent study), c.f. the names of the two different versions of the Japanese syllabary: hira+**g**ana (with voicing) vs. kata+**k**ana (without voicing)
c. Sensitivity to subdivisions of the vocabulary (native Yamato vs. Sino-Japanese/Foreign items, similar in kind to the distinction in the English vocabulary between native Germanic vs. Latinate/Greek items)
d. Nongradiency and contrastiveness
e. Cyclicity.

Compound voicing is thus a textbook example of a lexical process (this point apparently also holds for earlier stages of the language, see Unger (2000: 17)). In terms of the points listed in (3), it contrasts sharply with g-weakening (4), an allophonic process replacing non-initial /g/ by [ŋ] (e.g., /gai/→[ŋai] in [koku+ŋai] 'abroad', vs. word-initial [**g**ai] in [**g**ai+ʤiɴ] 'foreigner').[1]

(4) g-weakening: /g /→ [ŋ] / $_{PrWd}$[X ___ (where X =[+seg])

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

The properties of g-weakening are typical of postlexical processes: phonetic gradiency, non-contrastiveness, and sociolinguistic variation. There is significant gradiency in the degree of nasalization found in the results of g-weakening, depending on factors such as speech rate

[1] Since the phonotactics of Japanese do not permit word-final [g] or [ŋ], "non-initial" is in effect co-extensive with "word-medial".

and speech register. In a number of dialects, the result of g-weakening is not [ŋ], but rather a segment more similar to [ɣ]. The different status of the *contrastive* voicing that marks compounds and the *noncontrastive* nasality caused by weakening is clear to native speakers and finds a tangible expression in the fact that the first one, but not the second one, is marked by a diacritic in the native syllabaries. Hibiya 1999 shows in detail how the process is subject to systematic sociolinguistic variation, governed by regional, social, and generational factors.

It is in this last context that morphological factors start to have an effect on the allophonic weakening process--for example, recent loans are found to resist g-weakening more easily than older loans, etc. In addition, in compound words underlying [g] at the beginning of second members often remains unlenited, echoing the unlenited [g] found at the beginning of the isolation form of the simplex word in question. In Ito and Mester 1997a, this prototypical case of analogy is shown to be better analyzed in terms of parallelist Output-Output correspondence than in a traditional serialist-derivational framework. While the process in question thus provides arguments for some kind of parallelism, it is especially interesting, as we will now show, in that it at the same time does not sit well with a radical form of parallelism that denies the separation and serial interaction of lexical and postlexical phonology.

Turning to the interaction of the processes, it is easy to see that in rule terms, compound voicing feeds g-weakening in the focus of the rule ((5a): k→g→ŋ), and is itself counterfed by it in the environment of the rule, i.e., when the sonorant [ŋ] replacing the obstruent /g/ appears inside the second compound member (5b). Note that reversing the order of application would result in the wrong output *[saka+doŋe].

(5)	a. *feeding:*	b. *counterfeeding:*
	'folding paper'	'reverse thorn'
	/ori + **k**ami/	/saka+to**g**e/
compound voicing:	ori **g**ami	—blocked by (2)—
g-weakening:	ori ŋami	saka toŋe
	[ori ŋami]	[saka toŋe]

A preliminary OT-analysis of the two interacting alternations distilled from previous work appears in (6) and (8).[2] The subhierarchy responsible for compound voicing is given in (6), followed by illustrative tableaux in (7).

[2] A detailed treatment of the Rendaku-related phonology of Japanese is given in Ito and Mester 1998. The g-weakening part of the analysis 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.

(6)

OCP(voi) ! ! ! RealMorph ! ! ! Ident-IO (voi)	OCP-type markedness constraint, here understood as ruling out multiple obstruent voicing within a stem, see Ito and Mester 1998 for further development RealizeMorpheme (here, enforcing the realization of the compound voicing morpheme) faithfulness constraint militating against changes in voicing

RealizeMorpheme (REALMORPH) is here used as the constraint resulting in the appearance of sequential voicing. We assume (see Ito and Mester 1986 for motivation) that the input for word-word compounds contains a linking morpheme carrying the specification [+voiced], whose realization is regulated by REALMORPH.[3] In order to conserve space, our tableaux here and throughout feature only the most plausible candidates, leaving out potential rivals that violate obvious phonotactic, segmental, or faithfulness constraints.

(7) a. OCP(voi) ≫ RealMorph

/satsu-[+v]-taba/	OCP(voi)	RealMorph	IO-Ident(voi)
satsu-daba	*!		*
☞ satsu-taba		*	

b. RealMorph ≫ IO-Ident(voi)

/hana-[+v]-sono/	OCP(voi)	RealMorph	IO-Ident(voi)
☞ hana-zono			*
hana-sono		*!	

The sub-hierarchy responsible for g-weakening is shown in (8), followed by illustrative tableaux in (9) and (10).

(8)

$*_{PrWd}$[ŋ | *g | Ident-IO(nas)	positional markedness constraint against PrWd-initial ŋ markedness constraint prohibiting voiced dorsal obstruents faithfulness constraint against changes in nasality

[3] This is somewhat akin to the "Fugen-s of German in cases such Geburts+tag 'birthday', where the feminine gender of the first member provides no inflectional support for a genitive *-s*.

An important background assumption is that Japanese compounds, which as a rule contain at most one accent, consist of single prosodic words, different from English and many other languages (see Kubozono 1993 for justification). What matters here is not so much this specific assumption about prosodic words, but rather the fact that compounds constitute single prosodic domains of type α, and [ŋ] is barred from appearing initially in α. Relevant tableaux are given in (9) and (10), where the only difference between the two different 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 determined,[4] Richness-of-the-Base (see Prince & Smolensky 1993) dictates that either of them is a viable input.

(9) /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			*

(10) /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			

(11) combines the two subhierarchies in (6) and (8) into a single constraint system.

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

(11)

g-weakening > *$_{PWd}$[ŋ, *g, IO-Ident(nas) | OCP(voi), "RealMorph", IO-Ident(voi) | < compound voicing

Ito & Mester 1997b show that this analysis successfully deals with the transparent (feeding) interaction (5a) as in (12a), but predictably fails for the opaque (counterfeeding) interaction (5b), as shown in (12b).

(12) a. Feeding relationship – correct result

/ori-kami/ 'paper folding'	*$_{PWd}$[ŋ	OCP (voi)	Real Morph	*g	IO-Id(nas)	IO-Id(voi)
ori-**k**ami			*!			
ori-**g**ami				*!		*
☞ ori-ŋami					*	*

b. Counterfeeding relationship —wrong result:

/saka-toge/ 'reverse thorn'	*$_{PWd}$[ŋ	OCP (voi)	Real Morph	*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 (13). The gist of the approach is to force the grammar to select saka-toge (13a) as the sympathy-candidate (marked by "❀"), in virtue of being the optimal member of the set of *non-nasalizing co-candidates*. (13a) then serves 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 REALMORPH, forces the winner to echo the ❀-candidate's voiceless [t].

(13)

/saka-toge/	*$_{PWd}$[ŋ	OCP (voi)	❀O-Id(voi)	Real Morph	*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 (13) shows that the winning candidate (13c), with its voiceless [t], is sympathetically faithful to the ❀-candidate, whereas the competing candidate (13d) (the erstwhile problematic winner in (12)) is now excluded because of its unsympathetic [d]. The ❀-candidate itself (13a), while trivially fulfilling ❀O-IDENT(VOI), loses to (13c) on the *g-constraint.

A serious liability of this analysis is already recognized in Ito & Mester 1997b:[5] 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 (9) and (10), 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 should be necessary (or even possible). In other words, the grammar must be able to deal with input variants like /saka-toŋe/[6]—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 (13), it homes in on the wrong winner (namely *saka-doŋe) in (14).

(14)

/saka-toŋe/	*$_{PWd}$[ŋ	OCP (voi)	❀O-Id(voi)	Real Morph	*g	IO-Id(nas)❀	IO-Id(voi)
saka-toge			*!	*	*	*	
saka-doge		*!			*	*	*
☹ saka-toŋe			*!	*			
☞!!❀ saka-doŋe							*

[5] See note 4 in Ito and Mester (1997b), which expands on an observation by Kazutaka Kurisu and Philip Spælti.

[6] 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].

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.

3. Serial opacity

The strategy advocated here is in some respects the opposite of the Sympathy approach. It begins with the observation that opacity is not necessarily a unified phenomenon produced by a single device that is assigned the task to bring it about.[7] In our view, it 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. On the one hand, a certain type of constraint conjunction (markedness & faithfulness, see Lubowicz 1998) results in faithfulness-enhanced markedness effects ('parallel opacity', Ito & Mester to appear a). On the other hand, the separation of lexical and postlexical phonology as distinct and serially connected systems leads to the partial masking of word-level generalizations by phrase-level effects ('serial opacity'). We focus here on the second type.

The resulting picture of the grammar, worked out in greater detail in Ito & Mester to appear b, differs in three ways from the strictly serialist conception of opacity in Kiparsky 1998: (i) We assume that cyclic effects are due to Output-Output constraints. There is thus no cyclic re-application of the constraint system, following the morphological build-up of the word (as in Kiparsky 1998, 42-50; see Ito and Mester 1997a for discussion). (ii) A genuinely parallelist variety of opacity is recognized. (iii) The serial variety of opacity is restricted to the large-scale distinction between lexical and postlexical phonology, maintaining the lexical phonology as a single, parallel, and unitary constraint system.

Lexical phonology and postlexical phonology are characterized by the three essential properties listed in (15).

(15) a. The lexical and postlexical modules constitute separate constraint systems.
b. They share many (not necessarily all)[8] constraints, but rankings can differ in limited ways.
c. The two modules interact serially, with the output of the lexical module serving as the input to the postlexical module.

In broad outlines, the distinction is well-known from the theory of Lexical Phonology (see Kiparsky 1982 and related work), and it is unsurprising that this two-stage structure of the grammar results in opacity. Regarding (15b), we also do not exclude the possibility that the

[7] 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.

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

postlexical system might be quite different in character from the lexical one (echoing an earlier proposal in Liberman and Pierrehumbert 1984). For example, only the latter might turn out to be a strict OT-system, whereas the former might be a more broadly optimization-based quantitative system. But for present purposes and given the limits of our current understanding, we will continue to assume that both are strict OT-systems. After completing our analytical work, we will return to the question of how the rankings in the two components can differ. It is clear that not all pairings of lexical and postlexical constraint systems will yield viable languages, and we will make some proposals regarding the types of rerankings that are possible within a single grammar.

3.1 Reanalyzing g-weakening

It is useful to start out by scrutinizing the treatment of [g~ŋ] allophony seen so far on its own merits, abstracting away from its involvement in opaque alternations. The basic idea of the analysis has been that no specific constraint against intervocalic [g] is involved. Rather, all effects were due to the general constraint against [g], mitigated by a specific constraint against word-initial [ŋ]. In other words, the word-internal weakening of [g] is not seen as contextual weakening, but rather as a context-free markedness effect. We will now show that a traditional weakening analysis is in fact superior to this view in several respects.

The crucial part of the context-free markedness approach adopted so far appears in (16),[9] now expanded to include the presupposed ranking of basic segmental markedness constraints as *g ≫*ŋ. 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.

(16)

$*_{PWd}$[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 (16) has three questionable aspects. First, it might be problematic to be committed to the ranking [*g ≫*ŋ] since, under traditional generative assumptions, the underlying inventories of familiar languages such as English have contrastive /g/ but no contrastive /ŋ/ (i.e., with all surface [ŋ] deriving from nasal+velar clusters: /sɪNg/ → [sɪŋ], etc.).[10] Such considerations are not an infallible guide, however, and Ito & Mester (1997a,

[9] 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.

[10] As is well known, [ŋ] behaves as an NC clusters not only in being absent from onsets, but also in being absent after heavy nuclei in codas—banning [ŋ] from onsets by means of a

449-451) show, with cross-linguistic occurrence statistics based on Maddieson 1984, that the case under discussion remains somewhat ambiguous. On the one hand, the cross-linguistic frequency of contrastive ŋ increases when one considers surface inventories, where English, for example, has phonemic /ŋ/ in forms like /sɪŋ/. On the other hand, the very fact that inventory statistics such as those of Maddieson 1984 are based on taxonomic-phonemic inventories means that they do not provide a direct window on underlying inventories in the sense of generative phonology.

A second and independent problem for the contextfree makedness analysis (16) concerns the attempt to interpret the intervocalic replacement of [g] by [ŋ] strictly as a direct aerodynamic effect, with *g literally taken as a "phonologization" of Boyle's law (as in McCarthy and Prince 1995 and Ito and Mester 1997a). Given the expandability of the walls of the supraglottal cavity, this is not entirely straightforward in terms of the underlying physics, as Bruce Hayes and Patricia Keating have reminded us (*voce*). It is especially in intervocalic position that the aerodynamic difficulties connected with [g] are negligible—this is where [g] is in fact 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).

Such considerations tend to undermine any attempt to view the word-internal weakening of [g] strictly as a context-free markedness effect against the voiced velar plosive as a segment, and enhances the plausibility of the alternative contextual lenition account. The most plausible general assessment of the situation is found in Vance (1987, 111-112), where the word-internal weakening of [g] is seen as lenition, but with the usual ("natural") spirantized outcome [ɣ] preempted by ("unnatural") nasalization, for reasons internal to Japanese (as pointed out earlier, there are dialects with [ɣ] instead of [ŋ]).

McCarthy and Prince 1995, arguing against a lenition analysis and citing examples like iʃʃuukaɴ-ŋurai 'one week approximately', point out that the change /g/ →[ŋ] here takes place post-consonantally, not intervocalically. At least in derivational terms, however, "post-consonantal" here reduces to "post-ɴ", the nasal glide of Japanese lacking consonantal closure, i.e. a vocalic segment. And considering a place-assimilated surface configuration, we find assimilation of g to ŋ ([iʃʃuukaŋ-gurai] → [iʃʃuukaŋ-ŋurai]) in a familiar context, as in the historical sequence [zɪŋgən] > [zɪŋŋən] > [zɪŋən] 'to sing' in German and other postnasal g-deleting languages, where assimilation is followed by degemination (see also

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special $*_{\sigma}$[ŋ constraint tells only one half of the story. The facile adoption of such positional markedness constraints to cover some distributional facts may result in an overall loss in depth of explanation. Note, incidentally, that in our proposal in earlier work (Ito and Mester 1998) to reduce complex contextual markedness constraints to their simpler ingredients by means of constraint conjunction, e.g., coda conditions as conjunctions of NoCoda and *X (see also Ito and Mester to appear a for many examples and discussion), no obvious way of expressing the force of a putative constraint $*_{PWd}$[ŋ (or $*_{\sigma}$[ŋ) suggests itself, in the absence of elementary constraints *against* onsets and word-initial positions. Besides the obvious problems besetting constraint conjunction, this underlines the intrinsic restrictiveness of the conjunctive-reductionist approach to contextual markedness (e.g., in comparison to approaches freely fabricating constraints as the analysis develops).

Vance (1987, 108-109) and works cited there on the close relation of obstruent voicing to nasality in the history of Japanese). If so, g-weakening in Japanese is another example illustrating non-uniformity of causation in OT.

Another potential problem brought up against a lenition analysis—namely, why weakening should affect velars, but not labials and dorsals—is in fact a point in its favor since it falls under a well-known hierarchy of strength among places of articulation (cf. Foley 1977), with velars being cross-linguistically more prone to lenite than other places of articulation (as an historical example, compare the off-glide [j] in English *nail* to the corresponding [g] of the cognate German *Nagel*). Japanese itself shows intervocalic deletion of velar stops, for example, in the historical development of inflected adjectives (aka-ki > aka-i 'red-Present', cf. aka-ku 'red-Adverb'), and verbs (kak-i-te > ka-i-te 'write-Gerund', cf. kak-u 'write-Present')

A third point providing food for thought is the following. In order to get off the ground, the context-free markedness analysis (16) needs to assume the ranking *g ≫*ŋ. However, in a sudden reversal, the analysis needs to simultaneously rank the corresponding contextual markedness constraints in the opposite order $*_{PWd}$[ŋ ≫ $*_{PWd}$[g.[11] Unless a good reason can be given for the reversal, this must count as a major liability for the analysis.[12] It remains baffling why [ŋ] should be singled out by a special proscription in word-initial position. Along the lines of Smith 2001,one could perhaps attempt to view $*_{PWd}$[ŋ as a case of initial augmentation, but for the present case it remains unclear whether this is more than another name for the problem.

We could simply marvel at the wonders of the phonetic world and accept the exalted role of $*_{PWd}$[ŋ as a basic fact of life, trusting that accounts in terms of "ease of articulation" or "perceptibility"can perhaps be made precise enough to be compared with a formal analysis. However, it seems reasonable at this point to reconsider the merits and demerits of a traditional lenition analysis as an alternative. Upon reflection, $*_{PWd}$[ŋ looks more and more like an instance of one of the pitfalls of OT-analysis: the quasi-automatic conversion of cross-linguistic generalizations into constraints of Universal Grammar (the same holds, mutatis

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[11] An alternative, with slightly different empirical consequences, would be to argue that Universal Grammar simply lacks a constraint $*_{PWd}$[g—again, the different treatment of the two segments lacks motivation.

[12] As a positional markedness constraint against word-initial [ŋ], $*_{PWd}$[ŋ would stand in competition with well-motivated positional faithfulness constraints, which result in an increase in the number of contrasts found in prominent (including word-initial) positions (Beckman 1997, and work cited there). Note that replacing the positional markedness constraint $*_{PWd}$[ŋ with the positional faithfulness constraint IDENT-INIT(NAS) in the hierarchy (16) is not a solution here since it allows not only $_{PWd}$[g , but also $_{PWd}$[ŋ, i.e., it turns [g]/[ŋ] into a contrast in this position. Retreating to a weaker theory of faithfulness, with IDENT(±F)-distinctions (see Baković 2000 for arguments against this version of faithfulness), still does not help since IDENT-INIT(-NAS) does not rule out initial ŋ, i.e., $*_{PWd}$[ŋ would be needed in addition and would be doing all the work.

mutandis, for the syllable-initial version of the constraint, see note 10). While it is tempting to interpret the *cross-linguistic observation* that many languages lack α as direct evidence for the existence of a *universal constraint* *α, this is not a valid conclusion. Nothing within Optimality Theory 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 ire, it seems more fruitful to pursue a reductionist strategy, making the absence of initial [ŋ] instead follow from the general prohibition against dorsal nasals, coupled with higher-ranking constraints leading to the appearance of [ŋ] in internal positions. 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 either 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].

(17)

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

This basic analysis is illustrated in (18) and (19), using examples from the earlier discussion.[13]

(18) input /g/:

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

[13] A reviewer raises the question of how languages like English or German, similar to Japanese in lacking initial ŋ, but differing in allowing medial VgV, are possible in this approach. In the light of (17), the answer is simple: Such languages differ from Japanese in having *VgV ranked below IDENT(NAS).

(19) input /ŋ/:

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

A last remaining issue concerns the original motivation for the analysis in McCarthy and Prince 1995, viz., the underapplication of g-weakening in reduplicated mimetics in Japanese, as in [g]ara-[g]ara, *[ŋ]ara-[ŋ]ara, *[g]ara-[ŋ]ara 'rattling'. Their model of over- and underapplication has the property that underapplication only arises under the pressure of a specific structural constraint, otherwise overapplication (or normal application, depending on the ranking of IDENT-BR) is always optimal. In the Japanese case, it is $*_{PrWd}$[ŋ that plays the role of the specific structural constraint leading to underapplication, as shown in (20).

(20)

/gara–RED/	Ident-BR (nas)	$*_{PrWd}$[ŋ	*g	Ident-IO (nas)
a. [ŋara–ŋara]		*** !**		*
b. [gara–ŋara]	*** !**		*	
c. ☞ [gara–gara]			**	

With the new ranking in (17), this way of capturing the apparent underapplication of an allophonic process is not available since the crucial dominating constraint $*_{PrWd}$[ŋ is not present (21).

(21)

/gara–RED/	Ident-BR (nas)	*VgV	*ŋ	Ident-IO (nas)
a. ☞!!![ŋara–ŋara]			**	*
b. [gara–ŋara]	***!**		*	
c. [gara–gara]		***!**		

Fortunately, this is not a problem since further investigation has revealed that this putative case of an underapplying allophonic process is instead simply a case of lawful non-application: reduplicated mimetics consist of two separate prosodic words, with two accents: $_{PrWd}$[ga'ra]--$_{PrWd}$[ga'ra], as in (22).

(22)

/gara–RED/	Ident-BR (nas)	*VgV	*ŋ	Ident-IO (nas)
a. [ŋara]–[ŋara]			**	*
b. [gara]–[ŋara]	*!		*	
c. ☞ [gara]–[gara]				

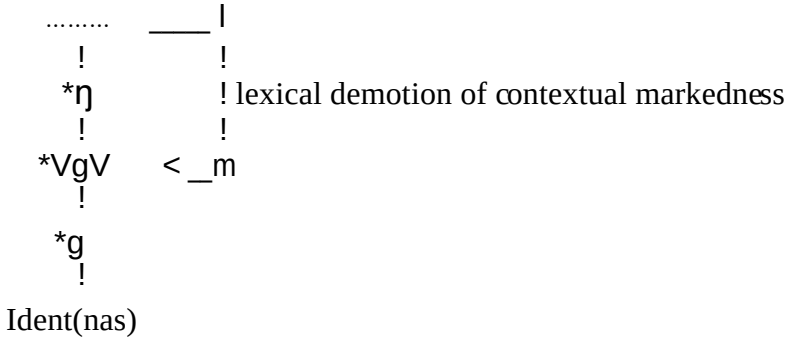
As further support, note that in non-mimetic cases of reduplication in Japanese, where the two parts do not form separate prosodic words, ŋ-weakening applies normally. This is true both for bound reduplicative compounds like ge+ŋe 'lowest' and for free reduplicative compounds like kuni+ŋuni 'various countries' (with Rendaku-induced g further replaced by ŋ).

The upshot is that (20) is a misanalysis, (17) encounters no problem, and Japanese mimetic reduplication presents no obstacle to a theory of reduplication, less powerful than that of McCarthy and Prince 1995, which rules out any underapplication of allophonic processes.

3.2 The lexical and postlexical modules of phonology

We are now ready for the decisive move which resolves the opacity of the interaction of g-weakening with compound voicing. In the conception of an OT-grammar assumed here, the traditional distinction between lexical phonology and postlexical phonology persists as a serial interface between two separate modules of grammar. As an allophonic alternation prone to variation, g-weakening was shown in section 1 to be a prime candidate for the postlexical module. Once this is taken seriously, the ranking seen so far (given in (17)) is the postlexical one, which differs from the lexical ranking in one crucial respect: The fact that weakening is not a lexical phenomenon means that the lenition-forcing constraint *VgV must lexically rank lower than *ŋ. This is shown in (23).

(23) Lexical ranking: no ŋ anywhere (including intersonorant position)



This kind of lexical demotion of contextual markedness results in the familiar restrictiveness of lexical segment inventories, in particular, as far as the admissibility of positional variants of segments (here, [ŋ] as a variant of /g/) is concerned (cf. the lexical-phonological notion of "structure preservation", see Ito & Mester to appear b). Ranked where it is in (23), i.e.,

immediately above its superconstraint *g, which is violated whenever *VgV is, the latter cannot do independent work at the lexical level. This OT-based notion of lexical structure preservation in no way infringes on the Richness of the Base Hypothesis. Both /ŋ/ and /g/ are viable lexical inputs, but because of high-ranking *ŋ, the candidate with [ŋ] will not be the lexical winner, as shown in (24).[14]

(24)

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

In accordance with the basic premises of OT, the lexical segment inventory, like any phonological inventory, is not defined separately, but derives from the constraints and their ranking in (23). The traditional lexical-phonological principle of structure preservation, built on strictly underspecificationist assumptions (see Kiparsky 1985, 92), has the effect that lexical outputs never contain elements whose specification is not possible in lexical inputs (and vice versa). In OT, the problematic link to underspecification is severed,[15] and structure preservation ceases to be a separate principle of the grammar. Instead, all structure preservation effects flow directly from the lexical constraint hierarchy. Applying Lexicon Optimization to the two tableaux in (24) and constructing a tableau des tableaux (see Ito, Mester, and Padgett 1995) in (25), the /ŋ/-input is seen to be occulted by the /g/-input in the familiar way.

(25)

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

As seen earlier, the postlexical module admits outputs with [ŋ] under the pressure of the contextual markedness constraint *VgV, which now dominates its antagonist *ŋ.

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[14] This is not to say that underspecified inputs are impossible in OT. On the contrary, Richness of the Base demands that in cases like (24) representations such as /kaGi/, unspecified for [nasal], are in principle viable inputs. Because faithfulness is low-ranking, the correct output will be chosen in this case as well (see Ito & Mester 1997a, 425-426 for discussion)

[15] This has the independent advantage that prosodic shape and size restrictions, which could never be successfully subsumed under underspecificationist structure preservation (as already recognized in Kenstowicz & Kisseberth 1979, 434), are now dealt with in the same way as segmental restrictions.

(26) (=17) Postlexical module: no [g] word-medially (instead: [ŋ])

*VgV
|
*ŋ
|
*g
|
Ident(nas)

For two modules to interface serially means that the output of the first module is the input to the second module. The result is here that the lexical module has a filtering function in that lexical outputs contain no ŋ. As we have seen, the lexical constraint ranking has the effect that lexical outputs are broadly speaking phonemic. 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 (27). As we will see, this removes the Richness-of-the-Base problem created by opaque interactions whose masking process is allophonic.

(27) 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-weakening with the subpart of grammar responsible for Rendaku voicing. The overall ranking of the lexical module combining all the relevant constraints is given in (28).

(28)

*ŋ
!
p
!
OCP(voi)
!
!
RealMorph
!
q
!
*VgV
!
!
*g
!
!
Ident(nas)
Ident(voi)

As shown in section 1, Compound Voicing has all the properties of a lexical phenomenon, being morphologically conditioned, having phonologically arbitrary exceptions, and not being subject to significant dialectal 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], and some have [kaɣi]).

Tableau (29) shows how the structure-preserving lexical module selects outputs with Rendaku voicing realized as [g] while eschewing [ŋ]. (29) motivates the ranking REALMORPH ≫ *VgV

(29) *Lexical*:

/ori-kami/	*ŋ	OCP (voi)	Real Morph	***VgV**	*g	Id (nas)	**Id (voi)**
ori-**k**ami			*!				
☞ ori-**g**ami				*	*		*
ori-ŋami	*!					*	*

The other diagonal domination line in (28), *ŋ ≫ REALMORPH, is motivated in (30).

(30) *Lexical*:

/saka-toge/	*ŋ	OCP (voi)	Real Morph	***VgV**	*g	Id (nas)	**Id (voi)**
☞ saka-toge			*	*	*		
saka-doge		*!		*	*		*
saka-toŋe	*!		*!			*	
saka-doŋe	*!						*

Since it is independently clear that REALMORPH ≫ IDENT(VOI) (see (7b) in section 1), we have *ŋ ≫ IDENT(VOI) by transitivity. This contains an important clue for the proper understanding of the relations between the lexical and the postlexical systems.

Given what has been said so far, the overall ranking of the postlexical module appears to be the one in (31), with high-ranking *VgV triggering g-weakening.

(31) *Postlexical ranking (preliminary--to be changed)*

***VgV**
!
*ŋ OCP(voi)
! p !
! RealMorph
! q !
*g !
! !
Ident(nas) Ident(voi)

It turns out, however, that this does not yet fully capture the relation between the lexical and the postlexical phonology of voicing. The low ranking of IDENT(VOI) in (31) is an inheritance from the lexical situation, where it is demanded by the fact that Compound Voicing takes place at all. It leads to the selection of the wrong postlexical winner, as shown in (32).

(32) *Postlexical*

/ori-gami/	***VgV**	*ŋ	OCP (voi)	Real Morph	*g	Id (nas)	**Id (voi)**
☞!! ori-**k**ami				*			*
ori-**g**ami	***!**				*		
ori-ŋami		*!				*	

(32) demonstrates that the ranking *ŋ ≫ IDENT(VOI) is only a lexical phenomenon, postlexically IDENT(VOI) ranks higher, forstalling devoicing as a repair strategy. The correct postlexical ranking is the one in (33), and (34) shows how the correct candidate [ori-ŋami] is selected.[16]

(33) *Postlexical ranking (final version)*

***VgV** ! q **Ident(voi)**
*ŋ ! p OCP(voi)
! RealMorph
! q
*g !
Ident(nas)

(34) *Postlexical*

/ori-gami/	***VgV**	**Id (voi)**	*ŋ	OCP (voi)	Real Morph	*g	Id (nas)
ori-**k**ami		*!			*		
ori-**g**ami	***!**					*!	
☞ ori-ŋami			*				*

It is now time to return to the opaque interaction that was problematic for Sympathy. Combining the separate lexical and postlexical tableaux seen earlier, (35) shows that this case of opacity resolves itself in a straightforward way--as a partial masking of a lexical pattern by a superimposed postlexical pattern. For this type of opacity, serialism remains the simplest and most explanatory account. (35a) illustrates how ŋ-less lexical outputs have no problem with overapplication of Rendaku: Since they contain medial g, voicing is blocked in the

[16] If, adopting a richer theory of faithfulness, IDENT(+VOI) and IDENT(−VOI) are separated as distinct constraints, their ranking can be fixed as IDENT(+VOI) ≫ REALMORPH ≫ IDENT(-VOI) in both the lexical and the postlexical modules. This would also account for the fact that saka-toge wins over *saka-doke, see Ito and Mester 1998 for further discussion.

familiar way. Postlexically (35b), 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.

(35)

a. *Lexical:*

/saka-toge/	*ŋ	OCP (voi)	Real Morph	***VgV**	*g	Id (nas)	**Id (voi)**
☞ saka-toge			*	*	*		
saka-doge		*!		*	*		*
saka-toŋe	*!		*!			*	
saka-doŋe	*!						*

b. *Postlexical:*

/saka-toge/	***VgV**	**Id (voi)**	*ŋ	OCP (voi)	Real Morph	*g	Id (nas)
saka-toge	*!				*!	*	
saka-doge	*!	*				*	
☞ saka-toŋe			*		*		*
saka-doŋe		*!	*				*

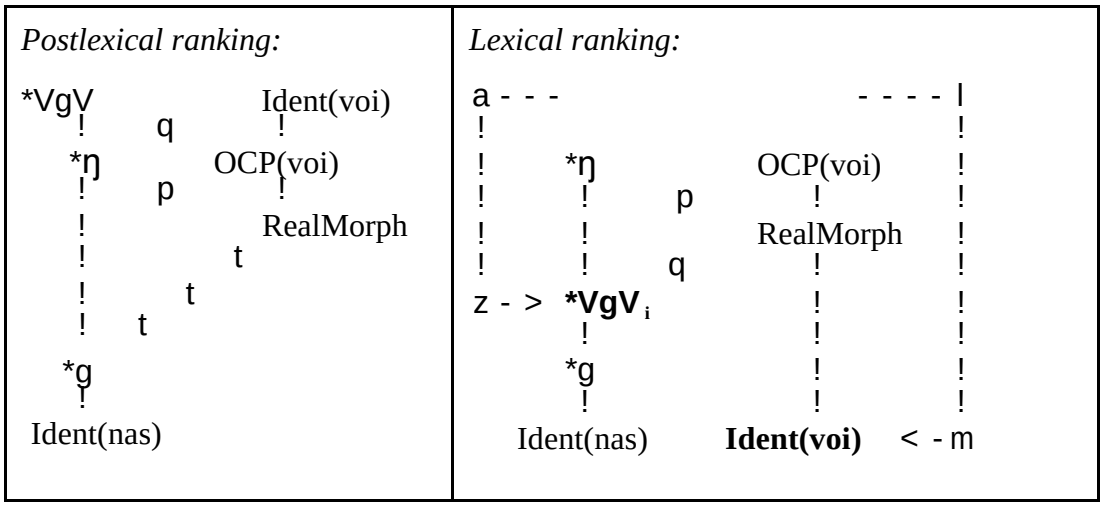
4. Conclusion

We have seen that a weakly parallel model of OT not only recaptures the central insights behind the traditional lexical/postlexical distinction, but also avoids the difficulties that Sympathy Theory faces: The Richness of the Base hypothesis is maintained, and the problem posed by opaque interactions whose masking process is allophonic disappears. A crucial role is played by the lexical module, which exerts a filtering function by restricting lexical outputs to a limited inventory ('structure preservation').

Finally, we turn to what is perhaps the most important open question: What are the limits on constraint reranking/demotion? Restricting reranking to demotion in the lexical system is a first step towards imposing limitations (in line with a suggestion by Tesar and Smolensky 1998). Note that the proposal in Ito and Mester 1999 dealing with the stratification of the lexicon is stated in terms of promotion of faithfulness in more peripheral areas, but can equivalently be characterized as demotion of faithfulness in more core areas and thus falls within the present perspective. But restricting reranking to demotion is clearly not sufficient. If nothing else is said, a promotion of *a* with respect to *b, c* and *d* can in general be mimicked by a demotion of *b, c,* and *d* with respect to *a*. Furthermore, unlimited freedom of demotion is clearly too powerful since there is nothing to prevent unwanted combinations, such as the lexical phonology of Dutch paired with the postlexical phonology of Indonesian, or the lexical phonology of Hindi with the postlexical phonology of English, etc.

While it is easy to identify the problem, it is much harder to come up with a solution. One way of restating the findings of this paper in a more general way is as follows: The monostratalism of strict parallel versions of OT undeniably has restrictiveness in its favor, as far as weak generative power is concerned. But the simultaneous loss of descriptive and explanatory adequacy is too high. We anticipate that the correct theory will impose tight limits on possible demotions. Besides the distinction between faithfulness and markedness constraints (see Ito and Mester 1999), substantive factors are likely to play a major role in defining what kinds of demotions are possible in a lexical system based on a given postlexical system. For the time being, let us take note of what the case under discussion has taught us. Taking the postlexical ranking as a baseline, perhaps acquired first (e.g., before any morpheme-specific facts are learned), we hypothesize that the more abstract lexical phonology is then acquired by the learner on its basis, by a few strategic steps of constraint demotion. For the case at hand, this is most easily seen by placing the two systems side-by-side.

(36)



We find lexical demotions of two kinds: (i) Contextual markedness (here, *VgV) is downgraded, making the weakening of [g] a strictly postlexical affair. (ii) Faithfulness (here, IDENT(VOI)) is downgraded, enabling compound voicing as a strictly lexical process. We tentatively suggest that these two kinds of constraint demotions exhaust the range of possibilities, pending the results of further studies. The resulting picture is summarized in (37), in juxtaposition with the concepts familiar form Lexical Phonology.

(37)

constraint-based Optimality Theory:	*rule-based Lexical Phonology:*
faithfulness is lexically demoted	rule applies only lexically (is "turned off")
contextual markedness is lexically demoted	structure preservation holds only lexically

Finally, note that we have not seen a case of a lexical demotion of contextfree markedness below an antagonistic faithfulness constraint. This is not surprising since it would mean that the lexical system has a richer inventory than the postlexical one, with some lexical contrasts postlexically obliterated in all contexts. We speculate that abstract systems of this kind cannot

arise simply because they are not learnable, i.e., the corresponding restriction need not be a formal one.

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