To appear in: Roca, Iggy, ed. *Derivations and Constraints in Phonology.* Oxford University Press.

Correspondence and Compositionality: The Ga-gyō Variation in Japanese Phonology*

Junko Itô
UC Santa Cruz
ito@ling.ucsc.edu

Armin Mester
UC Santa Cruz
mester@cats.ucsc.edu

July 1996

* The names of the authors appear in alphabetical order. Even though the research reported here has undergone several major overhauls since its first presentation at the 1989 Features and Underspecification Conference held at MIT, Alan Prince and Moira Yip, who gave us substantive written comments and helpful suggestions on the 1989 version, might still recognize the outlines of the original paper. Thanks are due to audiences at MIT, UC Irvine, Osaka University, UCLA, UC Santa Cruz, Kobe University, and Stanford University, for their comments and questions, in particular, to Bruce Hayes, Motoko Katayama, Pat Keating, Paul Kiparsky, Haruo Kubozono, Yuki Kuroda, John McCarthy, Orhan Orgun, Philip Spaelti, Donca Steriade, and Rachel Walker. For a careful and critical reading of the current version of the paper, we are indebted to René Kager, Dan Karvonen, and Jaye Padgett, whose extensive written comments led to numerous improvements in both content and style. Finally, we would like to thank Iggy Roca for giving us the opportunity to contribute the paper to this volume. This work was partially supported by faculty senate grants from the University of California at Santa Cruz and by the National Science Foundation under grant SBR-9510868.

1. Voiced Velar Nasalization in Japanese Phonology

1.1 Introductory Remarks

This paper is a contribution to the study of surface-to-surface, or output-output, correspondence constraints in Optimality Theory (see McCarthy & Prince 1995 for an authoritative statement of the original proposal, as well as numerous other works cited there). The particular question to be investigated concerns the tension between two widely shared theoretical assumptions about the computation of phonological form, which, taken together, seem to lead to a contradiction. First, there is the central tenet of OT summarized in (1): Phonological constraints are constraints on outputs.

(1) **Output-orientation**
Phonological constraints apply to outputs alone or govern input-output relations; they apply simultaneously in the course of the selection of the most harmonic candidate (Prince & Smolensky 1993).

In most current conceptions (see Prince & Smolensky 1993 for some discussion of alternatives) (1) has (2) as a corollary.

(2) **Nonsequentiality and Noncylicity**
There is no sequential phonological derivation in the sense of traditional generative phonology. There is no set of rules and operations applying in a certain order; there are also no cyclic derivations, in the sense that phonological operations first apply only within the smallest morphological domains available and work upwards through a series of more and more inclusive morphological domains.

At the same time, a large body of work in phonological theory and analysis since Chomsky & Halle 1968 (SPE) lends strong support to the view that the computation of the phonological structure of complex inputs must proceed in some sense "from the inside out": The phonological structure associated with certain subdomains of the whole form plays a privileged role ("cyclic" effects). In order to have a relatively theory-neutral way of referring to the phenomena in question, we borrow some terminology from formal semantics and state that the computation of complex phonological structures fulfills some form of compositionality (3).[1]

(3) **Compositionality**
Phonological form is computed compositionally: The phonological form of a morphologically complex input is a function of the phonological form of its parts, and of their mode of combination.

As a concrete illustration that prefigures one of the central topics of the paper, let us take a compound consisting of two stems, $stem_1 \frown stem_2$. Compositionality (3) means that its phonological output form should obey the statement in (4):

(4) $\phi(\text{stem}_1 \frown \text{stem}_2) = \phi(\text{stem}_1) + \phi(\text{stem}_2)$
The phonological output form ($\phi(x)$) of an input that consists of the morphological concatenation ($\frown$) of two stems, stem_1 and stem_2, is identical with the phonological combination (+) of the phonological output forms of the two stems.

Even though there is nothing inherently derivational about Compositionality,[2] which simply expresses a relation between the phonological output form of a whole and the phonological output forms of its parts (see Orgun 1995 for discussion), it is fair to say that a strong link between compositionality effects and derivationalism has been forged in the work of Chomsky & Halle 1968 and the succeeding generation of generative phonologists, where such effects have been consistently ascribed to cyclic rule application, with very few dissenting voices (most importantly, Liberman & Prince 1977 and Selkirk 1980). In the cyclic-derivationalist view, the reason why properties of $\phi(stem_2)$, for example, are mirrored in $\phi(stem_1 \frown stem_2)$ lies in the cyclic application of the relevant rules to larger and larger parts of the input form: first separately to the individual stems, as if they stood in isolation, and only subsequently to the whole form. This tradition of cyclic analysis culminated in the theory of Lexical Phonology (Pesetsky 1979, Kiparsky 1982, Mohanan 1986), with some differences in comparison to the original SPE proposal that should not obscure the invariance of the basic approach.

---

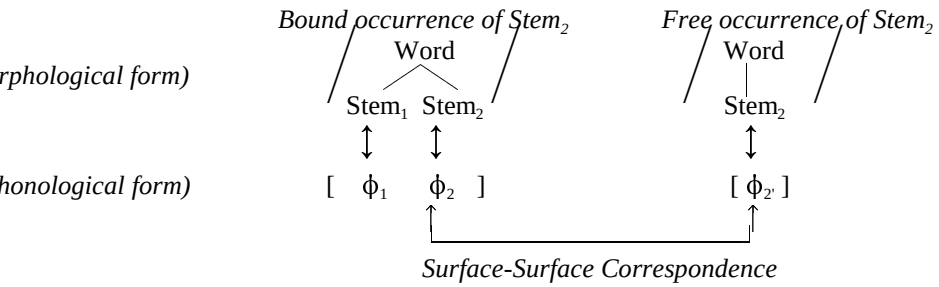
[1] (3) is vague in a number of respects, just as informal versions of the semantic principle of compositionality on which it is modeled (see von Stechow (1991: 95), where the origin of a principle of this kind in Gottlob Frege's work is discussed). For an application of the idea of compositionality in Montague Phonology, see Bach and Wheeler 1981.

[2] But is there something inherently compositional about derivations, which are restricted to the *addition* of morphological or phonological structure? As René Kager (personal communication) points out, the very notion of 'addition' amounts to a stipulation in itself, and if so, the derivational theory's 'explanation' of compositionality is only circular.

Seen from the perspective of cyclicity-based approaches to compositionality effects in phonology, then, Compositionality (3) stands in conflict with Nonsequentiality and Noncyclicity (2), and casts doubt on the program of Optimality Theory.[3] In this paper, we will argue that no such conclusion is in fact warranted—rather, compositionality effects are the results of constraints on outputs alone.

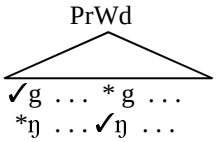
Within the theoretical context of Optimality Theory, it is natural to view Compositionality (3) not as a phonological constraint or principle in itself, but rather as a family of related constraints (a subgroup of the Faithfulness family of constraints) which are of the surface-surface (output-output) variety and hold between parts of a form and the form as a whole (for earlier versions of this proposal, see Benua 1995, Kenstowicz 1995, McCarthy 1995, Orgun 1995, Itô, Kitagawa, & Mester 1996, among others). Like all optimality-theoretic constraints, these constraints are ranked with respect to others, and are crucially violable. The basic idea is indicated in (5), in a schematic form: Compositionality effects are the results of correspondence constraints that link, for example, the bound occurrence of a stem within a compound word (ϕ_2) to its occurrence as an independent word ($\phi_{2'}$).

(5)



This paper approaches the issue through a detailed analysis of one particular phonological system, taking up a classical problem in the phonology of Japanese. A salient characteristic of the conservative dialect of Tokyo Japanese[4] is the nasalization of voiced velar plosives (*ga-gyō bionka*, henceforth "Voiced Velar Nasalization", abbreviated as VVN).[5] At first glance, VVN is nothing but a classical case of allophony, consisting in the replacement of word-internal *g* by its allophonic variant *ŋ*. As a result, the two voiced velar segments *g* and *ŋ* stand in (largely, see below) complementary distribution, as illustrated in (6), with *g* occurring initially, *ŋ* medially.[6]

(6)



The theoretical interest of this alternation, as we will show, lies in the combination of factors that block word-internal replacement of *g* by *ŋ* in a variety of contexts, leading to a superficially more complicated picture than what (6) suggests. Depending on the context, VVN may be blocked, optional, or obligatory. Some of the factors that lead to the different behavior of VVN can be traced to stratal distinctions (e.g., native vs loan), morphological structuring, and derived vs. underived environments. This would seem to be exactly the type of correlation that the derivational mechanisms, in particular those of Lexical Phonology, are designed to handle. The apparent derivational complexity of the phenomenon therefore presents a challenge for Optimality Theory. We will show in this paper that Correspondence Theory (in particular, Surface-Surface correspondence) offers a streamlined OT analysis of this complex set of factors. Perhaps more surprisingly, once the facts are considered in their totality, it turns out that the correspondence-theoretic analysis is actually superior to a Lexical Phonology account: The latter turns out to be not at all straightforward, requiring rather arbitrary assumptions which must be imposed from the outside.

The paper is organized as follows. After presenting the basic facts of the VVN alternation and its treatment in OT below, section 2

---

[3] Setting aside sequential variants of OT, see Prince & Smolensky (1993, ch. 2 and 5) for discussion and Black 1993 for a worked-out alternative model.

[4] Specifically, the variety of the language spoken by older residents of the (mostly affluent) Yamanote area of the metropolitan region. As a prestige dialect, it forms the basis for the modern standard language (*hyoojungo*), enjoying a semi-official status in government and broadcasting, which is reflected in standard pronunciation dictionaries (see Vance (1987, 1, 110) for further details).

[5] Partially having to do with sociological factors relating to the existence of nonalternating dialects, and to the fact that many younger speakers of the Tokyo dialect no longer consistently observe the *g*~*ŋ* alternation, language mavens and other cultural commentators refer to the phenomenon as "the *ga-gyō* problem" (i.e., the problem related to the *g*-column of the kana syllabary).

[6] Cf. Trubetskoi (1949, 293): "En japonais il existe entre *g* et *ŋ* un rapport de variante combinatoire, *g* n'apparaissant qu'à l'initiale de mot et *ŋ* qu'entre voyelles: ici également l'opposition *g : ŋ* ne peut différencier une pair de mots, mais cette opposition sert à délimiter le mot, *g* indicant toujours le début d'un mot." Note that Japanese syllable structure, in particular, the Coda Condition against consonantal Place (see Itô 1986, 1989 and subsequent work), rules out any possibility of PrWd-final *g* or *ŋ*.

turns to the main point of the paper, the interaction of VVN with morphological structure, and presents an analysis that makes crucial use of compositional correspondence constraints requiring identity between pairs of surface structures.
Section 3 argues that a correspondence-theoretic account within OT is superior to a derivational and rule-based alternative based on a traditional model of phonology. Section 4 concludes the paper by taking up some additional issues related to VVN in Japanese.

1.2 Facts and Basic Analysis

In traditional allophonic rule terms, VVN (Voiced Velar Nasalization) can be formulated as in (7): Underlying *g* appears as *g* in initial position, but is changed into *ŋ* in all other environments.

(7) Voiced Velar Nasalization (VVN)

/g/ → [g] / $_{PrWd}[$ —
/g/ → [ŋ] / elsewhere

Examples of PrWd-initial *g* are given in (8a), followed by examples with PrWd-medial *ŋ* in (8b). As indicated, choosing the other variant leads to illformedness in both environments.

(8) a. Initial g:

✓[**g** .....]	*[ŋ .....]	
geta	*ŋeta	'clogs'
giri	*ŋiri	'duty'
guchi	***ŋ**uchi	'complaint'
go	***ŋ**o	'(game of) Go'
garasu	***ŋ**arasu	'glass'

b. Internal ŋ:

*[... **g** ...]	✓[.... ŋ ....]	
*ka**g**i	kaŋi	'key'
*ka**g**o	kaŋo	'basket'
*kaŋ**g**ae	kaŋŋae	'thought'
*sasa**g**eru	sasaŋeru	'give'
*u**g**uisu	uŋuisu	'(Japanese) bush warbler'
*toka**g**e	tokaŋe	'lizard'
*i**g**irisu	iŋirisu	'England'

Differentiated in terms of morphological context, the nasal variant appears obligatorily in morpheme-internal position (9a-c), stem-finally before vowels (9d-e), and suffix/clitic-initially (9f-h).

(9)	MCat	+	Suffix/Clitic		
a.	kuŋu	+	ru	'pass through-PRESENT'	morpheme-internal
b.	kaŋo	+	ni	'basket+LOCATIVE'	
c.	tokaŋe	+	wa	'lizard+TOPIC'	
d.	oyoŋ	+	oo	'swim-HORTATIVE'	stem-final
e.	toŋ	+	anai	'sharpen-NEG-PRESENT'	
f.	kayoobi	+	ŋa	'Tuesday-NOMINATIVE'	suffix/clitic-initial
g.	mikka	+	ŋurai	'approximately three days'	
h.	gorira+no	+	ŋotoshi	'like a gorilla'	

The complementary distribution induced by VVN manifests itself in morpheme alternations in the case of bound roots, as in (10), which show the expected position-dependent variants. For example, /gai/ 'outside' is realized as [gai] when it is the first member of a compound (*gai-jiɴ* lit., 'outside-person', i.e., 'foreigner'), but as [ŋai] in second position (*koku-ŋai* lit., 'country-outside', i.e., 'abroad').

(10) Bound roots:

$_{PrWd}$[**g**... .....]				$_{PrWd}$[..... ŋ ..]		
gai	+	jiN	'foreigner'	koku + ŋai		'abroad'
go	+	zeN	'morning'	shoo + ŋo		'noon'
gam	+	peki	'quay, jetty, wharf'	kai	+ ŋaN	'sea shore'
gi	+	kai	'parliament'	shiŋ	+ ŋi	'deliberation'
guu	+	zeN	'accidental occurrence	soo	+ ŋuu	'meet accidentally'
gen	+	zai	'currently'	sai	+ ŋeN	'reappearance'

The compounds in (10) are made up of Sino-Japanese roots which only appear as bound morphemes.[7] The fact that they do not have a corresponding free form (i.e., **gai, *go, *gaN, *gi, *guu, *geN*, etc., as independent words) will figure centrally in the later analysis.

In their treatment of the basic allophonic relation between *g* and *ŋ*, which we adopt here in its essentials, McCarthy & Prince (1995: 353-355) take nasalization as resulting from the interaction of three constraints, ranked as in (11): The context-sensitive constraint prohibiting *ŋ* in initial position[8] outranks the context-free segment markedness constraint **g* banning voiced dorsal obstruents everywhere, which in turn outranks a relevant faithfulness constraint.[9]

(11)

*[ŋ	*$_{PrWd}$[nas(dorsal)	("ŋ is prohibited PrWd-initially")
|		
*g	*obs(dorsal)/[+voice]	("Voiced dorsal obstruents are prohibited")
|		
IdentLS(nas)	Lexical-Surface correspondents are identically specified for [nasal]	

In a broader perspective, (11) is simply a particular instantiation of the basic scheme (12) for the analysis of allophonic relations in Optimality Theory: Some constraint with syntagmatic effects is ranked over a conflicting context-free markedness constraint, which in turn dominates a relevant faithfulness constraint.[10]

(12)

constraint with syntagmatic effects
|
context-free markedness constraint
|
faithfulness constraint

In order to see how the analysis in (11) works, consider the composite tableaux for *kaŋi* and *geta* in (13) and (14).[11] In these multi-input displays, we first focus on the a-inputs /kagi/ and /geta/, respectively, with oral voiced velar segments. As the tableaux show, the

---

[7] The closest equivalent in English are so-called "Greek compounds", such as *cosmo-politan*, *micro-cosm*, *helico-pter*, *ptero-dactyl*, etc.

[8] Found frequently crosslinguistically: McCarthy & Prince 1995 point to English and Southern Paiute, see also section 4.1 below.

[9] Vance (1987, 111) points out (citing work by Donegan and Stampe) "that a velar voiced stop is more difficult than one articulated further forward, because the air chamber between the glottis and the obstruction is smaller and therefore fills up more quickly". McCarthy & Prince 1995 adopt this view and propose a constraint against voiced velar stops, noting that "[this constraint] phonologizes the familiar articulatory effect of Boyle's Law: It is difficult to maintain voicing when the supraglottal cavity is small; indeed, some nasal airflow is a typical accommodation to this articulatory challenge. The difficulty of maintaining voicing is obviously greatest when the supraglottal cavity is smallest." Empirical data bearing on this issue appear in Hayes 1996, who presents crosslinguistic inventory statistics which support the position that the velar place of articulation is indeed the least favored for obstruent stop articulations among the major places of articulation (see also section 4.1 below). Vance himself rejects a direct appeal to aerodynamics as an explanation of *g*-nasalization in Tokyo Japanese, arguing that such nasalization is not otherwise attested as a natural process resolving the velar voicing problem, and pointing to the existence of intervocalic voicing as a natural process attested in many languages. We anticipate that within a theory with violable constraints, Vance's objections are not insurmountable—e.g., intervocalic voicing of voiceless stops might be due to a dominant and overriding constraint favoring uninterrupted voicing domains—, and simply adopt a phonologization of the aerodynamic account for our analysis. In a similar way, the constraint against word-initial *ŋ* should properly be seen in the context of the status of foot/syllable-initial *ŋ* and other cases of segment distributions skewed against initial position (such as retroflexes favoring postvocalic position, see Steriade 1995 and work cited there). These and other legitimate questions are worth pursuing, but are tangential to our enterprise in this paper.

[10] See Itô & Mester (1995b, 195-205) for general remarks, illustrated by other allophonic relations in Japanese; see also Merchant 1996 for the *ich*-Laut/*ach*-Laut allophony in German. Jaye Padgett (personal communication) points out that the syntagmatic constraint at the top of this hierarchy need not necessarily be stated in terms of a specific environment, but could have a much more general content (such as a spreading imperative), whose effects would in certain contexts counteract those of the markedness constraint.

[11] The analysis in (13) and below assumes binary feature specifications, as in the standard version of Correspondence Theory (McCarthy & Prince 1995), i.e., *g* is [+dorsal, +voiced, -nasal], and *ŋ* is [+dorsal, +voiced, +nasal]. In the present context, this is strictly a matter of convenience, the analysis to follow can also be executed with privative [voice] and [nasal] features, which would require a slightly different conception of feature identity constraints (see Walker 1996 and works cited there). Dan Karvonen (personal communication) points out that insofar as the analysis expresses segment markedness relations by means of constraints such as **g* and **ŋ*, the ranking **g* » **ŋ* must hold. We will return to some issues involving markedness in the appendix (section 4).

candidate with internal *ŋ* is judged as optimal in (13) (we assume that a higher-ranked IdentLS(Place) rules out candidates like *kabi* or *kani*). On the other hand, the *g*-initial candidate wins the competition in (14) because of the overriding influence of the constraint **[ŋ*.

(13) kaŋi 'key'

Input			*[ŋ	*g	IdentLS(nas)
a.	/kagi/	(...[−nas]...)			
b.	/kaŋi/	(...[+nas]...)			
c.	/kaGi/	(...[0nas]...)			
	kagi	(...[−nas]...)		***!**	a.
					b. *
					c. *
☞	kaŋi	(...[+nas]...)			a. *
					b.
					c. *

(14) geta 'clogs'

Input			*[ŋ	*g	IdentLS(nas)
a.	/geta/	([−nas].....)			
b.	/ŋeta/	([+nas].....)			
c.	/Geta/	([0nas].....)			
☞	geta	([−nas].....)		*	a.
					b. *
					c. *
	ŋeta	([+nas].....)	***!**		a. *
					b.
					c. *

As observed by McCarthy & Prince 1995, since the segment structure constraints—both the context-free **g* and the context-sensitive **[ŋ*—outrank the relevant faithfulness constraint IdentLS(nas), the nasality specification of voiced velars in inputs is irrelevant for the output distribution of the two segments. The full tableaux in (13) and (14) above demonstrate that identical results are obtained with input *g* (the a-rows), with input *ŋ* (the b-rows), and with underspecified candidates (the c-rows). The low ranking of IdentLS(nas) means that the faithfulness constraint simply cannot play a role in the determination of the winner. Provided everything else is equal, some version of lexicon optimization (see Itô, Mester, & Padgett (1995, 593) for a formal analysis of this notion, building on Prince & Smolensky 1993 and Stampe 1972) select the /ŋ/-input in (13) and the /g/-input in (14). This would mean nonuniformity in underlying structure, a familiar situation in OT.

We note in passing an interesting aspect of the interaction of surface *ŋ* with voiced obstruents. The relevant situation arises in connection with Rendaku, a junctural process which voices the initial segment of second compound members (see Itô & Mester 1986). For example, in (15a) the *t* in *tama* 'ball' turns into *d* in *teppoo-dama*, literally, 'gun ball'. Lyman's Law regularly blocks voicing if the second compound member already contains a voiced obstruent. The internal *b* in *taba* blocks the voicing of the initial *t*, resulting in *satsu-taba*, not **satsu-daba* (15b). Against this background, consider the forms in (15c) with internal *ŋ*. It turns out that *ŋ* blocks compound voicing as well (*hasami-toŋi*, **hasami-doŋi*), i.e., surface *ŋ* here patterns with the voiced obstruents (15b) and not with the nasals (15a).[12]

(15) a. Rendaku (sequential voicing in compounds)

ta**m**a	'ball'	teppoo+**d**ama	'bullet'
ta**n**a	'shelf'	garasu+**d**ana	'glass shelf'

b. Blocking of Rendaku voicing in stems containing voiced obstruents (Lyman's Law):

ta**b**a	'bundle'	satsu+ {**t** / ***d**} aba	'wad of bills'
ta**d**e	'knotweed'	haru+ {**t** / ***d**} ade	'redshank'

[12] Not every *ŋ* is included in the Lyman's Law triggers. As shown in (i), any *ŋ* outside of the *g*~*ŋ* relation, such as a 'genuine nasal' in coda position, is Lyman's Law-neutral.

(i) teŋka 'empire' onna +**d**eŋka 'petticoat government'
keŋka 'quarrel' oyako+**g**eŋka 'quarrel between parent and child'

Both *teŋka* and *keŋka* are Sino-Japanese compounds that exceptionally undergo Rendaku, which is otherwise restricted to Yamato (native) items. Prototypical Yamato items with coda-*ŋ* always have a following *g* (because of the independent NC-restriction of Itô, Mester, & Padgett 1995, cf. also Hayes 1996) and are therefore not useful for the isolation of the Lyman's Law-behavior of coda-*ŋ* by itself.

c. Blocking of Rendaku voicing in stems containing ŋ:

toŋi	'sharpen'	hasami+{t, *d}oŋi	'knife grinder'
toŋe	'thorn'	bara+ {t, *d}oŋe	'rose thorn'

In our earlier work (Itô & Mester 1989, 1990), this was taken as evidence that the underlying segment must be *g* even in dialects with VVN. In the present theory, even though 'freedom-of-the-input' reasoning makes the explanation less direct (see (13) and (14) above), it remains true that Lyman's Law, an OCP-effect on obstruent voicing, treats all *ŋ*'s that stand in the *g*~*ŋ* relation as part of the voiced obstruent system. Although not without interest in itself, a full analysis of Lyman's Law and similar OCP-interactions goes beyond the limits of the present paper (see Itô & Mester (in prep.) for a proposal).

With the basic allophonic analysis of Voiced Velar Nasalization (4) in place, we are now in a position to turn to the morphologically complex cases, where VVN presents the analyst with an intriguing junctural puzzle.

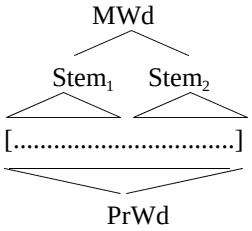
2. Surface-Surface Correspondence and Compositionality

Obligatory and optional phonological processes are typically associated with different types of morphological juncture (internal vs. external sandhi, lexical vs. postlexical level, etc., see e.g., Kiparsky 1985). The surprising fact about VVN is the systematic occurrence of both optional and obligatory instantiations of the process in one and the same morphological environment. This raises a serious problem for the traditional strategy in phonology to tie such contrasting modes of application (here, obligatory vs. optional) to different types of boundaries/levels. This section will show that this fact, far from being some small additional complication, is the key to the grammar of VVN since it reveals the central role of surface-surface correspondence constraints and of free ranking (lack of ranking specification for certain pairs of constraints in individual grammars) within the overall analysis.

2.1 A Junctural Puzzle

Japanese compounds behave accentually as single prosodic words, in the crosslinguistically established sense of permitting at most a single accent (see for example Poser 1990, Kubozono 1995, 1996, Kubozono & Mester 1995, among others).[13] The central observation is that even when both stems contain a lexical accent, the compound never appears with two accents. As a general rule, the initial member loses its lexical accent (e.g., *kúuki* 'air'+ *mákura* 'pillow' → *kuukimákura* , or *bíjin* + *konkúuru* → *bijinkonkúuru* 'beauty contest'). For present purposes, we assume that this outcome is brought about by a high-ranking Lex≈Pr constraint (or rather, by MCat-PCat alignment constraints, see Prince & Smolensky 1993, McCarthy & Prince 1995) requiring that for every MWd, there exists a PrWd which is simultaneously Left- and Right-aligned with it (see Hewitt & Crowhurst 1995 on such conjoined constraints). Given a compound word consisting morphologically of two stems, then, its (optimally-related) phonological structure will be a single PrWd, as in (16).

(16)



The structure in (16) taken together with the analysis of VVN as developed up to this point makes a clear prediction: *g* should be found only in $Stem_1$-initial (qua PrWd-initial) position: *geta+bako* 'clog cabinet', etc.; in all other positions, *ŋ* should be found to the exclusion of *g*: *kaŋe+ŋuchi* lit. 'shadow mouth', i.e. 'malicious gossip', etc.

The facts, however, are somewhat different. While it is true that $Stem_1$-initial position permits *g* and only *g*, it is not true that $Stem_2$-initial position allows *ŋ* and only *ŋ*. Rather, as illustrated in (17), instead of consistent nasalization, we find variation between *ŋ* and *g*. Thus the word for 'garden clogs', for example, can appear either as *niwa+geta* or as *niwa+ŋeta* (although the two variants are accentually identical).

[13] We follow the 'prosodic word' terminology of Kubozono & Mester 1995. Within Japanese accentology, a specialized terminology has developed since McCawley 1968, reflecting a more differentiated conception of the prosodic domains involved, and the relevant prosodic unit has also been called 'accentual phrase' and 'minor phrase' (see e.g., Pierrehumbert & Beckman 1988, Selkirk & Tateishi 1988). Nothing hinges on our particular choice of terminology, and the analysis can be easily restated in other terms. This also means that we do not exclude the possibility that further internal prosodic structure exists below the PrWd level that takes each stem to be some independent prosodic unit.

(17) Compounding with g-initial $Stem_2$: optional VVN

geta	'clogs'	niwa	+ {**g** / **ŋ**}	eta	'garden clogs'
goro	'grounder'	pitchaa	+ {**g** / **ŋ**}	oro	'a grounder to the pitcher'
gara	'pattern'	shima	+ {**g** / **ŋ**}	ara	'striped pattern'
gei	'craft, art'	shirooto	+ {**g** / **ŋ**}	ei	'amateur's skill'
go	'Go game'	oki	+ {**g** / **ŋ**}	o	'Go played with a handicap'

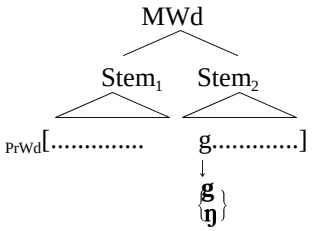
As is well known, compounds (provided their second element is a native stem) are the canonical site for Rendaku voicing, which requires the initial segment of $Stem_2$ to be voiced (e.g., ***s**ushi* vs. *maki-**z**ushi* 'rolled sushi', and ***t**ana* 'shelf' vs. *hon-**d**ana* 'book-shelf', see Itô & Mester 1986 and also (15) above). This leads to a further complication of the picture. In the same $Stem_2$-initial position where (17) shows optional VVN, we find obligatory VVN, without any variation, when the voiced velar is due to Rendaku voicing (instead of being underlying voiced). Illustrative examples appear in (18): Whenever a voiced velar in $Stem_2$ -initial position corresponds, via Rendaku, to *k* in the independent form of the stem, it obligatorily appears as *ŋ*.

(18) Compounds involving Rendaku: obligatory VVN

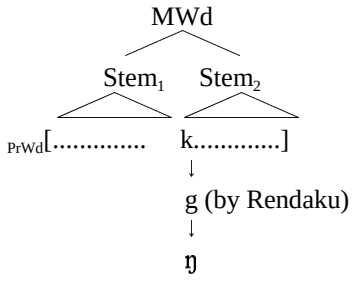
kuni	'country'	yuki	+ {**ŋ** / ***g**}	uni	'snow country'
kami	'paper'	ori	+ {**ŋ** / ***g**}	ami	'origami paper'
kaeru	'frog'	gama	+ {**ŋ** / ***g**}	aeru	'toad frog'
keŋka	'fight'	oyako	+ {**ŋ** / ***g**}	eŋka	'parent-child fights'
kaki	'writing'	yoko	+ {**ŋ** / ***g**}	aki	'horizontal writing'
kusuri	'medicine'	nuri	+ {**ŋ** / ***g**}	usuri	'medical ointment/cream'
kirai	'dislike'	onna	+ {**ŋ** / ***g**}	irai	'woman-hater, misogynist'

As schematically shown in (19), the underlying voiced velar *g* shows variation, with optional VVN, whereas Rendaku-induced *g* shows obligatory VVN and no variation.

(19) a. Underlying /g/ (cf. (17))



b. Rendaku-induced /g/ (cf. (18))



McCawley (1968, 86-87), who was the first to draw theoretical attention to these facts, points out that this difference in behavior between underlying *g*'s (19a) and Rendaku-induced *g*'s (19b) in compounding is puzzling since no plausible junctural explanation suggests itself. Positing different junctures (or levels) for the two cases would be nothing but a diacritic for optional vs. obligatory VVN, and would mean missing the overall generalization, namely, that the two cases are exactly alike in every other respect, for example, accentually. Similar considerations show that it would also not do to assume that there is some 'optional' internal prosodic word formation for the second stem in (19a): crucially, variable VVN here does not correlate with variable accent patterns.[14]

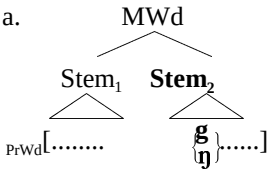
[14] From a different (and mainly historical) perspective, Martin 1987 notes that the behavior of the *k* and *g* under compounding in Tokyo Japanese is noteworthy in view of the probable historical origin of VVN, namely, a pattern of intervocalic weakening effects. Such a consonant gradation pattern has been reconstructed for the proto-language and is still found in the Tohoku dialect of northern Japan (Muraki 1970, Kanai 1982), as illustrated in (i).

(i) a. /ha**t**a/ → ha**d**a 'flag'
b. /ka**k**i/ → ka**g**i 'persimmon'
c. /ha**d**a/ → ha^{n}**d**a 'skin'
d. /ka**g**i/ → kaŋi 'key'

2.2 Optional Nasalization as a Free Ranking Effect

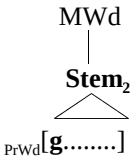
We begin our analysis with the case of optional VVN: When $Stem_2$ is *g*-initial in isolation, the compound juncture gives rise to variation, as depicted in (20). This raises two interrelated questions: (i) Why is PrWd-internal *g* possible here? and (ii) why do we find variation between *ŋ* and *g*, instead of a uniform outcome?

(20) a.



E.g. $_{PrWd}$[niwa + {g, ŋ}eta] 'garden clogs'

b. in isolation:



$_{PrWd}$[**g**eta] 'clogs'

The simplest and most attractive answer to the first question is already contained in diagram (20): In a sense to be made precise, *g* is possible in compound-internal position (*niwa+geta*) because $Stem_2$ also occurs in isolation (*geta*), where it shows *g* (and only *g*) as its first segment. This appeal to a corresponding independent form finds both a natural place and a precise formalization in the context of recent work on Surface-Surface correspondence (Benua 1995, McCarthy 1995, Itô, Kitagawa, & Mester 1996, Kenstowicz 1995). The idea, then, is to focus on the fact that the related simplex (non-compounded) form of $Stem_2$ (e.g., ***g**eta* 'clog') shows surface PrWd-initial *g*. A version of the relevant Surface-Surface correspondence constraint IdentSS is given in (21). It is responsible for the PrWd-internal *g* in the compound *niwa**g**eta* by requiring segmental correspondence to the related surface form ***g**eta*.

(21) IdentSS($Stem_{bound}$, $Stem_{free}$)
The bound form of a stem is segmentally identical with its corresponding free form:
$\{(Stem_{bound} = Stem_{free}) \wedge [\phi(Stem_{free}) = p\ ]\} \supset (\phi(Stem_{bound}) = p)$

A pair consisting of a bound and a free occurrence of a stem incurs one violation of IdentSS for each pair of nonidentical correspondent segments (i.e., the unit of measurement here is the segment and not the feature, a point that will turn out to be important in section 2.3 below).

Taking up our remarks at the beginning of this paper (see section 1), IdentSS is nothing but one element from a set of low-level surface-surface identity constraints through which the overall imperative of compositional computation of complex forms is implemented in an optimality-theoretic grammar, distributed over the constraint system. The instantiation for compounds is given in (22) (here repeated from section 1).

(22) $\phi(stem_1 \frown stem_2) = \phi(stem_1) + \phi(stem_2)$
"The phonological output form ($\phi(x)$) of an input that consists of the morphological concatenation ($\frown$) of two stems, $stem_1$ and $stem_2$, is identical to the phonological combination (+) of the phonological output forms of the two stems."

There is, strictly speaking, no 'principle of compositionality' in the sense of some unshakable truth. In Optimality Theory, the compositionality imperative is rather distributed over the constraint hierarchy in the familiar way, namely, in the form of individually ranked and individually violable constraints. This is a more flexible and arguably superior conception of compositionality than a monolithic all-or-nothing principle. Note, again, the fallacy of projecting some kind of quintessentially derivational nature into the facts of compositionality. The essential insight behind the derivational metaphor is the asymmetry of compositional relations, that is, the isolation form of the parts crucially enters into the form of the whole, not vice versa. But this primacy of the parts is hardly surprising, and it is not absolute— as Prince & Smolensky (1993, ch. 3) have shown, 'bottom-up' effects are found alongside 'top-down' effects in the phonologies of natural languages—a situation naturally captured by ranked and violable constraints.

Our next task is to find a place for the new constraint IdentSS (21) within the basic analysis discussed in section 1 (here repeated in (23)).

(23) *[ŋ » *g » IdentLS

As it turns out, this provides us with a very simple way of solving the second of the problems raised above, viz.: Why is *ŋ* possible at all at the beginning of $Stem_2$, given that *g* is required by (21)? The answer must be that the compositional correspondence constraint

---

Intervocalic voiceless stops (ia,b) undergo voicing, and intervocalic voiced stops (ic,d) are nasalized in a non-neutralizing way: /d/ is prenasalized to [ⁿd], and /g/ appears fully nasalized as [ŋ]. But the derived voiced stops in [hada] (ia) and [kagi] (ib) do not undergo further nasalization. Against this background, the interaction of VVN with Rendaku is surprising: *g* weakens only optionally to *ŋ* (19a), whereas *k* obligatorily shifts all the way to *ŋ* (19b). Gradation systems typically exhibit a chain-shift pattern as in (i), where shifts occur in staggered stages, i.e., in a contrast-preserving ("counter-feeding") way (see Pullum 1983 for relevant discussion, and see also Kirchner 1996 for an OT analysis of such phenomena).

IdentSS (21) does not reign supreme, but rather occupies a dominated position in the ranking. More precisely, as shown in (24), it occupies the same rank as the segmental markedness constraint **g*, i.e., two constraints are unranked with respect to each other. We refer to this kind of scenario as *free ranking*.[15]

(24) *[ŋ » { ***g** / **IdentSS** } » IdentLS

Postponing further discussion for a moment, we interpret the lack of ranking here as follows: A violation of *either* constraint can count as dominating a violation of the other, the choice is left open by the grammar. Free ranking derives two winners in a two-competition (two-tableau) scenario, as in (25ab), with one competition per ranking. In (25) and subsequent tableaux, "Surf" denotes the independent surface form of $Stem_2$, and underlining expresses the Surface-Surface correspondence relation.

(25) a. **[IdentSS » *g]** -ranking

Lex: /niwa-geta/ Surf: [geta]	*[ŋ	**IdentSS**	***g**	IdentLS
☞ [niwa geta]			*	
[niwa ŋeta]		***!**		*

b. **[*g » IdentSS]** -ranking

Lex: /niwa-geta/ Surf: [geta]	*[ŋ	***g**	**IdentSS**	IdentLS
[niwa geta]		***!**		
☞ [niwa ŋeta]			*	*

With the [IdentSS » *g]-ranking (25a), the *g*-candidate *niwageta* is the winner, because being identical to the related surface form *geta* is more important than avoiding the voiced velar *g*. On the other hand, the [*g » IdentSS]-ranking (25b), with a stronger aversion to voiced velars, awards the palm to the *ŋ*-candidate *niwaŋeta*. In both (25a) and (25b), the **[ŋ* constraint is fulfilled by all candidates (there is no PrWd-initial *ŋ*), and IdentLS plays no crucial role since the competition is already decided by the higher ranking markedness constraint **g* and the compositional correspondence constraint IdentSS. Even if the input for the tableaux above was taken to be *niwa-ŋeta*, the winners would still be the same.

In the free ranking approach in (25a,b), strict domination holds within each competition, even though it is not observed in the grammar (i.e., in the overall constraint ranking). As an alternative where strict domination does not even hold for individual competitions, there is the *tied ranking* interpretation: two (or more) constraints are true equals, in the sense that a violation of neither constraint ever counts as dominating a violation of the other. This type of ranking has been invoked in ranking paradox situations where any specific dominance relation between two constraints derives incorrect results for some inputs (for an example, see Ní Chiosáin 1995). Closer to the purpose at hand, tied ranking opens up the possibility for a single competition to yield two optimal candidates, and has been used in Müller 1995 and Smolensky 1996 to account for optionality phenomena in syntax.

Tied ranking means that violations of the two constraints IdentSS and **g* count as equivalent: It is just as bad to violate IdentSS as it is to violate **g*. In (26), this is indicated by assigning the two relevant constraints to the same column in the tableau, without a separating vertical line. It stands to reason that tied ranking only produces two winners in a single competition when the candidates in question perform equally well with respect to all other constraints, including the lower-ranked ones. This condition is frequently not fulfilled, as shown in (26a,b), where the (otherwise inert) low-ranked constraint IdentLS breaks the tie in favor of the input-faithful candidate.

(26) a.

Lex: /niwa-geta/ Surf: [geta]	*[ŋ	IdentSS	*g	IdentLS
☞ [niwa geta]			*	
[niwa ŋeta]		*		***!**

[15] Building on an idea first put forth in Prince & Smolensky (1993, 51), this approach to optionality and variation has proved fruitful in sociolinguistics (see, for example, a number of the papers presented at NWAVE XXIII) and has been taken up in work by Kiparsky 1993b, Kager 1994, Liberman 1994, Reynolds 1994, Sells, Rickford, & Wasow 1994, Anttila 1995, Hayes & MacEachern 1996, among others.

b.

Lex: /niwa-ŋeta/ Surf: [geta]	*[ŋ	IdentSS *g	IdentLS
[niwa geta]		*	*!
☞ [niwa ŋeta]		*	

In this tied ranking scenario, the *input* specification of the voiced velar segment becomes all of a sudden crucial (different from the free-ranking analysis presented earlier)—now the source for optionality lies in the indeterminacy of the input, and not in the constraints or their ranking.[16]

Indeterminacy in input specification (see section 1 above), hitherto considered analytically awkward, would here be put to full advantage: Surface indeterminacy (i.e., optionality) directly results from lexical indeterminacy. This is an intriguing outcome which, while deserving further attention, will be left for future exploration. The remainder of the paper adopts the more conservative free ranking interpretation (24-25), which adheres to the strict domination doctrine of Prince & Smolensky (1993).

2.3 Rendaku Voicing and Obligatory Nasalization

Besides accounting for the optionality of VVN at compound junctures, the analysis in (24) has the additional benefit that it explains the surprising asymmetry noted above in (19) between underlying voiced velars in $Stem_2$-initial position, and cases whose voicing is Rendaku-induced (variation in the former cases, no variation in the latter). The minimal-pair contrasts in (27) (due to Kamei 1956 and Kindaichi 1967) are reported to be very clear for speakers of a consistent VVN-dialect.

(27)

Underlying [+voi]: optional VVN			*Rendaku-induced [+voi]: obligatory VVN*		
boN	+ {g, ŋ}oro	‘mediocre grounder’	boN	+ ŋoro	‘Bon period’
	goro	‘grounder’		koro	‘time’
oo	+ {g, ŋ}ama	‘big toad’	oo	+ ŋama	‘big kettle’
	gama	‘toad’		kama	‘kettle’
ita	+ {g, ŋ}arasu	‘plate glass’	ita	+ ŋarasu	‘pain crow’
	garasu	‘glass’		karasu	‘crow’
kita	+ {g, ŋ}iši	‘kita technician’	kita	+ ŋiši	‘north shore’
	gishi	‘technician’		kishi	‘shore’
ki	+ {g, ŋ}umi	‘yellow berry’	ki	+ ŋumi	‘yellow group’
	gumi	‘berry’		kumi	‘class’

It turns out that our analysis already contains the basic ingredients for the solution, once the familiar Rendaku voicing requirement is incorporated into the constraint system. The requirement is stated informally in (28) as a sequential voicing constraint SeqVoi, which can be taken as a constraint-based counterpart[17] to the (language-specific) voicing morpheme figuring in earlier analyses (see Itô & Mester 1986, and see Anderson 1992 for recent discussion of alternatives to the traditional concept of a morpheme within a rule-based framework).

(28) **Sequential Voicing (SeqVoi)**: “In $[_{Wd}\ X_1\ X_2\ ]$, X_2 begins with a [+voi] segment.”
(informal statement)

[16] Another relevant input candidate is one in which the voiced velar is unspecified for [nasal] (indicated by capitalization):

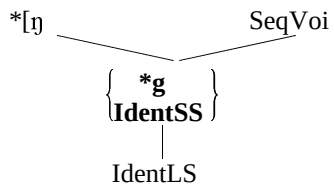
Lex: /niwa-Geta/ Surf: [geta]	*[ŋ	IdentSS *g	IdentLS
☞ [niwa geta]		*	*
☞ [niwa ŋeta]		*	*

Here the relevant competing candidates (assuming a high-ranking constraint requiring surface specification as either [+nasal] or [−nasal]) are treated equally by Ident LS(nas) and emerge as co-winners in a single competition (as in Müller 1995 and Smolensky 1996; see also Hammond 1994 for an analysis deriving stress variability in Walmatjari from the fact that the constraint system is not fine-grained enough to determine a single winner in all situations).

[17] This formulation is chosen here mainly in order to sidestep some distracting technical complications of the analysis. The status of SeqVoi (28) in our analysis is akin to that of Free-V in Prince & Smolensky’s 1993 analysis of Lardil since it is presumably a language-particular constraint—even though one could always declare it universal, in the uninteresting Pickwickian sense of being ranked at the bottom of the hierarchy in most, if not all, languages except Japanese (and, perhaps, the Northern Athapascan language Slave, see Rice 1988). A formal OT analysis of sequential voicing is developed in Itô & Mester (in prep.), in the context of an investigation of its interaction with the OCP.

SeqVoi (28) is not dominated by any of the other constraints here under investigation (even though dominated in the overall analysis by the OCP, which is responsible for Lyman's Law effects, see (15) above and Itô & Mester 1986). The constraint diagram (29) shows that SeqVoi (28) ranks crucially above the Ident constraints and the markedness constraint **g*.

(29)



Tableaux for the illustrative input /yuki+kuni/ 'snow country', where the selection of the winning candidate crucially involves Rendaku, are given in (30) for the two different ranking scenarios, [IdentSS » *g] (30a) and [*g » IdentSS] (30b).

The central result is that in this case ranking variation does not translate into variation in the output. With either ranking, the same candidate is selected, namely, the *ŋ*-candidate *yuki+ŋuni*. This is so because the compositional correspondence constraint IdentSS is violated both by the *g*-candidate (*yuki+guni*, with Rendaku-voicing) and the *ŋ*-candidate (*yuki+ŋuni*, with Rendaku-voicing and nasalization), since neither is identical (in its second part) to the isolation form *kuni*. Therefore, IdentSS is unable to distinguish between the two, whatever its ranking. The only candidate to fulfill IdentSS (and IdentLS) is the *k*-candidate (*yuki+kuni*), which loses the competition early in violating high-ranking SeqVoi. This means that the markedness constraint **g* is all-powerful, selecting the *ŋ*-candidate (*yuki+ŋuni*) in both competitions.

(30) /yuki+kuni/ 'snow country'

a. **[IdentSS » *g]** -ranking:

Lex: /yuki-kuni/ Surf: [kuni]	*[ŋ	SeqVoi	**IdentSS**	***g**	IdentLS (nas)
[yuki guni]			*	***!**	*
☞ [yuki ŋuni]			*		*
[yuki kuni]		***!**			

b. **[*g » IdentSS]** -ranking:

Lex: /yuki-kuni/ Surf: [kuni]	*[ŋ	SeqVoi	***g**	**IdentSS**	IdentLS (nas)
[yuki guni]			***!**	*	*
☞ [yuki ŋuni]				*	*
[yuki kuni]		***!**			

Obligatoriness of *ŋ* in Rendaku contexts thus follows without special pleading, and the fact that *k* goes all the way to *ŋ* is not a surprise, given surface-surface correspondence. Since they do not correspond to any isolation surface form, Rendaku-induced *g*'s are not under the protection of IdentSS.

It is essential in this context that IdentSS (see (21) above) operates at the level of the segment and is not specific to an individual feature like [nasal] (cf. the Input-Output constraint IdentLS(nas)). Two occurrences of a stem fulfill IdentSS (i.e., are segmentally identical) if all pairs of correspondent segments are identical. Segment identity itself is determined in a categorical ("yes/no") way and not in a gradient way, in terms of individual features shared. The latter could be implemented (i) by a single gradiently violable segment identity constraint, or (ii) by a family of feature-specific identity constraints). Either scenario yields wrong results: In (i), the *ŋ*-candidate would show two violations (*[+nas] and *[+voi]) and therefore lose to the *g*-candidate in (30a), which only has one violation: *[+voi]. In (ii), the ŋ-candidate would violate both IdentSS[nas] and IdentSS[voi], whereas the g-candidate would violate only the latter. This shows the importance of a nongradient notion of segment identity, besides all gradient measures of similarity.[18] Taking note of the fact that this is a necessity for the present analysis, we speculate that the difference between the two Ident

[18] Cf. Cohn & McCarthy (1994: 54) for a related case. Note also that IdentSS in Japanese is still limited to segmental identity—the prosodic form of free and bound occurrences can differ (for example, accentually).

constraints is a reflection of a more fundamental difference between "input-output" (LS) faithfulness and "output-output" (SS) identity, an issue beyond the scope of the present investigation.[19]

2.4 Obligatory Nasalization of Bound Elements

Besides Rendaku-voiced velars discussed in the preceding subsection, there are also underlying voiced velars which do not show optionality at compound junctures. Again, there are well-known minimal pairs (Kamei 1956, Kindaichi 1967) illustrating the contrast between optional and obligatory VVN, as shown in (31). For example, we have a contrast between 'poison moth' and 'poison fang', where 'poison moth' can be pronounced *doku-ga* or *doku-ŋa*, but 'poison fang' is obligatorily *doku-ŋa*.

(31)

Stem$_2$ occurs as a free form: optional VVN			*Stem$_2$ does not occur as a free form: obligatory VVN*		
doku	+ {g, ŋ}a	'poison moth'	doku	+ ŋa	'poison fang'
	ga	'moth'		*ga	'fang' (→ kiba)
seN	+ {g, ŋ}o	'thousand-five'	seN	+ ŋo	'post-war'
	go	'five'		*go	'after' (→ ato)
ko	+ {g, ŋ}aN	'solitary wild goose'	ko	+ ŋaN	'lake shore'
	gaN	'wild goose'		*gaN	'shore (→ kishi)
ai	+ {g, ŋ}o	'matched go-players'	ai	+ ŋo	'tender care'
	go	'Go'		*go	'care' (→mamoru)

As the table already shows, this is not a haphazard collection of optional and obligatory nasalized forms. A correlation is found between optionality and the status of the second compound element as an independent lexical item (i.e., occurring in isolation), as indicated in the right-hand column in (31). For example, *ga* in the meaning of 'moth' can occur as a free (noncompounded) form, but not when it refers to 'fang', in which case it only occurs as a bound element. When referring to a fang in isolation, the alternative lexical item *kiba* (shown in parenthesis to the right of the ungrammatical form) is used.[20]

Why, then, is nasalization optional when Stem$_2$ can stand alone as an independent word, and obligatory when it cannot? It is of course possible to appeal to a distinction in morphological category, e.g., between bound stems and free stems, and rely on a junctural solution for these cases (as in Itô & Mester 1989, 1990). But from the present vantage point, such proposals merely serve to encode the crucial factor, namely, the existence or non-existence of a free form. The strength of the present analysis is that no such appeal to morphological category distinction is necessary or warranted, since the analysis developed so far already covers these new cases, without any change or extension: Just as in the case of Redaku-induced voicing discussed in the preceding subsection, variation is absent in this case because the IdentSS constraint is irrelevant for candidate selection in these cases, wherever it is ranked. In this case, however, the relevant candidates all tie with respect to IdentSS not because they all violate it (as in the Rendaku case), but because they all fulfill it: When the second member is a bound form, there is no surface correspondent, and hence IdentSS is vacuously satisfied, and either ranking leads to the *ŋ*-candidate, as shown in (32).[21]

---

[19] Care must be taken in characterizing constraints like IdentSS (21) in terms of "gradience" and "multiple violation": Even though it does not matter *how much* an individual segment diverges from its correspondent, it does matter *how many* segments are different from their correspondents. IdentSS measures identity in terms of whole segments, but, as René Kager (personal communication) reminds us, can incur multiple violations, depending on the number of nonidentical pairs of segments: *pata/bata* and *pata/mata* show one violation, *pata/bati* and *pata/mati* two, etc.

[20] The same Kanji character (GA) is used for both the (Sino-Japanese) bound form *+ga+* (*ondoku* 'sound reading') and the isolation (Yamato) form *kiba* (*kundoku* 'meaning reading'). This kind of contrast is perhaps most equivalent in English to Greek/Latinate versus Germanic morphemes, such as *penta-* and *five*, where only the Germanic form *five* can be used as an independent lexical item. As Iggy Roca (personal communication) has reminded us, the notion of an independently existing form is not as straightforward as it might at first glance seem. What seems to be involved, beyond mere existence, is the establishment of a true connection between dependent and independent occurrence. Thus some Sino-Japanese stems have independent uses, which are arguably not connected in a derivational way to their bound occurrences inside established compounds. See note 21 for related discussion.

[21] An alternative approach to optionality that comes to mind in this context could exploit differences in the *accessibility* of independent correspondents in cases like (32). The vacillation between *g* and *ŋ* is traced back not to some ranking variation, but rather to the character of the candidate set itself that enters the selection process (namely, as either equipped with an SS-relation, or without such a relation.) More specifically for the case at hand, the ranking is fixed as [*[ŋ » IdentSS » *g » IdentLS], and the optionality effect is captured by whether or not the surface form of the compound member in isolation is available to the computation. In (a), the surface form [*geta*] is available, and hence IdentSS is instrumental in selecting the *g*-candidate. On the other hand, in (b), no independent surface form is available, making IdentSS powerless.

(32) /doku-ga/$_{Lex}$ 'poison fang' ☞ [doku ŋa]

a.

Lex: /doku-ga/ Sur: ---	*[ŋ	**IdentSS**	***g**	IdentLS
[doku ga]			*!	
☞ [doku ŋa]				*

b.

Lex: /doku-ga/ Sur: ---	*[ŋ	***g**	**IdentSS**	IdentLS
[doku ga]		*!		
☞ [doku ŋa]				*

2.5 Summary

To recapitulate the analytical results of this section, we have achieved a single unified analysis (33) for what at first appears to be a diverse patterning of VVN in compounds summarized in (34) and (35).

(33) *[ŋ » {***g** / **IdentSS**} » IdentLS

(34) VVN Variation:

Stem$_2$ occurs in isolation.

doku + {**g** / **ŋ**}ama 'poison toad' gama 'toad' (section 2.2)

(35) No VVN Variation:

a. Stem$_2$ occurs in isolation, but undergoes Rendaku in compounds.

doku + ŋuchi 'abusive language' kuchi 'mouth' (section 2.3)

b. Stem$_2$ does not occur in isolation.

doku + ŋa 'poison fang' *ga 'fang' (kiba) (section 2.4)

Classical OT ranking logic tells us that the ranking of two constraints makes a difference only when the two competing candidates each pass, and fail, one of the constraints, as in (36), here leading to variation due to the free ranking of these two constraints, IdentSS and *g.

---

a.

Lex: /niwa-geta/ Surf: [geta]	*[ŋ	IdentSS	*g	IdentLS
☞ [niwa geta]			*	
[niwa ŋeta]		*		***!**

b.

Lex: /niwa-geta/ Surf: ---	*[ŋ	IdentSS	*g	IdentLS
[niwa geta]		*vac.*	***!**	
☞ [niwa ŋeta]		*vac.*		*

There may be some empirical evidence that favors this kind of interpretation. Although all the relevant compounds exhibit optionality, speakers note that some compounds usually have *ŋ*, others tend to have *g*, and still others that are truly optional (cf. NHK 1985). When the compound itself is more widely used than the individual item, then *ŋ* is preferred, whereas if the individual item is more common than the compound, *g* is preferred. When both the compound and the individual item are just as common (or rare), then no preference is given. Which words belong to which type differs widely with respect to individual speakers —not surprisingly, since usage of a certain word or compound surely differs among individual speakers. Although more serious empirical and statistical work would have to be done on the topic, the noted tendencies might be attributed to the accessibility of the independent correspondent. When the speaker perceives the particular compound to be compositional, then the compositional correspondence constraint IdentSS is relevant (leading to the *g*-candidate), but not otherwise (leading to the *ŋ*-candidate).

(36)

L: /doku-gama/ S: [gama]	**IdentSS**	***g**
☞ [doku gama]		*!
[doku ŋama]	*	

L: /doku-gama/ S: [gama]	***g**	**IdentSS**
[doku gama]	*!	
☞ [doku ŋama]		*

On the other hand, if the candidates either both violate (37a) or both satisfy (37b) one of the constraints, then the constraint in question (here, IdentSS) has no deciding power. When a constraint is in this way irrelevant, it stands to reason that its ranking with respect to the other constraint will also be irrelevant—hence different rankings have no effect and lead to the same winner.

(37) a. IdentSS violated:

L: /doku-kuchi/ S: [kuchi]	**IdentSS**	***g**
[doku guchi]	*	*!
☞ [doku ŋuchi]	*	

L: /doku-kuchi/ S: [kuchi]	***g**	**IdentSS**
[doku guchi]	*!	*
☞ [doku ŋuchi]		*

b. IdentSS satisfied:

L: /doku-ga/ S: ---	**IdentSS**	***g**
[doku ga]		*!
☞ [doku ŋa]		

L: /doku-ga/ S: ---	***g**	**IdentSS**
[doku ga]	*!	
☞ [doku ŋa]		

The upshot of the analysis is that the complex of optionality/obligatoriness factors that has defied a junctural solution turns out to have at its core a fairly simple OT constraint ranking analysis. In order to complete the argument, we now turn to a possible lexical phonological account along lines previously pursued in our earlier work (Itô & Mester 1989, 1990), and show why the OT analysis is superior.

3. A Derivational Alternative

VVN exhibits many of the characteristics and correlations that Lexical Phonology (LP), supported by appropriate assumptions about featural underspecification, is designed to handle: the distinction between obligatory and optional VVN is reminiscent of properties typically associated with lexical vs. postlexical rule application; alternation in derived contexts (*gai+jiN* 'foreigner' vs. *koku+ŋai* 'abroad') is accompanied by a corresponding lack of contrast in underived contexts (*kaŋi*, **kagi* 'key'), a correlation that is the hallmark of the strict cycle; and finally, different phonological behavior in morphologically complex cases is expected to follow from cyclicity, as it is built into the architecture of standard LP (Kiparsky 1982, 1985).

An account along such lines recalls the central strategy of classical generative phonology (Chomsky & Halle 1968), faithfully preserved in LP, namely, to seek the explanations for complex phonological patterns in the inner workings of a multi-staged derivational phonology: with cyclic vs. non-cyclic rule application, Structure Preservation, lexical levels, underspecified representations gradually filled up by batteries of default rules, etc. As Itô & Mester 1989, 1990 have shown, an analysis of VVN using the resources of Lexical Phonology indeed looks initially very promising, viewed in the abstract from an eagle's perch. However, in order to be able to make any valid comparison between the OT analysis developed in this paper and such a derivational alternative, we must at least sketch a concrete LP analysis which actually captures all the generalizations of VVN.

3.1 Cyclic Default Rules and Specificational Blocking

Within a derivational analysis, Voiced Velar Nasalization is conceived of as a rule, here formulated as in (38).

(38) VVN: [+voiced, +dorsal] → [+nas] / ... __ (where ... is nonnull.)

The first analytical step is to invoke an obligatory/optional distinction between a lexical and a postlexical application of (38). Lexical applications are responsible for the obligatory appearance of *ŋ* in word-internal contexts (e.g., *kaŋi* 'key', *tookyoo+ŋa* 'Tokyo-NOM'). Postlexically, (38) should apply optionally at compound junctures, leading to variation (e.g., *niwa-geta* ~ *niwa-ŋeta* 'garden clogs').

A moment's reflection reveals, however, that distinguishing the two levels in this way is not sufficient to account for the junctural puzzle noted in section 2.1: When the compound juncture is occupied by a velar whose voicing is Rendaku-induced, then *ŋ* is obligatory (e.g., *yuki-ŋuni* 'snow country', *kuni* 'country'). Differentiating compound types (between those that undergo obligatory VVN or optional VVN) in terms of further level distinctions is not an acceptable solution, since, as discussed in detail in section 2, there is no other correlating difference, either morphological or prosodic, between compounds like 'snow country' (*yuki-ŋuni* with Rendaku and obligatory *ŋ*) and 'garden clogs' (*niwa-geta ~ niwa-ŋeta* with optional *ŋ*) except for the fact that Rendaku happens to be able to leave an audible mark on the former, but not on the latter.

What is necessary to get the derivational analysis off the ground is to start with the assumption that lexical VVN also applies obligatorily to compounds (to account for the cases involving Rendaku) but that it is blocked—by some mechanism to be discussed below—from applying in those cases where the *g* must be protected against obligatory nasalization, so as to remain a candidate for later optional postlexical VVN. A partial derivation of the relevant forms is given in (39). The bolded lexical outputs show *yuki-ŋuni* with *ŋ* and *niwa-geta* with *g*; only the latter is available for the optional postlexical application of VVN, leading to variation in its postlexical output, *niwa-geta* and *niwa-ŋeta*. Variation is not found for *yuki-ŋuni* since its *ŋ* is derived by the obligatory lexical application of VVN.

(39) Lexical:

Compound cycle:	yuki-kuni	niwa-geta
Rendaku:	... g ...	----
VVN (obligatory):	... ŋ ...	*"blocked"*
Lexical output:	**yuki-ŋuni**	**niwa-geta**

Postlexical:

VVN (optional):	----	... {g, ŋ} ...
Postlexical output:	**yuki-ŋuni**	**niwa-{g, ŋ}eta**

The remaining challenge is to explain why lexical VVN is blocked in *niwa-geta*. In the earlier cycle [*geta*], *g* is initial and the structural description of VVN is not met. In the compound cycle, however, *g* has become word-internal through compounding, in other words, *g* stands in a derived environment—why is it not subject to obligatory VVN? It is clear that neither Cyclicity nor the Strict Cycle Condition of standard Lexical Phonology (Kiparsky 1982, 1985) provides a solution, the answer has to be sought elsewhere. As demonstrated in Itô & Mester 1989, 1990, the blocking effect can be achieved by shifting the explanatory burden away from the Strict Cycle Condition and towards a very different assumption, namely, that lexical rules are strictly feature-filling (i.e., they cannot change feature specifications), coupled with cyclic default rules. More precisely, the analysis incorporates the following assumptions (40).[22]

(40)
a. Underspecification of the feature [nasal] for velar segments.
b. Lexical (cyclic) VVN is feature-filling, assigning [+nasal] to non-initial *g*'s.
c. Postlexical VVN is feature-changing.
d. A cyclic default rule fills in [–nasal] (or, if [nasal] is treated as privative, another appropriate feature, such as [oral] or [raised velum]) on initial *g*'s.

This basic scheme is illustrated in (41), where voiced velars underspecified for nasality are indicated by capital G. Lexical VVN supplies the specification [+nasal] in *kaGo → kaŋo* 'basket', and the cyclic default rule fills in [–nasal] in *Gomi → gomi* 'rubbish'.

(41)	/kaGo/ 'basket'	/Gomi/ 'waste, rubbish'
VVN (feature-filling)	kaŋo	---
Cyclic [–nas] default:	---	gomi

For *niwa-geta* in (42), the cyclic default rule applies on the earlier [*geta*]-cycle, thereby preventing VVN on the compound cycle [*niwageta*]. The optional postlexical version of the rule—which is assumed to be feature-changing, different from the lexical version—is not blocked by the prior application of the default rule, and derives the optional surface *ŋ*-variant correctly.

[22] In making these assumptions, the LP analysis of VVN developed in Itô & Mester 1989, 1990 is in many ways reminiscent of the revised model of Lexical Phonology that was later independently proposed in Kiparsky 1993a.

(42) Lexical

Stem cycle	/niwa/	/Geta/
VVN+cyclic default:	niwa	geta
Compound (word) cycle:	niwageta	
VVN (feature-filling, obligatory):	*"blocked"*	

Postlexical

VVN (feature-changing, optional): niwa{g, ŋ}eta

Given (40), lexical VVN only applies to voiced velar archisegments (i.e., segments underspecified for the feature nasal). At a given stage of the derivation, such archisegments will be available only if there is no earlier cycle in which VVN or the cyclic default rule could have taken place. In other words, the analysis encodes morphological structure as feature structure.
For example, the suffix /-Ga/ (43) 'Nominative' does not constitute a cyclic domain, and as a result, its voiced velar will for the first time be subject to VVN on the cycle of the full suffixed form *geta-Ga* 'sandals-NOM', where it undergoes VVN. If the suffix constituted a cycle on its own, the default rule would have inserted [–nasal] on this domain, thereby wrongly preventing lexical, hence obligatory, nasalization.

(43)

	/Geta/	/-Ga/	
Stem cycle:	Geta		
VVN+default	geta		
Word cycle:	geta	Ga	
VVN+default		ŋ	
Output:	geta	ŋa	'clogs+NOM'

In order to account for the VVN-behavior of stems that do not happen to occur as independent forms, it is necessary to assume that they (mostly of Sino-Japanese origin) fail to constitute cyclic domains. This entails that such stems become available for lexical rule application only on the cycle where they are conjoined with another lexical element (typically another stem). Given the lack of an earlier cycle, archisegmental G is preserved undisturbed up to this point, setting the form up for lexical (hence obligatory) VVN. This account is illustrated by the stem /-Gai-/ 'outside' (*koku+ŋai* 'abroad', cf. *gai +jiN* 'foreigner') in (44).

(44)

	/-koku-/	/-Gai-/
Stem cycle:	---	---
Word cycle:	koku + Gai	
VVN+default:	koku + ŋai	

Compounds with Rendaku-derived *g*'s unquestionably have an internal cycle—but they lack a *relevant* internal cycle, i.e. a cycle on which the default rule could have filled in [–nasal] (on a voiced velar). As illustrated in (45), the underlying form /kuni/ is an internal cycle, but the voiced velar does not yet exist on that cycle. Consequently, lexical VVN applies correctly to derive *yuki-ŋuni* 'snow country', with obligatory *ŋ*.

(45)

Stem cycle:	/yuki/		/kuni/
Output:	yuki		kuni
Compound cycle:	yuki	kuni	
Rendaku:		G	
VVN:		ŋ	
Output:	yuki	ŋuni	

We have, then, succeeded in constructing a viable account of both optional and obligatory VVN within a derivational model, crucially relying on the assumptions in (40).

3.2 Assessment and Comparison

Before turning to the comparison with the OT analysis, we should first critically look back at the derivational analysis that has been arrived at within the conceptual framework of Lexical Phonology and Featural Underspecification Theory. The analysis has at least two problematic aspects of a general nature that are worth mentioning, the first with respect to Underspecification Theory, the second with respect to a central tenet of standard Lexical Phonology.

First, in relying on specificational blocking by the insertion of a [–nasal] feature in the phonological derivation, the feature is in effect being treated as a diacritic to prevent the segment from undergoing nasalization. This reveals itself in the form of ternary distinctions that arise at certain points in the derivation: There are voiced velars with no nasal specification, voiced velars with [+nasal], and voiced velars with [–nasal], illustrated by examples like *suŋi+geta-Ga* 'cedar+clog-NOM', which, at the beginning of the highest cycle, has the form / ... *[+nas]... [–nas] ... [Ønas] ...* /. There is no difference at all between the two non-nasal voiced velars, except in one respect: one of them is supposed to undergo lexical VVN, the other one is not supposed to undergo it.[23] This raises the disturbing possibility that the seemingly principled underspecification account has hardly moved beyond diacriticity: Lacking independent motivation, underspecification of [nasal] only serves to encode relevant aspects of morphological structure in terms of abstract contrasts (which are themselves brought about by judiciously ordered default rules), relegating it to a mechanical role within the derivational algorithm.

The second troubling aspect is the central analytical assumption that the rule of VVN applies as a cyclic lexical rule. The problem here is that the rule is (semi-)allophonic, and clearly not structure-preserving (there is no underlying *ŋ* in Japanese). Since Structure Preservation is one of the properties generally ascribed to cyclic lexical rules, having to posit a non-structure-preserving lexical VVN rule is at least worrisome. On the other hand, it has been shown in other cases (for example, by Borowsky 1986 for several Level 2 rules in English) that Structure Preservation needs to be weakened. Simply abolishing it would be a short-sighted move since the structure-preserving character of the vast majority of morphophonemic alternations remains a fact calling for an explanation (see Myers 1991 for pertinent discussion).

The two general concerns mentioned so far may not be serious impediments to the derivational analysis at hand, but they should be taken into account in an overall assessment of the principles and goals of Lexical Phonology.

As a starting point of our comparison between the OT analysis in section 2 and the derivational alternative in section 3.1, we will look at what exactly is involved in accounting for the main set of empirical generalizations of VVN, summarized in section 2.4 and repeated below in (46) and (47).

(46) Optional VVN if $Stem_2$ occurs in isolation

doku + {g, ŋ}ama 'poison toad' gama 'toad'

(47) Obligatory VVN if:

a. $Stem_2$ does not occur in isolation.

doku + ŋa 'poison fang' *ga 'fang' (→kiba)

b. $Stem_2$ occurs in isolation, but undergoes Rendaku in compounds.

doku + ŋuchi 'abusive language' kuchi 'mouth'

In the OT analysis, the optionality in (46) follows from the free ranking of the two constraints IdentSS and **g*, while in the LP analysis the postlexical application of VVN is optional. The LP analysis might seem to have a competitive edge here, since it is sometimes surmised that postlexical optionality follows directly from the theory and does not have to be stipulated. However, the validity of such a claim is questionable since many well-established postlexical processes (e.g., flapping, downstep, etc.) are in fact obligatory.[24] This means in a derivational theory, which conceives of optionality as a property of *rules*, that each individual rule needs to be annotated as "optional" or "obligatory", in order to declare its mode of application. Adding a label "x" does not amount to a serious formal account (let alone, explanation) of x-behavior (here, optionality), and is not connected to anything else in the grammar. Sometimes this is all we can do at the present state of our knowledge—but sometimes we can do better. Free ranking, even without considering its further advantages for this case (see below), constitutes an analytically superior move since it at least attempts to explicate optionality behavior by something else (instead of simply offering a label), thus potentially establishing connections to other phenomena.

The obligatory appearance of *ŋ* in (47) follows in the OT analysis again from the freely ranked constraints IdentSS and **g*. As discussed in detail in section 2.4, whichever ranking is chosen, IdentSS does not play a deciding role, because it is either vacuously satisfied (47a) or violated (47b) in the relevant candidates.

In the LP analysis, the obligatoriness of (47) is accounted for by the appropriate selection of cyclic domains and cyclic default rules. For (47a), an independent cycle on $Stem_2$ must be avoided, since such a cycle would induce default insertion of [–nasal], thus preventing the factually required VVN on the higher cycle. The absence of a cycle here is usually ascribed to the generalization that

[23] Note that the issue raised here is more basic than the narrow technical concern about a ternary distinction [+/–/Ø] arising in connection with a binary conception of [nasal]. As shown in Itô & Mester 1989, the issue is rather a diacritic use of feature structure, which carries over to a privative conception of [nasal], in which *suŋi+geta-Ga* might take the form / ... *[nasal]... [oral] ... [Ø]* ... / (Ø stands for "neither nasal nor oral"), or to an equivalent feature-geometric implementation with further node structure, such as a [soft palate] node.

[24] There is also some question whether lexical application automatically implies obligatoriness. Obligatory application is certainly the unmarked state of affairs for lexical rules, but, for example, Kiparsky's 1986 reanalysis of the interaction between stress and umlaut in Chamorro crucially relies on optional lexical rules.

bound stems do not constitute cyclic domains (Brame 1974, Kiparsky 1982, Inkelas 1989). Two points are worth noting in this connection.

First, there is no intrinsic reason in the cyclic theory itself that would prevent a cycle on stems that do not occur as independent words (as opposed to stems that occur as free forms), so this particular restriction, instead of being a consequence of a derivational theory, amounts to a separate stipulation.

The second point arises in considering what it means to be a bound stem: namely, an item that does not occur as a prosodic word by itself in surface structure. So, when we say that bound stems do not constitute a cycle, we are in effect denying a cycle to items that do not happen to constitute surface prosodic words by themselves. That is, only stems with a surface prosodic word status at the *end* of the derivation constitute cyclic domains *earlier* in the derivation. This is quite close to the IdentSS correspondence constraint in the OT analysis, but the two are by no means theoretical equivalents. While surface correspondence requirements are a natural outgrowth of an output-oriented theory like OT, and amply supported in other areas, such as reduplication (see McCarthy & Prince 1995), they must be added on from the outside in a derivational approach. In a theory predicated on the assumption that lexical phonological rules apply cyclically, following an inside-out path through the morphological structure of the word, the prosodic surface status of some deeply embedded substring of a whole form should be irrelevant for the way the substring is treated at an early point of the derivation. To the extent, therefore, that correspondence to other related output forms *is* a real force in phonology, the derivational theory is at a disadvantage since such information has to be transmitted back upstream, into the derivation—for the case at hand, by means of restrictions on cyclic domains that make covert reference to output structure.

It is of course possible to *encode* the crucial distinctions by means of appropriately chosen nodes and labels[25]—the decisive point is that the correspondence theoretic OT analysis gets by without such encodings and is in this sense a *minimal* theory of compositionality effects.

For the Rendaku-derived *g*-cases (47b), it is crucial that the cyclic default rule inserting [–nas] affects only voiced velars and no other segments. In particular, it must not affect the voiceless velar *k*: Every *k* from an earlier cycle, after undergoing Rendaku voicing, changes to *ŋ*, so the cyclic default rule must not have applied to it. But why should the cyclic default rule apply only to *g*, and not to *k* (or, for that matter, to all other segments)? After all, in order to have explanatory merit, a cyclic application of default rules must have the status of a general convention. Principles like the Redundancy Rule Ordering Constraint (RROC) of Radical Underspecification Theory (Archangeli 1984) are of no help (among other things, the insertion of the marked value of a feature by a phonological rule does not trigger the RROC-insertion of the unmarked value of the feature, let alone on one and only one kind of segment, to the exclusion of all others). It seems unavoidable to conclude that the cyclic default rule is a liability of the LP analysis, since it must be a language-specific rule ordered in the cycle after VVN.

To sum up, the main characteristics of the LP analysis are: (i) optional and obligatory application of VVN, (ii) selection of cyclic domains, and (iii) blocking by cyclic default rules. Although these properties initially seem to follow from the theory itself, closer consideration reveals that this is not so: each involves a language-specific stipulation and/or special pleading. For each case, we need an assumption designed to account for a particular type of example. After optionality is declared for some cases, the obligatoriness of the two other cases each rests on additional unrelated (and somewhat questionable) assumptions.

In contrast, the crucial analytical move of the OT analysis consists in the free ranking of two constraints, one of them being the compositional correspondence constraint IdentSS. It is legitimate to ask what, if anything, is different about the free ranking stipulation in comparison with the stipulation of optionality for one rule. Free ranking in itself is indeed not of overwhelming interest; noteworthy is rather the fact that, given the content of of the constraints involved, the free ranking analysis captures further facts beyond the optionality behavior itself.

Instead of understanding optionality as the application mode of a given process, the OT account reduces it to a local property of the constraint system and links optionality to other properties and phenomena in a deductive way, providing a unified account of optional and obligatory VVN. The strength of the OT analysis, in other words, is that it is woven from a single cloth, tying various facts together in a more intrinsic way.

4. Appendix: Other Issues

This appendix provides some background for the analysis of VVN developed in the paper. Section 4.1 investigates the empirical underpinnings of the central segmental markedness considerations. In 4.2, we turn to some additional factors affecting the relation between *g* and *ŋ*, tying up some loose ends and completing the analysis developed in the preceding sections.

4.1. Markedness Relations

If Universal Grammar contains some constraint against dorsal nasals (**ŋ*), any *ŋ* in the output is a violation of **ŋ*. Any analysis, therefore, that views VVN as a way of complying with the constraint against voiced dorsal obstruents (**g*), must hold that the ranking is **g* » **ŋ*. If the ranking was the opposite, or if the two constraints were unranked, *ŋ* would not be consistently preferred over *g* (in word-internal position, and abstracting away from correspondence effects).

[25] In HPSG-oriented theories, such as Orgun's 1994 sign-based approach or Matsui's 1996 JPSG phonology model, this point would carry over in a declarative-nonderivational context, as long as the central element of the derivational approach is preserved, namely, the encoding of the distinction by means of additional nodes and category labels.

This raises the question of whether any direct markedness relation between the two segments can be substantiated. McCarthy & Prince (1995: 353) point out that "UG does not provide a fixed hierarchy of the form *ŋ ≫ *g or of the form *g ≫ *ŋ, since neither segment is obviously more marked than the other."

We are somewhat unclear about the criteria that are often invoked in making the leap from segment distributions in inventories to markedness relations in Universal Grammar. In our attempt to understand the basis of such relationships, we have made some simple calculations based on the data reported in UPSID (Maddieson 1984: 35, 60), arranged in (48) so that each cell contains the number of occurrences of the relevant type of segment.

(48) Frequency of Plain Consonants in UPSID data (Maddieson 1984, 35, 60)

places / manners	*labials*	*coronals*	*dorsals*	(average)
[–voi] plosives	263	309	283	285
[+voi] plosives	199	195	175	190
nasals	299	316	167	261
(average)	254	273	208	245

In (49), each cell of (48) is divided by the associated *row* average in order to calculate *index(x,y)*, the 'index of representation' of Place *x* within Manner *y*. In (50), each cell in (48) is divided by the associated *column* average, obtaining *index(y,x)*, the index of representation of Manner *y* within Place *x*. *Index(x,y)* >1 means that Place *x* is overrepresented within Manner *y*; *index(x,y)* <1 means underrepresentation.

(49) Representation of places within manners: *index(place, manner)*

places / manners	*labials*	*coronals*	*dorsals*	(average)
[–voi] plosives	0.92	1.08	0.99	(1.00)
[+voi] plosives	1.05	1.03	0.92	(1.00)
nasals	1.15	1.21	0.64	(1.00)
(average)	1.03	1.12	0.85	(1.00)

(50) Representation of manners within places: *index(manner, place)*

places / manners	*labials*	*coronals*	*dorsals*	(average)
[–voi] plosives	1.04	1.13	1.36	1.16
[+voi] plosives	0.78	0.71	0.84	0.77
nasals	1.18	1.16	0.80	1.06
(average)	(1.00)	(1.00)	(1.00)	(1.00)

Since the relevant reference points (averages) are different (i.e., manner average vs. place average), the two indices are usually different for a given place/manner combination. For example, *index(labial, voiced plosive)* in (49) is 199/190=1.05 i.e., labials are very slightly overrepresented among voiced plosives. On the other hand, *index(voiced plosive, labial)* in (50) is 199/254=0.78, i.e., voiced plosives are significantly underrepresented among labials.[26] The comparisons emerging from (49) and (50) are summarized in (51) and (52), respectively, with notable underrepresentation (index< 0.9) indicated by bolding.

(51)

	Manner class	Place comparisons based on (49)
a.	Voiceless	Coronal > Dorsal > Labial
b.	Voiced	Labial > Coronal > Dorsal
c.	Nasal	Coronal > Labial > **Dorsal**
d.	average	Coronal > Labial > **Dorsal**

[26] This indicates that the question whether some segment or class of segments is "marked" or "unmarked", without an explicit reference group, is hard to assess.

(52)

	Place class	Manner comparisons based on (50)
a.	Labial	Nasal > Voiceless > **Voiced**
b.	Coronal	Nasal > Voiceless > **Voiced**
c.	Dorsal	Voiceless > **Voiced** > **Nasal**
d.	average	Voiceless > Nasal > **Voiced**

The summary generally confirms markedness (or 'underrepresentation', in the more neutral terminology chosen here) statements made in the literature. In the voiceless class, *p* (0.92) is slightly underrepresented (51a), as is *g* (0.92) in the voiced class (51b). The only major departure from the standard index of 1 is found in the nasal class (51c) with the dorsal *ŋ* (0.64), which is responsible for bringing down the average dorsal index (0.85) in (51d). If the average of the different manners is to be taken as an indicator of general markedness, then Dorsal is more marked than Labial overall, suggesting a refinement of the usual dichotomy, which contrasts (unmarked) Coronal with (marked) Noncoronal. For manner comparisons within a given place class (52), we find notable underrepresentation (index<0.9, indicated by bolding) for the voiced plosives within all place classes (*b*: 0.78, *d*: 0.81, *g*: 0.84), and for the nasals within the dorsal class (*ŋ*: 0.80).

Returning to our point of interest, namely, the relation between *g* and *ŋ*, it is important to bear in mind that an index of representation has two arguments, in other words, it is defined only strictly internal to a given reference group. Noting that the relevant reference group for *g* and *ŋ* is a Place class, namely Dorsal in (50) and (52c), we find that *ŋ* (0.80) has an index only slightly lower than that of *g* (0.84). In other words, the two can be considered equally underrepresented within the dorsal class. The manner classes in (49) and (51) provide no basis on which *g* and *ŋ* could be legitimately compared: It is true that *g* is underrepresented with respect to *d* and *b* (reference group: voiced plosives), and *ŋ* with respect to *n* and *m* (reference group: nasals)—but no direct comparison between the two dorsals in question emerges from this, confirming McCarthy & Prince's 1995 assessment that neither can be said to be universally more marked than the other. Rather, there are constraints against voiced dorsal obstruents and dorsal nasals, which can be ranked with respect to each other in individual grammars.

4.2. Suppression of Nasalization and Faithfulness Promotion

Throughout this paper, our analysis of VVN has been concerned with a conservative version of the Tokyo dialect, i.e., with a pattern of speech showing consistent observance of the VVN alternation. Within Modern Japanese, this dialect coexists with a large number of varieties which do not exhibit the *g*~*ŋ* alternation and admit *ŋ* only as the allophone of a nasal consonant before dorsals (as in *keŋka* 'quarrel'); in a number of other dialects, the prestige position of Tokyo speech has led to a partial adoption of the *g*~*ŋ* alternation, resulting in more or less sporadic cases of VVN accompanied by high variability, hypercorrections, and similar sociolinguistic symptoms. Abstracting away from this kind of social and geographic variation by focusing on a consistent VVN-dialect, our analysis has proceeded under the assumption that the occurrence of PrWd-internal *g* is always due to compositional correspondence (viz., to a related *g*-initial stem, see section 2). In order to round off the picture, we will briefly deal with another source of internal *g*, namely, a parochial promotion of faithfulness (crucially, above the conflicting markedness constraint **g*).

The richest source of word-internal *g* consists in unassimilated loanwords (53), an important subpart of the contemporary Japanese lexicon (Shibatani 1990, Itô & Mester 1995a,b).

(53)

	✓[...**g**...]	*[...ŋ...]	
a.	e**g**oisuto	*eŋoisuto	'egoist'
b.	puro**g**uramu	*puroŋuramu	'program'
c.	suroo**g**aN		'slogan'
d.	koN**g**o		'Congo'
e.	poruto**g**aru		'Portugal'

Such internal *g*'s conform to the foreign (mostly English) source word. They tend to be replaced by *ŋ* as the form becomes assimilated and partially nativized, as illustrated by the old and long-established loanwords like *iŋirisu* 'England' (54a). There are also forms where the foreign source already contains *ŋ*, as in (54b).[27]

(54)

a.	*i**g**irisu	iŋirisu	'England'
	*oru**g**aN	oruŋaN	'organ' (musical instrument)

[27] Some forms occupy a transitional status in terms of nativization (*doguma* ~ *doŋuma* 'dogma'), and pronunciation dictionaries show some degree of divergence (for example, whereas the NHK pronunciation dictionary (NHK 1985) lists the loanword corresponding to 'organ' *as oru**g**aN*, it appears as *oru**ŋ**aN* in Kindaichi 1958. Conceivably, prosodic position might also play some role here, with foot-initial position (as in (53b)) (vs. foot-medial position, as in (54a)) serving as some kind of secondary licenser for *g* (assuming left-aligned footing, as suggested in Itô & Mester 1992).

b.	*kiŋ**g**u	kiŋŋu	'king'	[kɪŋ]
	*zooriŋ**g**eN	zooriŋŋeN	'Solingen'	[zoːlɪŋ ən]

In the approach to the phonological lexicon developed in Itô & Mester 1995b, nonnasalized *g* in loanwords, as in (53), is a case of lexicon-internal variation reducible to lexicon-internal ranking variation (specifically, of correspondence-sensitive constraints). For the case at hand, the crucial point is that IdentLS(nas) occupies a higher rank, resulting in the lexicalized ranking IdentLS(nas) » **g* (58).

(55) a. Ranking in the grammar:

*[ŋ
|
*g
|
IdentLS(nas)

b. Lexically marked ranking:

*[ŋ
|
IdentLS(nas)
|
*g

Taking up our earlier treatment (Itô & Mester 1995b), we suggest that the relation of the lexicalized ranking [Ident-LS(nas) » **g*] (55b) to the general ranking [**g* » Ident-LS(nas)] (55a) posited in the grammar can be conceived of in terms of a generalized notion of "taking precedence". The familiar notion of precedence (lexicographic precedence, in Strict-Domination-OT, following Prince & Smolensky 1991, 1993) is an instance of a 1st level precedence, as in (56a).[28] The next logical step is to consider the possibility of 2nd level precedence statements, as in (56b), which express relations between 1st level precedences, i.e., constraint rankings..

(56) a. 1st level precedence ("»")
relation between constraints—constraint ranking: C_n » C_m

b. 2nd level precedence ("»»")
relation between constraint rankings
(i.e., between first level precedences): [C_n » C_m] »» [C_m » C_n]

Note now that the relation of a lexicalized ranking like [Ident-LS(nas) » **g*] to the ranking [**g* » Ident-LS(nas)] posited in the grammar is of a particular kind: The two rankings conflict,[29] the first (lexically marked) relates to the second (lexicon-wide) ranking as the specific to the general, and the first (specific) ranking is visibly active in the lexicon of Japanese (as evidenced by the existence of outputs like *egoisuto* instead of *eŋoisuto*). In other words, their relation falls under Prince & Smolensky's 1993 Pāṇinian theorem on constraint ranking (appropriately generalized to accommodate precedence relations of any level), and (57) must hold.

(57) [IdentLS(nas) » *g]$_{lex}$ »» [*g » IdentLS(nas)]

A tableau illustrating the lexicalized ranking appears in (58).

(58)

/egoisuto/ 'egoist' [IdentLS(nas) » *g]$_{lex}$	*[ŋ	**IdentLS(nas)**	***g**
☞ egoisuto			*
eŋoisuto		***!**	

For the forms in (54) with normal VVN, it can simply be assumed that they are subject to the general ranking [**g* » IdentLS(nas)], as shown in (59) for the form *iŋirisu*.[30]

---

[28] This raises the question of whether constraints themselves can be formally understood as 0th level preference relations holding between linguistic structures. This is conceivable for many among the currently used constraints: Thus the constraint Onset declares that a consonant-initial syllable is preferable to ("≻") a vowel-initial syllable, and the constraint NoCoda declares a consonant-final syllable to be inferior to a vowel-final syllable.

(i) Syllable wellfor medness constraints as 0th level preference relations on structures:
Onset: σ[C ≻ σ[V NoCoda: V]σ ≻ C]σ

It remains to be seen, however, whether all constraints can be profitably expressed in such a comparativist format, and what the consequences would be for the formal theory of candidate competition and selection.

[29] In a 2nd level sense of "conflict": The two rankings result in grammars selecting a different output for at least one input.

[30] However, it is not entirely clear whether this is the correct way of dealing with the cases in (54b), where the *ŋ* in the Japanese form is probably not merely a case of the emergent native *ŋ*-pattern, but a Japanese *ŋ* corresponding to an *ŋ* in the source word. If it is appropriate to incorporate such considerations within the purview of formal grammar (see Silverman 1992 and Yip 1993 for different proposals in this context), this might call for a further extension of Correspondence Theory—the crucial

(59)

/igirisu/ 'England'	*[ŋ	***g**	**IdentLS(nas)**
igirisu		***!**	
☞ iŋirisu			*

Apart from unassimilated loanwords, word-internal *g* occurs in VVN-dialects in certain areas of the native lexicon under the pressure of construction-specific Ident-constraints, namely, Ident-BR and Ident-κ.[31] One relevant context, mimetic (sound-symbolic) reduplication, has recently been given a correspondence-theoretic analysis by McCarthy & Prince 1995. Within the Japanese lexicon, mimetics form a separate stratum with special phonological and morphological characteristics (McCawley 1968, Hamano 1986, Mester & Itô 1989, Itô & Mester 1995a,b). Mimetic stems are subject to regular VVN: as shown in (60), stem-internally *ŋ* occurs to the exclusion of *g*.

(60) moŋu+moŋu 'mumbling' *mo**g**u+mo**g**u
iŋa+iŋa 'irritating voice' *i**g**a+i**g**a

Mimetics are thus subject to the same analysis as all core elements of the lexicon, as illustrated in (61)[32]—sound-symbolism apparently provides no special license for word-internal *g*.

(61)

/mogu/	*[ŋ	*g	IdentLS(nas)
mogu		***!**	
☞ moŋu			*

There is one context, however, where VVN is suppressed: When mimetic stems are reduplicated, *g* at the beginning of the second part is never nasalized, but it remains *g*, just as its correspondent at the beginning of the first part (62).

(62)

gara+**g**ara	'rattle'	*__g__ara+ŋara, *__ŋ__ara+__ŋ__ara
geji+**g**eji	'centipede'	etc.
goto+**g**oto	'sound of large moving objects'	
gii+**g**ii	'scraping'	
guu+**g**uu	'snoring'	
goo+**g**oo	'strong windy sound'	
gatsu+**g**atsu	'starvingly'	
goro+**g**oro	'rolling'	
gee+**g**ee	'retching'	

For this kind of underapplication of an allophonic alternation in reduplication, we adopt McCarthy & Prince's analysis, reproduced below in (63).[33]

correspondence relation would here reach out to a related output in a different language. In the most general sense, of course, the two items—loan word and source word—stand in some kind of relation. What remains to be seen is whether it is theoretically fruitful to extend the linguistic (grammatical) notion of correspondence to cover such relations between languages.

[31] See Itô, Kitagawa, & Mester 1996 for some discussion of the close connection between (i) the lexicalized promotion of a faithfulness constraint and (ii) the proliferation of separately rankable construction-specific faithfulness constraints.

[32] Identical results are obtained from the alternative inputs /moŋu/ or /moGu/ (with underspecification of [nasal]), see (13) in section 1.

[33] There is a possible alternative analysis of internal *g* in mimetic reduplication which links the phenomenon directly to a genuine prosodic property of the forms in question: As pointed out by Haruo Kubozono (personal communication), the accentual characteristics of mimetic forms reveal in many cases that they consist of two separate prosodic words. If so, the reduplication-specific property enforced by base-reduplicant identity is a prosodic one (*two prosodic words*—perhaps word-onset must correspond to word-onset?), whereas all segmental effects are secondary. In this analysis, "internal *g*" is not internal in the relevant sense, so there is no underapplication here of an allophonic process. In addition, the lack of underapplication in other reduplicated forms noted below in the text (see (64)) is fully expected (as normal compounds, they constitute single prosodic words). A genuine (but isolated) example of non-prosodic overapplication pointed out to us by Michinao Matsui (personal communication) is found in connection with the morphophonemic alternation whereby single /h/ in Japanese corresponds to geminate /pp/: The ('lexically reduplicated') form *haha* 'mother', when combined with the gemination-inducing prefix *baka-* 'foolish', yields *bakappapa* 'foolish mother' and not **bakappaha* or *??bakahhaha* (this can also be conceived of as underapplication, taking /p/ to be underlying, see Matsui 1996: 125, note 10).

(63)

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

Internal nonnasalized *g* is specific to mimetics—it does not hold in general for reduplication. Thus in intensifying and pluralizing reduplication (64), we find the normal replacement of *g* by *ŋ*. 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*, see section 2 above).

(64)

ge+**ŋ**e	'lowest'	*ge+ge
ga+**ŋ**a (taru)	'rugged'	*ga+ga
kuni+ŋuni	'various countries'	
kane+ŋane	'for a long time'	

A final case of nonnasalized internal *g* occurs in the recitation of the kana syllabary, where each column is treated as a single phonological word with antepenultimate accent: *a-i-ú-e-o*, *ka-ki-kú-ke-ko*, etc. In the case of the *g*-column (*ga-gyō*), we find (65a), with nonnasalized PrWd-internal *g*, instead of (65b).

(65) a. **g**a **g**i **g**ú **g**e **g**o b. ***g**a ŋi ŋú ŋe ŋo

One possibility of analyzing this case would be to assimilate it to the that of the loanwords seen earlier, i.e., to claim that the recitation of the kana-syllabary is likewise governed by the lexicalized ranking [Ident-LS(nas) » **g*]. However, it is not clear whether this gets to the core of the phenomenon, which is arguably not the preservation of *g* per se, but rather the establishment of uniformity throughout the 'paradigm' (here, the *g*-column) (see Raffelsiefen 1995:39, among others, for this approach to paradigm uniformity effects). Making this idea more concrete, we will assume that the invariance of the onset element throughout all members of a kana-column (***k**a-**k**i-**k**u-**k**e-**k**o*, ***m**a-**m**i-**m**u-**m**e-**m**o*, etc.[34] is expressed in the grammar by means of a surface-surface (output-output) correspondence relation κ (mnemonic for "kana"), akin to base-reduplicant correspondence in the case of mimetic reduplication (see (60) and (61) above).
κ links the correspondent onset elements into what we can refer to as a κ-chain. One possible formulation of the identity constraint on members of such chains is given in (66).[35]

(66) Ident-κ: The members of a κ-chain must be identical to its head (i.e., its initial member).

Notating κ by means of co-superscription of correspondent elements, tableau (67) shows how kana column uniformity is enforced by adding the constraint Ident-κ at the top of the constraint hierarchy.

(67)

/ga-gi-gu-ge-go/	*Ident-κ	*[ŋ	*g	IdentLS (nas)
a. g^{κ}a-ŋ$^{\kappa}$i-ŋ$^{\kappa}$u-ŋ$^{\kappa}$e-ŋ$^{\kappa}$o	***!*****		*	****
b. g^{κ}a-g$^{\kappa}$i-ŋ$^{\kappa}$u-ŋ$^{\kappa}$e-ŋ$^{\kappa}$o	***!****		**	***
c. ŋ$^{\kappa}$a-ŋ$^{\kappa}$i-ŋ$^{\kappa}$u-ŋ$^{\kappa}$e-ŋ$^{\kappa}$o		***!**		*****
d. ☞ g^{κ}a-g$^{\kappa}$i-g$^{\kappa}$u-g$^{\kappa}$e-g$^{\kappa}$o			*****	

[34] This extends to the case of the onsetless vowel kana ***Ø**a-**Ø**i-**Ø**u-**Ø**e-**Ø**o* as identity of zero onsets, in ways familiar from the analysis of poetic rhyme and alliteration (cf. ***Ø**in and **Ø**out* alongside *part and parcel, spic and span*, etc.), see Jakobson 1963 and Kiparsky 1973 for discussion.

[35] An alternative would be to formulate chain identity more simply as in (i):
(i) The members of a κ-chain must be identical
In this case, for a set of chain members M, the domain of evaluation is the Cartesian Product $M \times M$, and each pair (m_i, m_j) with $m_i \neq m_j$ counts as a violation. This is perhaps a more elegant way of stating the constraint (which avoids the conceptually clumsy reference to the first chain element), with potentially different empirical results (note that (67b) has six violations in this mode of reckoning, thereby losing to (67a) with four violations). On the other hand, it is conceivable that reference to the first member is an irreducible fact, for substantive reasons (see Beckman 1995 and Padgett 1995 for discussion of such prominence-related factors).

Within the total analysis, Ident-κ turns out to be a dominated constraint, as shown by the fact that kana column uniformity is violated, for example, in the *s*-column (*sa-gyoo*): *sa-ʃi-su-se-so*. Building on the analysis in Itô & Mester 1995a,b, this is correctly captured by the constraint ranking in (68), where the constraint IdentLS(ant), different from IdentLS(nas), ranks above Ident-κ and above the antagonistic markedness constraint **ʃ*. On the other hand, both Ident-constraints are dominated by the sequential constraint **si*.

(68) *si » IdentLS(ant) » Ident-κ » *ʃ

An illustrative tableau is given in (69).

(69)

/sa-si-su-se-so/	*si	IdentLS (ant)	Ident-κ	*ʃ
a. sᵏa-ʃᵏi-ʃᵏu-sᵏe-sᵏo		****!**	**	**
b. ☞ sᵏa-ʃᵏi-sᵏu-sᵏe-sᵏo		*****	*	*
c. ʃᵏa-ʃᵏi-ʃᵏu-ʃᵏe-ʃᵏo		****!*****		*****
d. sᵏa-sᵏi-sᵏu-sᵏe-sᵏo	***!**			

References

ANDERSON, STEPHEN R. 1992. A-Morphous Morphology. University Press, Cambridge, UK.
ANTTILA, ARTO. 1995. Deriving Variation from Grammar: A Study of Finnish Genitives. ms., Stanford University.
ARCHANGELI, DIANA. 1984. Underspecification in Yawelmani Phonology and Morphology. Doctoral dissertation, Massachusetts Institute of Technology. [Published 1988, Outstanding Dissertations in Linguistics Series, Garland, New York.]
BACH, EMMON, & DEIRDRE WHEELER. 1981. Montague Phonology: A First Approximation. University of Massachusetts Occasional Papers in Linguistics 7. UMass, Amherst. 27-45.
BECKMAN, JILL N. 1995. Shona Height Harmony: Markedness and Positional Identity. In J. Beckman, S. Urbanczyk, & L. Walsh, eds. University of Massachusetts Occasional Papers in Linguistics [UMOP] 18: Papers in Optimality Theory. GLSA, Amherst, MA. 53-75.
BENUA, LAURA. 1995. Identity Effects in Morphological Truncation. In J. Beckman, S. Urbanczyk, & L. Walsh, eds. University of Massachusetts Occasional Papers in Linguistics [UMOP] 18: Papers in Optimality Theory. GLSA, Amherst, MA. 77-136.
BLACK, H. ANDREW. 1993. Constraint-Ranked Derivation: A Serial Approach to Optimization. Doctoral dissertation, University of California, Santa Cruz.
BOROWSKY, TONI. 1986. Topics in the Lexical Phonology of English. Doctoral Dissertation, University of Massachusett, Amherst.
BRAME, MICHAEL. 1974. The Cycle in Phonology: Stress in Palestinian, Maltese, and Spanish. Linguistic Inquiry 5. 39-60.
CHOMSKY, NOAM, & MORRIS HALLE. 1968. The Sound Pattern of English. Harper & Row, New York.
HAMANO, SHOKO. 1986. The Sound-Symbolic System of Japanese. Doctoral dissertation, University of Florida.
HAMMOND, MARK. 1994. An OT Account of Variability in Walmatjari Stress. ms., Univ. of Arizona. ROA-20.
HAYES, BRUCE. 1996. Voicing in NC Clusters. Handout of talk given at University of California, Santa Cruz.
HAYES, BRUCE, & MARGARET MACEACHERN. 1996. Folk Verse Form in English. ms., UCLA. ROA-121.
HEWITT, MARK S., & MEGAN J. CROWHURST. 1995. Conjunctive Constraints and Templates in Optimality Theory. ms., University of North Carolina, Chapel Hill.
INKELAS, SHARON. 1989. Prosodic Constituency in the Lexicon. Doctoral dissertation, Stanford University. [Published 1990, Outstanding Dissertations in Linguistics Series, Garland Press, New York.]
ITÔ, JUNKO. 1986. Syllable Theory in Prosodic Phonology. Doctoral Dissertation, University of Massachusetts, Amherst. [Published 1988, Outstanding Dissertations in Linguistics series, Garland, New York.]
ITÔ, JUNKO. 1989. A Prosodic Theory of Epenthesis. Natural Language and Linguistic Theory 7. 217-259.
ITÔ, JUNKO, YOSHIHISA KITAGAWA, & ARMIN MESTER. 1996. Prosodic Faithfulness and Correspondence. Journal of East Asian Linguistics 5, 217-294.
ITÔ, JUNKO, & ARMIN MESTER. 1986. The Phonology of Voicing in Japanese: Theoretical Consequences for Morphological Accessibility. Linguistic Inquiry 17. 49-73.
ITÔ, JUNKO, & ARMIN MESTER. 1989. Gagyoo: Featural and Prosodic Characteristics. ms., University of California, Santa Cruz.[Presented at the Conference on Feature and Underspecification Theories, MIT, Oct. 1989.]
ITÔ, JUNKO, & ARMIN MESTER. 1990. Proper Containment and Phonological Domains. Handout distributed at KATL, Osaka University, Dec. 1990.
ITÔ, JUNKO, & ARMIN MESTER. 1992. Weak Layering and Word Binarity. Linguistics Research Center Report No. 92-09. University of California, Santa Cruz
ITÔ, JUNKO, & ARMIN MESTER. 1995a. Japanese Phonology. In Goldsmith ed. Handbook of Phonological Theory. Blackwell. 817-838.
ITÔ, JUNKO, & ARMIN MESTER. 1995b. The Core-Periphery Structure of the lexicon and Constraints on Reranking. In J. Beckman, S. Urbanczyk, & L. Walsh, eds. University of Massachusetts Occasional Papers in Linguistics [UMOP] 18: Papers in Optimality Theory. GLSA, University of Massachusetts, Amherst. 181-210.
ITÔ, JUNKO, & ARMIN MESTER. in prep. Structural Economy and OCP Interactions in Local Domains. Paper prepared for WECOL 1996, University of California, Santa Cruz.
ITÔ, JUNKO, ARMIN MESTER, & JAYE PADGETT. 1995. Licensing and Underspecification in Optimality Theory. Linguistic Inquiry 26-4. 571-614.
JAKOBSON, ROMAN. 1963. On the So-called Vowel Alliteration in Germanic Verse. Zeitschrift für Phonetik, Sprachwissenschaft, und Kommunikationsforschung 16.
KAGER, RENÉ. 1994. Generalized Alignment and Morphological Parsing. ms., Research Institute of Language and Speech, Utrecht University. ROA-36.
KAMEI, TAKASHI. 1956. Ga-gyō no Kana. Kokugo to Kokubungaku 39.9. 1-14.
KANAI, YOSHIMITSU. 1982. A Case against the Morphophonemic-Allophonic Principle. Linguistic Inquiry 13. 320-323.
KENSTOWICZ, MICHAEL. 1995. Cyclic vs. non-cyclic constraint evaluation. Phonology 12. 397-436.
KINDAICHI, HARUHIKO, ed. 1958. Meikai Nihongo Akusento Jiten <Japanese Accent Dictionary>. Sanseido, Tokyo.
KINDAICHI, HARUHIKO. 1967. Nihongo On'in no Kenkyū <Sudies in Japanese Phonology>. Tokyōdō, Tokyo.
KIPARSKY, PAUL. 1973. The Role of Linguistics in a Theory of Poetry. Daedalus 102. 231-245.
KIPARSKY, PAUL. 1982. Lexical Morphology and Phonology. Yang, I.S. Linguistics in the Morning Calm. Hanshin, Seoul. 3-91.
KIPARSKY, PAUL. 1985. Some consequences of Lexical Phonology. Phonology Yearbook 2. 82-138.
KIPARSKY, PAUL. 1986. Systematic Optionality in the Lexical Phonology of Chamorro. ms., Stanford University.

KIPARSKY, PAUL. 1993a. Blocking in Nonderived Environments. Hargus, S., & E. Kaisse. Phonetics and Phonology, vol. 4: Studies in Lexical Phonology. Academic Press, San Diego, etc. 277-313.
KIPARSKY, PAUL. 1993b. Variable Rules. Handout distributed at ROW-1, October 1993.
KIRCHNER, ROBERT. 1996. Synchronic Chain Shifts in Optimality Theory. Linguistic Inquiry 27, 341-50.
KUBOZONO, HARUO. 1995. Constraint Interaction in Japanese Phonology: Evidence from Compound Accent. In Walker, R., O. Lorentz, & H. Kubozono, eds. Phonology at Santa Cruz [PASC] 4. Linguistics Research Center, University of California, Santa Cruz. 21-38.
KUBOZONO, HARUO. 1996. Lexical Markedness and Variation: A Nonderivational Account of Japanese Compound Accent. WCCFL 15.
KUBOZONO, HARUO, & ARMIN MESTER. 1995. Foot and Accent: New Evidence from Japanese Compound Accentuation. Handout distributed at LSA Meeting, New Orleans, January 1995.
LIBERMAN, MARK. 1994. Optionality and Optimality. Fragment of a draft, Univ. of Pennsylvania.
LIBERMAN, MARK, & ALAN PRINCE. 1977. On Stress and Linguistic Rhythm. Linguistic Inquiry 8. 249-336.
MADDIESON, IAN. 1984. Patterns of Sounds. Cambridge University Press, Cambridge, UK.
MARTIN, SAMUEL E. 1987. The Japanese Language through Time. Yale University Press, New Haven & London.
MATSUI, MICHINAO. 1996. An Introduction to JPSG Phonology. In Gunji, Takao, ed. Sudies on the Universality of Constraint-Based Phrase Structure Grammars. Osaka University. 111-142.
MCCARTHY, JOHN J., & ALAN S. PRINCE. 1995. Faithfulness and Reduplicative Identity. In Beckman, J., S. Urbanczyk, & L. Walsh, eds. University of Massachusetts Occasional Papers in Linguistics [UMOP] 18. GLSA, Amherst, Massachusetts. 249-384.
MCCARTHY, JOHN J. 1995. Extensions of Faithfulness: Rotuman Revisited. ms., University of Massachussets, Amherst.
MCCAWLEY, JAMES D. 1968. The Phonological Component of a Grammar of Japanese. Mouton, The Hague.
MERCHANT, JASON. 1996. Alignment and Fricative Assimilation in German. Linguistic Inquiry 27.
MESTER, ARMIN, & JUNKO ITÔ. 1989. Feature Predictability and Underspecification: Palatal Prosody in Japanese Mimetics. Language 65. 258-93.
MOHANAN, K. P. 1986. The Theory of Lexical Phonology. D. Reidel Publishing Company, Dordrecht, etc.
MÜLLER, GEREON. 1995. Partial Wh-Movement and Optimality Theory. ms., Seminar für Sprachwissenschaft, Universität Tübingen.
MURAKI, MASATAKE. 1970. A Sound Change in a Tohoku Dialect. Papers in Linguistics 3. 341-347.
MYERS, SCOTT. 1991. Structure Preservation and the Strong Domain Hypothesis. Linguistic Inquiry 22. 379-385.
NÍ CHIOSÁIN, MÁIRE. 1995. Prosodic Well-formedness and Sonority Constraints: Epenthesis in Irish. ms., University College Dublin, Ireland. ROA-89.
NHK (JAPAN BROADCASTING CORPORATION). 1985. Nihongo Hatsuon Akusento Jiten <Japanese Pronunciation Accent Dictionary>. Nihon Hōsō Kyōkai, Tokyo.
ORGUN, CECIL ORHAN. 1994. Monotonic Cyclicity and Optimality Theory. In Mercè Gonzàles, ed. Proceedings of the 24st Annual Meeting of the North-East Linguistic Society. GLSA, University of Massachusetts, Amherst . 461-474.
ORGUN, CEMIL ORHAN. 1995. Correspondence and Identity Constraints in two-level Optimality Theory. WCCFL 14.
PADGETT, JAYE. 1995. Feature Classes. In Beckman, J., S. Urbanczyk, & L. Walsh, eds. University of Massachusetts Occasional Papers in Linguistics [UMOP] 18. GLSA, Amherst, Massachusetts.
PESETSKY, DAVID. 1979. Russian Morphology and Lexical Theory. ms., Cambridge, Mass.
PIERREHUMBERT, JANET, & MARY BECKMAN. 1988. Japanese Tone Structure. MIT Press, Cambridge, Massachusetts.
POSER, WILLIAM J. 1990. Evidence for Foot Structure in Japanese. Language 66. 78-105.
PRINCE, ALAN S. & PAUL SMOLENSKY. 1991. Notes on Connectionism and Harmony Theory in linguistics. Technical Report CU-CS-533-91. Department of Computer Science, University of Colorado, Boulder.
PRINCE, ALAN S., & SMOLENSKY, PAUL. 1993. Optimality Theory: Constraint Interaction in Generative Grammar. Ms. Rutgers University, New Brunswick, and University of Colorado, Boulder.
PULLUM, GEOFFREY K. 1983. Morphophonemic Rules, Allophonic Rules, and Counterfeeding. Linguistic Inquiry 14. 179-184.
RAFFELSIEFEN, RENATE. 1995. Conditions for stability: the case of schwa in German. Theorie Des Lexikons Nr. 69. Universität Düsseldorf, Germany.
REYNOLDS, WILLIAM T. 1994. Variation and Phonological Theory. Doctoral dissertation, University of Pennsylvania.
RICE, KEREN. 1988. Continuant Voicing in Slave (Northern Athapaskan): The Cyclic Application of Default Rules. In Hammond, Michael, & Michael Noonan, eds. Theoretical Morphology. Academic Press, San Diego.
SELKIRK, ELIZABETH O. 1980. The Role of Prosodic Categories in English Word Stress. Linguistic Inquiry 11.3. 563-605.
SELKIRK, ELISABETH O., & KOICHI TATEISHI. 1988. Constraints on Minor Phrase Formation in Japanese. Papers from the 24th Annual Regional Meeting of the Chicago Linguistic Society. Chicago Linguistic Society, Chicago. 316-336.
SELLS, PETER, JOHN RICKFORD, & THOMAS WASOW. 1994. An Optimality-Theoretic Approach to Variation in Negative Inversion in AAVE. ms., Stanford University. ROA-53.
SHIBATANI, MASAYOSHI. 1990. The Languages of Japan. Cambridge University Press, Cambridge, England.
SILVERMAN, DANIEL. 1992. Multiple scansions in loanword phonology: evidence from Cantonese. Phonology 9.2. Cambridge University Press. 289-328.
SMOLENSKY, PAUL. 1996. On the Comprehension/Production Dilemma in Child Language. Linguistic Inquiry 27.

STAMPE, DAVID. 1972. How I spent my summer vacation [A dissertation on Natural Phonology.] Doctoral Dissertation, University of Chicago. New York, Garland, 1980.

STERIADE, DONCA. 1995. Underspecification and Markedness. In J. Goldsmith, ed. Handbook of Phonological Theory. Blackwell. 114-174.

TRUBETSKOI, NIKOLAI SERGEEVICH. 1949. Principes de phonologie. C. Klincksieck, Paris. Traduit par J. Cantineau.

VANCE, TIMOTHY. 1987. An Introduction to Japanese Phonology. SUNY Press, New York.

VON STECHOW, ARNIM. 1991. Syntax und Semantik. In von Stechow, Arnim, & Dieter Wunderlich, eds. Semantik. Ein internationales Handbuch der zeitgenössischen Forschung. Walter de Gruyter, Berlin & New York. 90-148.

WALKER, RACHEL. 1996. Neutral Segments and Locality. ms., University of California, Santa Cruz.

YIP, MOIRA. 1993. Cantonese Loanword Phonology and Optimality Theory. Journal of East Asian Linguistics. Kluwer, Dordrecht. 261-292.

Department of Linguistics
Stevenson College
University of California, Santa Cruz
Santa Cruz, CA 95064, U.S.A.