In Goldsmith, John, ed. 1995. The Handbook of Phonological Theory. Blackwell, 817-838.

29 Japanese Phonology

JUNKO ITÔ AND R. ARMIN MESTER

0 Introduction

This article sketches some of the most important aspects of the sound pattern of Modern Japanese, focusing on segmental processes and restrictions. Even at this basic level of phonological organization, an empirically and conceptually adequate description requires explicit reference to the large-scale stratification of the Japanese lexicon into morphemes of different classes. A secondary purpose of this article is to show that a formal explication of the structure of the phonological lexicon – a complex network of partially overlapping phonological regularities of various degrees of generality – calls for significant emendation and extension of traditional views on morpheme classes and necessitates the development of a constraint-based model of lexical organization.

1 Lexical Organization

One of the best-known aspects of the Japanese lexicon is its stratified structure, corresponding in kind to the distinction in English between the Germanic and the Latinate vocabulary. In Japanese, stratification is more elaborate in that four different morpheme classes have traditionally been distinguished. *Yamato* forms constitute the native stratum,[1] corresponding to the Germanic/Anglo-Saxon vocabulary in English. Like the Latinate/Greek stratum in English, *Sino-Japanese* roots constitute the vast technical and learned vocabulary of the language. They are mostly bound forms and occur only compounded with other Sino-Japanese roots. Taking over the role of Sino-Japanese as the main source of new technical vocabulary are the ever-increasing loanwords of the *Foreign* stratum. Alongside these three strata (Yamato, Sino-Japanese, and Foreign), there is a substantial class of *Mimetic* vocabulary items.[2] The examples in (1) illustrate the four morpheme classes.

(1)

	Morpheme Class			
Gloss	Yamato	Sino-Japanese	Mimetic	Foreign
"shine"	kagayak-u	-koo-	kira-kira	šaiN
"dog"	inu	-keN-[3]	waN-waN	doggu

While the items in each row of (1) all occupy approximately the same semantic field, they are used in radically different contexts and are by no means homonymous (the same holds for English: *cow/beef/bovine/bucolic, write/describe, moon/lunatic, six*-pack/*sex*tet/*hexa*gon, etc.). If such morpheme classifications were nothing more than a record of etymological history, they would have no claim to a place in a synchronic grammar.[4] However, as is familiar from the classical linguistic literature on the subject (see, e.g., Chomsky and Halle 1968, pp. 174, 373; McCawley 1968, pp. 62–75; Postal 1968, pp. 120–139; Saciuk 1969, pp. 505–512), such classifications require explicit synchronic recognition if, and as far as, they continue to play a role in the grammar. Here their role is not confined to the task of drawing lexical demarcation lines, across which morpheme combinatorics is limited or altogether prohibited (for example, Latinate suffixes attaching only to Latinate stems; Sino-Japanese roots compounding only with other Sino-Japanese roots, etc.). Morpheme classes also figure prominently in organizing the lexical domains of phonological regularities, affecting both segmental alternations and structural constraints (see, e.g., Lightner 1972, p. 433). Thus the Velar Softening alternation in English (*criti*[k]~*criti*[s]ize~*criti*[s]ism, etc., see Chomsky and Halle 1968, pp. 48, 174, 223) is restricted to the juncture between Latinate stems and Latinate suffixes, both level 1 suffixes like *-ize* and level 2 suffixes like *-ism* (see Kiparsky 1982, pp. 3–4, for this classification of [certain uses of] these suffixes, and Goldsmith 1990, pp. 261–262, for further discussion).

The native stratum of Chamorro (Chung 1983, p. 37) has no underlying mid vowels, but such segments do exist in Spanish loans. In the native stratum of German, a word-initial sibilant can be either the voiced alveolar [z] or the voiceless postalveolar [š], but not the otherwise unmarked voiceless alveolar [s] (Trubetzkoy 1939): ([z]*ee* "sea", [š]*ön* "beautiful", [š]*tuhl* "chair"; *[s]*ee*, *[s]*ön*, *[s]*tuhl*, etc.). This restriction does not hold in a large class of loans ([s]*ex*, [s]*teak*, [s]*kandal*, etc.). In Mazateco (Fries and Pike 1949, p. 30), postnasal stops are uniformly voiced in native words (similar to Japanese, cf. (3) below), but not in Spanish loans (*siento* "one hundred"). In Mohawk (Postal 1968, p. 130), the stratum consisting of French loans shows word stress on the final syllable (instead of native penult stress), and in addition allows the labials [m,b,p], which are not permitted in native items. In Turkish (Lees 1961; Zimmer 1969), the Labial Attraction Constraint requiring high vowels to be round after tautomorphemic labial consonants (*armud* "pear", **armɨd*) holds only for native items.

In Japanese, several phonological constraints are stratum-specific and hold only for a particular morpheme class. Thus the compound voicing alternation traditionally known as *Rendaku* "sequential voicing", whereby initial consonants of second members are voiced (2a), is only found in [Yamato] items (Martin 1952, pp. 48–9; Martin 1987, pp. 26–29; McCawley 1968, pp. 86–87; Itô and Mester 1986, pp. 54–55, 66, 72). Also restricted to [Yamato] is the voicing restriction allowing only a single voiced obstruent per morpheme (*Lyman's Law*, (2b)). A property specific to the Sino-Japanese stratum is the restriction that all stems must be (underlyingly) monosyllabic ((2c), see Martin 1952, pp. 24–26; Tateishi 1989a; Itô and Mester 1993a). And the canonical shape of [Mimetic] roots is the minimal word of Japanese (2d): one bimoraic foot (see section 4 below), i.e., two moras (*kira-kira* "glittering", etc., see Hamano 1986; Mester and Itô 1989; and Poser 1990).[5]

(2) (a) Rendaku [Yamato]: Voicing on second compound member
yu "hot water" + toofu "tofu" → yudoofu "boiled tofu"
de "leave" + kuči "mouth" → deguči "exit"

(b) Lyman's law [Yamato]: Morphemes contain at most one voiced obstruent.
futa "lid" fuda "sign" buta "pig" *buda
cf. also: onna + kotoba → onnakotoba "feminine speech" (*onnagotoba)

(c) Monosyllabism [Sino-Japanese]: |root| = σ

(d) Foot Restriction [Mimetic]: |root| = minwd = F (= μμ)

Of considerably greater interest, in the context of Japanese phonology, are the three syllable-related constraints in (3), which each extends over more than a single morpheme class while still not holding over the entire lexicon.

(3) *P A constraint against single [p]: Yamato and Sino-Japanese forms tolerate /p/ only in a geminated or at least partially geminated form (*kappa* "river imp", *nippoN* "Japan", and *kampai* "cheers", but never **kapa* or **nipoN*). The *P-constraint governs neither mimetics (cf. *pika-pika* "glittering") nor foreign items (cf. *peepaa* "paper").

*NT A nasal cluster voicing constraint, ruling out clusters like **nt*, **mp*, **ŋk*: Post-nasal obstruents must be voiced in Yamato and Mimetic (*tombo* "dragonfly", *kande* "chewing", *šombori* "lonely", *unzari* "disgusted", cf. Itô, Mester, and Padgett 1995). The *NT-constraint does not hold in Sino-Japanese and Foreign (*sampo* "walk", *hantai* "opposite", *kaŋkei* "relation"; *kompyuutaa* "computer", *santakuroozu* "Santa Claus").[6]

*DD A constraint ruling out voiced obstruent geminates (*bb, *dd, *gg, *zz): Geminate obstruents must be voiceless in Yamato, Mimetic, and Sino-Japanese (*katte* "buying", *nikkori* "smiling", *šippai* "failure"). Foreign items do allow geminate voiced obstruents (*doggu* "dog", *beddo* "bed").

Notice that each of the constraints in (3) holds of more than one morpheme class, as shown schematically below in (4).

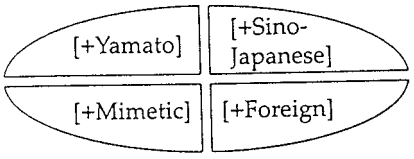
(4)					
	(a)	Yamato	*P	*NT	*DD
	(b)	Sino-Japanese	*P	—	*DD
	(c)	Mimetic	—	*NT	*DD
	(d)	Foreign	—	—	—

In the Yamato stratum (4a), all three constraints hold, which contrasts markedly with the Foreign stratum (4d), where none of them is observed. Sino-Japanese and Mimetic occupy an intermediate position. What we are beginning to see in this simple example are the outlines of a core-periphery organization characterizing the overall lexicon. The maximum set of lexical constraints hold in the core lexical domain, occupied by lexical items traditionally referred to as [Yamato], in the case of Japanese. As the peripheral domain is approached, many of the constraints cease to hold (are "turned off"), or are weakened in various ways.[7]

A second, and equally important, observation about (4) is that it is not in general possible to impose a total ordering on vocabulary strata, in the way lexical phonologists conceive of lexical levels as being strictly ordered, with level 1 preceding level 2, etc. To be more precise, a total ordering of the Japanese strata is not possible in a theory that conforms to the domain continuity principle, which holds that the domain of a constraint or rule must always be continuous, i.e., not interrupted by areas where the constraint or rule is not in force (see, e.g., Mohanan 1986, p. 47). In the case of (4), no total ordering of the four strata is compatible with such continuity. While in one respect (*P) Yamato should be directly followed by Sino-Japanese and not by Mimetic, another constraint (*NT) leads exactly to the opposite conclusion.

Given this kind of evidence for structural patterns within the phonological lexicon of natural languages, how can the grammar take formal account of such facts of lexical organization? It turns out that standard morpheme class features, with labels like [Germanic], [Spanish], etc., by themselves do not constitute an adequate tool for this purpose. In the case of Japanese, we would be dealing with four such features: [Yamato], [Sino-Japanese], [Mimetic], and [Foreign] (cf. McCawley 1968, pp. 62–75, for such a proposal), suggesting a total partitioning on the lexicon, as pictured in (5). What we see emerging, in this conception, are four separate sublexicons, each one obeying its own specific rules and its own specific constraints (as triggered by the relevant diacritic features: [+Yamato], [+Sino-Japanese], [+Mimetic], and [+Foreign]).

(5) The sublexicon model:



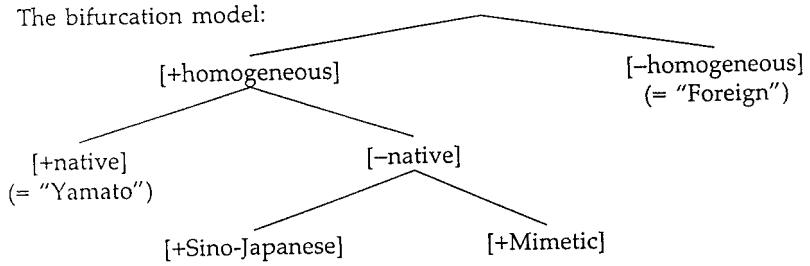
The straightforward prediction of this kind of model is that the strata/sublexicons should each be equipped with their own independent mini-phonologies, much like the early lexical phonology model of morphological levels, where each level had its associated level-specific phonology (Kiparsky 1982), a model since abandoned in favor of an integrated and unitary phonological component governed by the Strong Domain Condition (Kiparsky 1985; Borowsky 1986; Myers 1991b; Padgett 1991), where rules and conditions can be turned off at the end of a certain level, but otherwise cannot be entirely specific to one lexical level.[8] McCawley (1968, p. 73) noted this kind of problem, pointing out that even with a partitioned lexicon the grammar itself remains single and undivided. There is a unitary phonological component of Japanese, not a separate one for each stratum. The problem with the sublexicon model is that it misses the systematic relationships among the various lexical areas visible in (4): the sometimes overlapping constraint domains, and the overall core-periphery structure.[9] Such relationships could of course be imposed from outside, by explicit stipulation, but this would miss the central point – basic design features of lexical structure should form an integral part of the model of the lexicon itself.

The sublexicon model also fails to adequately reflect the often gradual character of lexical stratification, suggesting instead a kind of homogeneity within all the subclasses that is not found in the empirical world, where, e.g., different degrees of nativization among foreign words are commonplace (see, e.g., Holden 1976 for Russian and Nessly 1971 for English). As we will show below, a stratum like Foreign in Japanese is not a homogeneous class of lexical items, all behaving alike with respect to phonological alternations and constraints, but rather covers a whole range of items at different stages of nativization, from the almost fully assimilated to the barely integrated. It might be said that glossing over such differences constitutes harmless idealization, but this is a questionable understanding of this notion. We are here not dealing with grammatically random lexical variation, but instead with lexical variation that provides a window into the inner organization of the lexical constraint system.

Some of these empirical and conceptual inadequacies of morpheme class features like [Latinate] have been pointed out, in different theoretical contexts, by Kiparsky (1968), Nessly (1971), Lightner (1972), Holden (1976), and most extensively by Saciuk (1969). Kiparsky (1968a, 19–20), recognizing the gradualness inherent in the notion "foreign lexical item," calls for a theory in which the feature [Foreign] is replaced by a cascade of redundancy rules of the form "[-Rule X] → [-Rule Y]," predicting, in the typical case, "a hierarchy of foreignness, with exceptions to one rule always being exceptions to another rule, but not vice versa." This important observation strikes at the heart of the sublexicon model in (5). Saciuk (1969, pp. 480–505), taking up this non-homogeneity problem, introduces the class labels [+homogeneous] and [–homogeneous] as nodes within an overall model of the lexicon as a branching tree diagram, illustrated for the case of Japanese in (6). Here the overall lexicon

is divided into a nonhomogeneous ("foreign") part and a homogeneous part, the latter further subdivided into native and nonnative, and the nonnative part finally splitting into Sino-Japanese and Mimetic. The whole approach is cast within the Markedness Theory of Chomsky and Halle (1968), with [+native] and [+homogeneous] acting as the unmarked feature values.

(6) The bifurcation model:

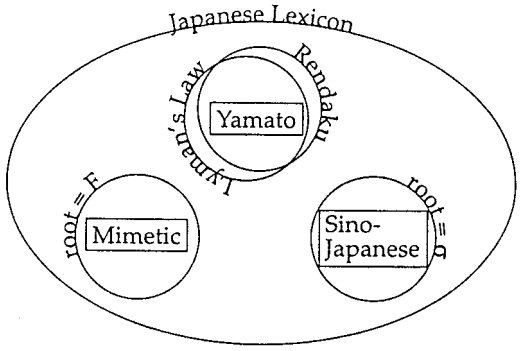


While this markedness approach in principle represents an important insight into the core-periphery structure of the lexicon (see below for further discussion), there are a number of serious problems with any attempt, along the lines in (6), to model lexical structure by a series of successive bifurcations of the lexicon by means of binary features. It seems, first, that nonhomogeneity is, at least to some degree, a property of all strata, and not only of the foreign stratum (even though the issue is most pronounced in the latter case). Second, partitioning the lexicon into two parts and calling one of the resulting sublexicons [–homogeneous] does not amount to a formal characterization (as opposed to a labeling) of nonhomogeneous behavior. Finally, a tree diagram with successive bifurcations, as in (6), has the inherent limitation that any given node can have only one mother node. This property makes it impossible to give formal expression, for example, to the fact that both Mimetic and Sino-Japanese have close, but different, affinities with Yamato (see (4)). This problem cannot be overcome by restructuring the diagram. Once one of the two, either Mimetic or Sino-Japanese, is grouped into a single constituent with Yamato, it is impossible for the other one to be grouped in a similar way. This is an unfortunate trade-off relation: expressing one generalization in the grammar means sacrificing another one. But it is incumbent upon the grammar to capture the precise patterning of *all* the various constraint domains. We are faced with a situation of partial crossclassification, which in the general case (see Chomsky 1965) cannot be captured by branching tree diagrams as in (6).

All these consideration suggest that it might be worth having a closer look at the empirically tangible patterning of (phonological) constraint domains in the lexicon. Instead of directly partitioning the lexicon with labels like "Yamato," "Sino-Japanese," etc., which each imply various phonological properties (constraints), let us begin more modestly by directly modeling the constraint domains within the lexicon, and study the resulting configurations, which we will graphically express by means of Venn diagrams serving as constraint

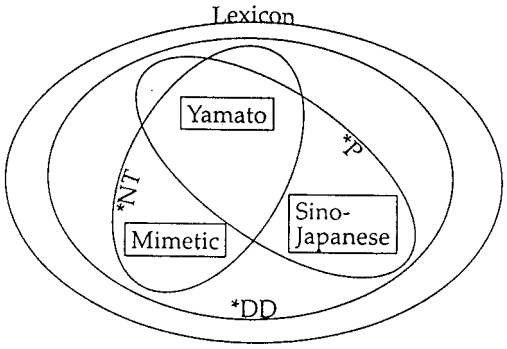
domain maps. Consider first the class-specific constraints in (2), whose domains are each coextensive with a single morpheme class, as shown in (7)

(7)



More interesting are the overlapping constraints in (3), whose domain map appears in (8). The outermost ellipse represents the lexicon as a whole. The two innermost ellipses represent the single-p constraint, *P, and the nasal cluster voicing constraint, *NT, whose domains do not stand in an inclusion relationship, but rather overlap in the core area, containing the items of the [Yamato] class (see (4)). This central area is also the domain of Rendaku and Lyman's Law (2a, b). The ellipse immediately surrounding the two overlapping domains represents the *DD-constraint, which includes the areas occupied by Yamato (innermost area), Sino-Japanese (within *P) and Mimetic (within *NT).

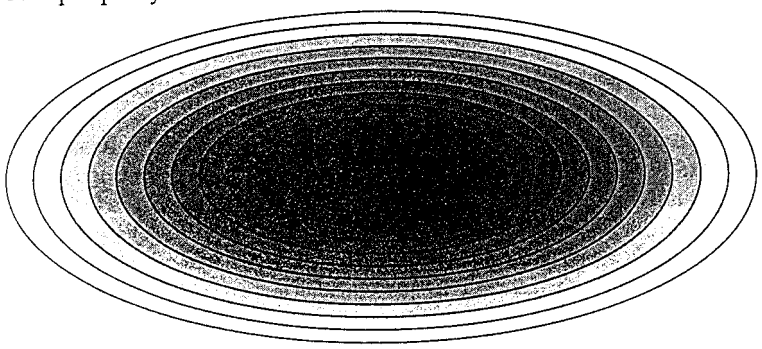
(8) The constraint domains model:



The constraint map (8) indicates that there exist lexical areas which are non-Yamato, non–Sino-Japanese, non-Mimetic, but still obey the *DD constraint. This is exactly as desired: such areas are occupied, e.g., by strongly assimilated loans like *hando-bakku* "handbag" (with a devoiced geminate).

We will develop the constraint domain model in (8) by filling in more of the constraints which collectively make up the phonology of Japanese and locating their relative domains. Abstracting away from the fact noted above that the boundaries of *all* strata are to some extent in flux, we will continue to assume that Yamato, Sino-Japanese, and Mimetic exist as lexical areas ("strata") (see (8)), relatively well-defined in terms of bundles of closely coinciding constraint "isoglosses." On the other hand, the large and very heterogeneous class of Foreign items (cf. Saciuk's 1969 [–homogeneous] class) should not be considered as constituting a uniform stratum. Rather, we are simply dealing with less central areas of the lexicon, where more and more constraints are violated. Thus the overall lexicon is viewed as an abstract space, with a core and a periphery.[10] The distinction between more and less nativized items (Kiparsky 1968; Nessly 1971; Holden 1976) concerns the number of constraints that an item complies with: the less nativized an item, the more it is exempt from lexical constraints, i.e., the more it is located toward the periphery, falling outside of various constraint domains. These constraint domains are centered around an abstract core, governed by the maximum set of lexical constraints (the core is thus "unmarked," cf. Saciuk 1969). This is illustrated in (9) (where for graphical perspicuity constraint overlap is ignored).

(9) Core-periphery structure:



As the periphery is approached, many of the constraints cease to hold, or are weakened in systematic ways (we will encounter the latter type of situation in section 3). A plausible hypothesis is that the periphery usually does not add a new constraint, nor strengthen an existing one. Compare this with a simple bifurcation between Foreign and non-Foreign, as in (6), which does not yield any predictions as to what kinds of differences might arise. The core/periphery distinction suggests that we should not expect to find a language where, e.g., the *NT-constraint holds in the foreign loanwords but not in the native vocabulary, or a situation where the stronger version of the constraint holds

in the periphery and the weaker version in the core. What the core-periphery distinction entails, then, is a notion of distance from the lexical core: as the distance increases, constraints are weakened and abolished, and the range of admissible structures increases.[11] With this conception of constraint domains, we will now illustrate the various constraints of Japanese, asking what they tell us about the design of the phonological lexicon.

2 Segment Inventory Differences and Allophonic Rules

The goal of this section is to further substantiate the distinction between the lexical core, including Yamato, Sino-Japanese, and Mimetic, and the lexical periphery. One of the most salient differences lies in the underlying segment inventories. We first focus on the bilabial fricative [f] and and the alveolar affricate [t^s].[12] As shown in (10), these segments do not occur in the core domain except before [u].

(10) (a) *[fa] *[fe] *[fi] *[fo]
*[t^{s}a] *[t^{s}e] *[t^{s}i] *[t^{s}o]

(b)	[fu]:	too**fu**	"tofu"	**fu**ji	"Fuji"	afureru "overflow"
	[t^{s}u]:	t^{s}ukue	"desk"	fut^s**uu**	"ordinary"	kat^s**-u** "win" (pres.)
						cf. kat-anai "win" (neg.)

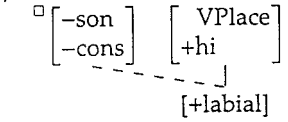
In phonemic terms, [f] and [t^s] are allophonic variants of /h/ and /t/, and the fact that [fu] and [t^{s}u] are allowed goes hand in hand with the fact that *[hu] and *[tu] are excluded. Thus in the recitation of the lines of the syllabary, we find *kakikukeko* "*k*-column", but *tačit^{s}uteto* "*t*-column" and *haçifuheho* "*h*-column". We analyze these facts as resulting from the interaction of two pairs of constraints. First, there are the segmental constraints in (11) barring the labial fricative [f] and the coronal affricate [t^s].

(11) (a) *F: $*\begin{bmatrix}-\text{son}\\ \text{LAB}\end{bmatrix}$ / [+cont]

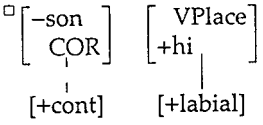
(b) *TS: $*\begin{bmatrix}-\text{son}\\ \text{COR}\\ +\text{ant}\end{bmatrix}$ → [−cont] [+cont]

Second, we posit the sequential constraints in (12) requiring labialization of [h] and affrication of [t] before [u] (where the broken line represents the association relation which must necessarily (indicated by □) hold in configurations fulfilling the rest of the structural description).

(12) (a) □FU:



(b) □TSU:



These sequential constraints disallow [h] and [t] before [u] and require [f] and [tˢ], respectively. Since each of the constraints in (12) is operative in the grammar and conflicts, as a more specific constraint, with the corresponding more general constraint in (11), it follows by the Pāṇinian theorem of optimality theory (Prince and Smolensky 1993, pp. 81–82) that (12a) must rank over (11a), and (12b) over (11b).

The decision to separate the segmental constraints (11) from the sequential constraints (12) is confirmed by the behavior of peripheral items. In the peripheral domain, [f] and [tˢ] are found before all vowels (13), indicating that the segmental constraints (11) are no longer in force.

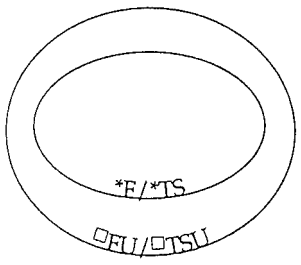
(13)						
	[fa]	faito	"fight"	[tˢa]	tˢaitogaisuto	"Zeitgeist"
	[fe]	fesutibaru	"festival"	[tˢe]	tˢerutozakku	"Zeltsack"
	[fi]	sufiŋkusu	"Sphinx"	[tˢi]	eritˢiɴ	"Yeltsin"
	[fo]	šifoɴ	"chiffon"	[tˢo]	kantˢoone	"canzone"
	[fu]	furutaimu	"full-time"	[tˢu]	tˢuŋge	"Zunge"

Even though /f/ and /tˢ/ are phonemes in their own right in the lexical periphery, the sequences [hu] and [tu] are still disallowed. Where the loan source contains [hu] or [tu] (14), these sequences are rendered with labialization or affrication the resulting homonymy in cases like *fuudo* notwithstanding (or, as in the case of *hook*, a variant pronunciation lowers the vowel so as to keep the [h] quality of the consonant in the source word).

(14)	(a)			(b)		
		fuupu	"hoop"		tˢuaa	"tour"
		fuuzufuu	"Who's Who"		tˢuiɴ	"twin"
		fukku~hokku	"hook"		tˢuuraɴ	"two-run homer"
		fuudo	"hood/food"		tˢuna	"tuna"

The resulting constraint map is given in (15).

(15)



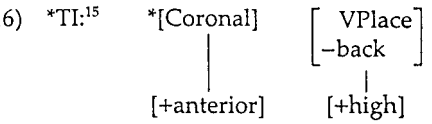
Here the inner ellipse represents the domain of the segmental *F/*TS-constraints, and the larger containing circle that of the sequential □FU/□TSU-constraints.[13]

3 Palatality Constraints and Peripheral Weakening

Traditional classification divides the Japanese CV-moras into plain and palatal moras, where the term "palatal" refers to several different phonetic correlates. For coronals, "plain/palatal" refers to a contrast in primary place of articulation (dental/alveolar vs. alveopalatal:[14] *ta* "field" vs. *ča* "tea", *saku* "fence" vs. *šaku* "wine-serving"). The palatal versions of noncoronals are complex segments with a secondary palatal articulation (*boo* "stick" vs. *bʸoo* "second", *kuukoo* "airport" vs. *kʸuukoo* "express"). Finally, the plain counterparts of palatal glide moras are onsetless syllables (*ane* "sister" vs. *yane* "roof", *umi* "sea" vs. *yumi* "arrow").

Although allowed as underlying elements, these segments have associated sequential restrictions, somewhat similar to *FU/*TSU discussed above. One such restriction is the *TI-constraint (16), which excludes nonpalatal coronal consonants followed by the high front vowel [i] (e.g., **ti, *di, *si, *zi*).

(16) *TI:[15]



(17)	(a)	/kat/	kat-oo	kat-e	kač-i	"win", tentative/imperative/infinitive
		/hanas/	hanas-oo	hanas-e	hanaš-i	"talk", tentative/imperative/infinitive
	(b)	/-suru/		kiN-zuru ~	kiN-ǰiru	"forbid"

When a verbal root ends in an alveolar consonant (17a), concatenation with an [i]-initial suffix results in the sequence [ti] or [si], and the coronal obstruents are realized as palatal [č] and [š]. And the form /-zuru/, itself a postnasal alternant of the bound suffix /-suru/ "do", has a variant form [-ǰiru], with a front vowel and a palatal consonant (17b).

The *TI-constraint also applies in assimilated foreign loans. Where the source word contains the illicit [nonpalatal] + [i] sequence, the loanword avoids this sequence in one of two ways: usually by palatalizing the consonant (18) (i.e., by changing its anteriority value), but sometimes by lowering the vowel (19) (i.e., by changing its value of [high]).

(18)

SOURCE: [ti/di] → LOAN: [či/ǰi]		SOURCE: [si/zi] → LOAN: [ši/ǰi]	
team	čiimu	cinema	šinema
ticket	čiketto	dressing	doreššiŋgu
dilemma	ǰiremma	zigzag	ǰiguzagu

(19)

SOURCE: [ti/di] → LOAN: [te/de]	
spaghetti	supagettee
tissue	teššu
disco	desuko

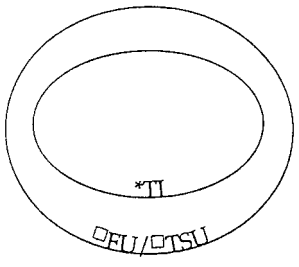
Both (18) and (19) can be interpreted as the result of enforcing the *TI-constraint.[16] Different from □FU, which holds throughout the lexicon, *TI is not enforced in the periphery, and we encounter the sequence [ti] unchanged in recent loans (20).

(20)

SOURCE: [ti] → LOAN: [ti]		
teen(ager)	tiiN	(*čiiN)
party	paatii	(*paačii)
disc jockey	disuku-ǰokkii	(*ǰisuku-ǰokkii)
duet	dʸuetto	(*ǰuetto)

The relevant part of the constraint map is given in (21).

(21)



Related to the *TI-constraint, but less well known, is a set of sequential restrictions in Japanese which rules out all kinds of palatal segments preceding the mid front vowel [e] (Bloch 1950; McCawley 1968). The individual subcases are listed in (22).

(22)

(a)	*CE:	No sequence [alveopalatal C] + [e]	(*če, *še, *že, *ǰe, etc.)
(b)	*KYE:	No sequence [palatalized C] + [e]	(*k^{y}e, *p^{y}e, m^{y}e, *d^{y}e, etc.)
(c)	*YE:	No sequence [palatal glide] + [e]	(*ye)

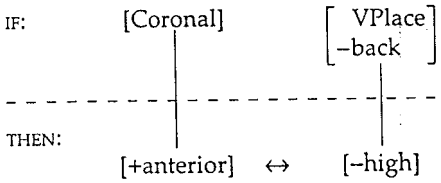
The *ČE-constraint holds in Yamato, Sino-Japanese and Mimetic. The sequence [palatal C] + [e] does not occur underlyingly, and there are no conceivable derived cases (roots do not end in palatal obstruents; for root-final [y], see the discussion in conjunction with the *YE constraint below). Among Foreign items, we find cases of depalatalization. If the loan source contains a [palatal-C] + [e] sequence, (23), the palatal is reanalyzed as a plain coronal (i.e., as [+anterior]).

(23)

SOURCE: [še]/[ǰe] → LOAN: [se]/[ze]	
shepherd (dog)	sepaado
gelatine	zeračiN[17]
Los Angeles	rosanzerusu
general strike	zene-suto

The *ČE-constraint can be merged with the *TI-constraint by positing a single feature implication statement, (24), governing the relative positioning of tongue blade and tongue body (see Archangeli and Pulleyblank in press for similiar tongue configuration constraints governing [ATR] and height features).

(24) ČE/*TI:[18]



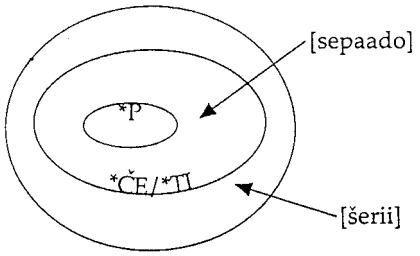
(24) yields two licit and two illicit types of combinations, e.g., with a voiceless fricative: *se, ši,* and **še, *si.* The combined statement in (24) makes a strong prediction: being part of a single constraint, *TI and *ČE should have the same domain of applicability. Since [ti] is allowed in the periphery (20), [če] should also be found there, e.g., in recent loans. This is indeed the case, as (25) shows.

(25)

SOURCE: [če/še/ǰe] → LOAN: [če/še/ǰe]	
chain	čeeN
Nietzsche	niiče
sherry	šerii
jet	ǰetto

Within the lexicon as whole, the *ČE/*TI-constraint forms a proper subdomain, as in (26), leaving a periphery ungoverned by this restriction. The constraint domain map shows the location of loans like *sepaado* "shepherd dog", which obey the *ČE/*TI-constraint, and that of unassimilated loans like *šerii* "sherry", which do not.

(26)



One might at this point entertain the question whether assimilated Foreign words should be considered as having joined the Yamato morpheme class. That is, should a form like *sepaado* in (26) now be considered totally "native"? Even though it fulfills the *ČE-constraint, it still lies outside of the domain of the *P-constraint, and the form clearly cannot be identified as Yamato. Thus to undergo the process of nativization does not mean that a loanword necessarily joins a native morpheme class (see Holden 1976 for similar cases in Russian). It is of course possible for a form to already obey all the constraints holding in [Yamato]. In such cases, it has the potential to be fully admitted to the morpheme class. For example, *tabako* "tobacco", an unaccented form with a single voiced obstruent, counts in all relevant respects as a native item.[19] Another more striking example is *karuta* "carta" (a sixteenth-century Portugese loan), which even undergoes the Rendaku voicing rule (2a) (normally restricted to [Yamato] items) in *hana-garuta* "flower card game" (see note 5 for similar phenomena in Malayalam). Nativization cannot be equated with the enforcement of a single constraint like *ČE/*TI – the forms in (18) and (23) are clearly non-Yamato, non-Mimetic, and non-Sino-Japanese. They cannot and should not be categorized as another morpheme class – a proliferation of terms like "Foreign," "Assimilated Foreign," "Fully Integrated Foreign," etc., is misleading and gives rise to the illusion that such labels refer to homogeneous classes (see the discussion in section 1, and Saciuk 1969).

It is also important not to entirely equate "peripheral" with "foreign." Violations of the *ČE-constraint are not restricted to recent loans, but are also found among items of native origin, as in (27).

(27) če? (swearword)
šee (exclamation used by famous cartoon figure)

Such forms are undoubtedly native, but peripheral.[20]

It is not the case that hardly any constraint holds in the outer lexical periphery – many basic constraints of Japanese are in full force (e.g., basic syllable

constraints making nonhomorganic consonant clusters impossible, etc.). In fact, as we will see immediately below, the palatality restrictions *YE and *KYE are also still observed in the periphery, even though *ČE and *TI are not.

The *YE-constraint (22c) disallows the sequence [palatal glide] + [e].[21] Where such a sequence would be expected, we find the disappearance of the prevocalic /y/. With roots ending in /y/, the intransitive ending /-eru/ would result in the illformed sequence [ye] (28b), cf. (28a). In these cases we find deletion of the root-final /y/ in the output (/moy-eru/ → *mo-eru*).

(28)		Transitive	Intransitive	
	(a)	tob-asu	tob-eru	"fly"
		sam-asu	sam-eru	"cool down"
		hag-asu	hag-eru	"peel off/become bald"
	(b)	moy-asu	mo-eru	"burn"
		tay-asu	ta-eru	"extinguish/be extinct"
		koy-asu	ko-eru	"make/become fat"

Two strategies of dealing with loan sources containing the sequence **ye* are illustrated in (29). Either the [y] is deleted, as in the core verbal paradigm above ([erit^{s}iN] for "Yeltsin"), or it vocalizes the [i] as in [i.e.meN] for "Yemen".

(29)			
	(a)	e.ri.t^{s}iN	"Yeltsin"
	(b)	i.e.meN	"Yemen"
		i.e.su.maN	"yes-man"

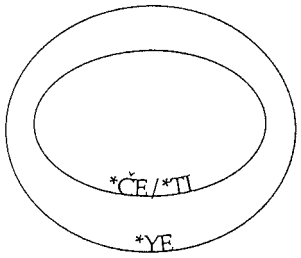
The crucial point here is that the *YE-constraint is never violated, even with very recent loans like [erit^{S}iN].[22]

Turning next to the *KYE-restriction (22b), it turns out that we are not dealing with an additional independent constraint, but rather with a different facet of the *YE-constraint. The *KYE-restriction excludes [palatalized C] + [e], there are no restrictions on any other vowels after palatalized consonants (e.g., *b^{y}ooki* "sickness", *m^{y}aku* "pulse", *k^{y}uuri* "cucumber"). This suggests a straightforward solution, given the feature-geometrical analysis of palatalized segments as containing a secondary place characterizing [y] besides a major consonantal place (cf. Clements and Hume, chapter 7 in this volume, and references cited there).

We can use this idea to make formal sense of the intuitive analysis encoded in the kana syllabaries. In these terms, [C^{y}V] = [C + yV], such that all [k^{y}a], [b^{y}o], etc., originate in /k+ya/, /b+yo/, etc. It follows that consonantal complexes containing [y] (*[kye], *[mye], *[bye], etc.) cannot occur before [e], simply because they would have to contain the illformed sequence *[ye], which is already ruled out by *YE.[23] Thus *KYE and *YE are not separate constraints, but reduce to the *YE-constraint. The *ČE-constraint, on the other hand, plays a role independent of the *YE-constraint in the grammar, and must remain formally separate. As we have seen, *ČE holds only within a portion of the lexicon, whereas *YE holds everywhere. Thus the periphery allows the sequence

[če], (25), but not the sequences [ye] nor [kye]. The *YE-constraint must encompass the entire lexicon, with an inner *ČE circle, as in (30).

(30)



What, then, is the formal relation between *ČE and *YE? We are here dealing with a weakening of the palatality constraint towards the periphery. Different from constraints like *P and *NT, the palatality constraint does not become inoperative, but instead is reduced in force. The close relation between *ČE and *YE becomes evident with a formal statement of the *YE-constraint:

(31) *YE: $*\begin{bmatrix}\text{Coronal}\\ \text{approx}\end{bmatrix}\quad\begin{bmatrix}\text{VPlace}\\ \text{–back}\end{bmatrix}$

[–anterior] [+high]

(31) assumes that [y] is specified for [COR, –ant] (see Mester and Itô 1989) and that the articulator is specified for glidehood with the feature [approximant] within the "gestural" articulator complex (Browman and Goldstein 1989; Padgett 1991). *ČE (24), the stronger version of the palatality constraint disallowing all palatals before [e], is domainwise limited to the lexical core; *YE (31), the weaker version disallowing only approximants in this position, has the whole lexicon, with core and periphery, in its domain.

Just as the approximant constraint *YE is still enforced in the periphery, there is also a fricative remnant of the *TI-constraint, namely the *SI-constraint, that is still operative in the periphery. It ensures that coronal fricatives must be palatal before [i], as illustrated by the examples in (33).

(32) *SI: $*\begin{bmatrix}\text{Coronal}\\ \text{fricative}\end{bmatrix}\quad\begin{bmatrix}\text{VPlace}\\ \text{–back}\end{bmatrix}$

[+anterior] [+high]

(33)

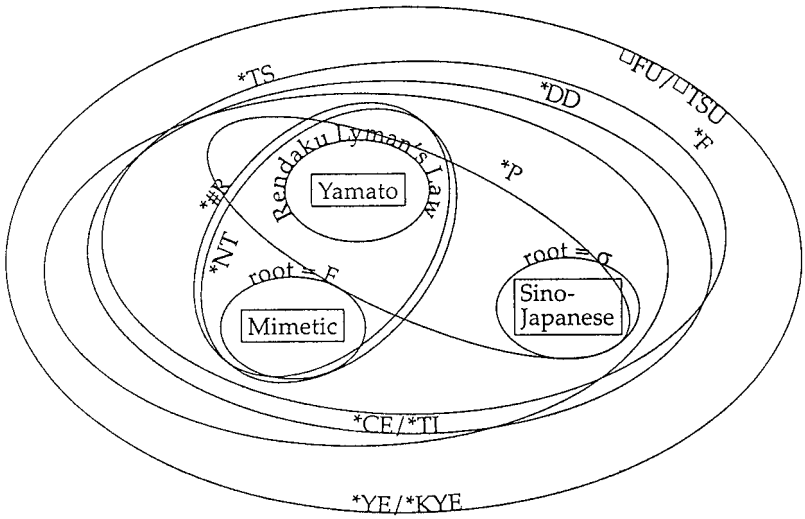
SOURCE: [si/zi] →	LOAN: [ši/ži]
sea food	šii fuudo
zip code	žippu koodo
Citibank	šiti baŋku

As a result, a fricative coronal followed by [i] always appears as palatal, even though its stop counterpart does not. The asymmetry between stops and fricatives is most clear in the last example, *Citibank*, where [s] becomes palatal [š], but [t] remains alveolar.[24] The constraint domain model straightforwardly depicts the rather subtle patterning of the palatal sequences and their distribution in the lexicon, and the notion of "weakening" of constraints makes sense in terms of core and periphery.

The overall structure emerging in the lexical constraints model, with more and more constraints "turning off" toward the lexical periphery, is highly reminiscent of certain proposals encountered in the lexical phonology literature with respect to the notion of structure preservation, within a theoretical approach strongly committed to the notion of a sequential derivation. Thus both Kiparsky (1985, p. 135 n. 3) and Myers 1991 have argued for a derivationally articulated notion of structure preservation. Here the successive loosening of the constraints (which collectively define the "structure" to be "preserved") is identified with the "turning off" of rules during the derivation (Strong Domain Condition). It is noteworthy, then, that the lexical core/periphery distinction substantiated in this paper has nothing to do with "early" vs. "late" in the derivation: the periphery is just as underlying as the core. Since we are dealing with the same formal relations between constraints and constraint domains, a single theory should encompass both areas. This means that the lexical-phonological idea of "turning off" rules and constraints must be subsumed under a more general theory of the lexicon organized by concentric constraint domains of the kind discussed here. The lexical facts of Japanese (and no doubt of most other languages, if studied with a sufficient degree of detail, see again Saciuk 1969 for a rich collection of relevant evidence) reveal the need for a more general concept of what it means for an item or a morphological formation to obey a certain constraint ("structure preservation") and what it means for a constraint to be out of force ("turned off"). In order to capture these aspects of lexical wellformedness with an adequate degree of generality, the notion of structure preservation must be made independent of the notion of a phonological derivation proceeding in a step-by-step fashion (for arguments against the traditional "sequence-of-operations" view of phonology, see recent work in Optimality Theory, in particular Prince and Smolensky 1993, and in a more general vein, other work making use of the harmony concept in phonology (Goldsmith 1990, 1991, 1992)).

As a conclusion of this section, (34) shows an overall constraint map of the phonological lexicon of Japanese, incorporating all the constraints presented in this paper.[25]

(34)



4 Concluding Remarks

Besides some brief remarks on templatic constraints (2c, d), this article has hardly touched on the prosodic aspects of Japanese. This should not be taken as minimizing the importance of the work in this area – on the contrary, we believe that the more important and influential discoveries have been made in the areas of prosodic constituency and accent, with far-reaching consequences not only for Japanese, but also for phonological theory.

Regarding the prosodic organization of Japanese, strong evidence has emerged for both the mora and the syllable as prosodic units. Influenced by the standard syllabaries whose basic unit (the *kana*) is a (C)V unit roughly coextensive with the mora, most naive phonological categorization is built on the mora and makes no use of the syllable. This reflects the fact that the mora, as a phonological unit of abstract timing, is exceptionally well established for Japanese (see, e.g., Katada 1990; Nagano-Madsen 1992; Otake et al. to appear). While invariant local phonetic cues for moras are apparently not uniformly detectable in the acoustic signal (Beckman 1982), recent work has corroborated the phonetic relevance of moras for phonetic timing at the level of the phonological word (Port, Dalby, and O'Dell 1987). Beginning with McCawley's (1968) characterization of Standard Japanese as a mora-counting but syllable-accenting language, numerous writers have adduced significant evidence in support of syllabic organization in addition to moraic organization (see Itô 1986, 1989; Itô and Mester to appear; Poser 1990; Kubozono 1989b; and references cited there).

A significant finding (Poser 1990) about higher-level prosody in Japanese is its organization in terms of foot structure. The fact that such higher-level

organization into feet asserts itself in Japanese, a language lacking an intensity-based system of prominence ("stress," see Beckman 1986), has helped theorists overcome the illfounded limitations of a conventional understanding which sees foot structure only motivated for stress languages like English. In Japanese, the relevant evidence includes a multitude of template-based formations built on a strictly bimoraic foot, i.e., a unit realized as a single heavy syllable or as a sequence of two light syllables. As the minimal word (see chap. 9, this volume, and McCarthy and Prince 1986; Itô 1990) of Japanese, it plays a pivotal role in various types of name truncations (Poser 1990; Mester 1990), monomoraic lengthening cases, loanword clippings (Itô 1990; Itô and Mester to appear), language games (Tateishi 1989b; Itô, Kitagawa, and Mester to appear), and in a number of other areas (see Haraguchi 1992 for a collection of relevant work currently pursued in Japan).

The Japanese pitch accent system has been the subject of a number of recent analyses, building on the classical studies of Hattori (1960), Akinaga (1960), Martin (1952), and McCawley (1968). Haraguchi (1977) initiated the autosegmental analysis of pitch accent, continued in the work of Higurashi (1983), Poser (1984b), Kubozono (1989a, 1993), and others. One of the central questions in all these approaches concerns the way in which metrical (prosodic) organization (into moras, syllables, feet, and prosodic words, etc.) interacts with tonal structure. The analysis in Pierrehumbert and Beckman (1988) makes crucial use of boundary tones (tonal elements assigned to higher levels of the prosodic hierarchy and realized in peripheral position) and of tonal underspecification, supporting the view that phonological representations of Japanese utterances remain tonally only sparsely specified up to and including the level that constitutes the input to phonetic interpretation.

Thus, Japanese has played a pivotal role in almost every area related to modern prosodic phonology, and the contributions are so numerous that an overview article like the present one cannot do justice to the relevant research. Rather than offering a cursory survey of well-known work, we have instead chosen to focus on some of the segmental and sequential constraints of the language. This allowed us to present in some detail the less well-known, but no less interesting, constraint-based organization of the phonological lexicon, which is of fundamental importance as a frame of reference for all in-depth work on Japanese phonology.

NOTES

1 Here and throughout, we follow established practice (see e.g. Saciuk 1969) in reserving the term *stratum* for subdivisions of the total vocabulary. Strata in this sense should not be confused with the affixation levels of lexical phonology, which will be referred to as *levels*, using the term introduced for this purpose in the work of Kiparsky (1982, 1985, etc.).

2 Mimetics are sound-symbolic items

that play a much more important role in the overall system than corresponding words in English. As McCawley (1968, p. 64) points out, mimetics "function syntactically as manner adverbs and may refer to just any aspect (visual, emotional, etc.) of the activity involved, rather than just its sound."

3 Cf. *koo-taku* "brilliance", *hak-koo* "white light", *keN-ši* "canine tooth", *kyoo-keN* "rabid dog". We use small capital N for the placeless coda nasal of Japanese.

4 In fact, it is well-known that the synchronic classifications, as evidenced by the overt behavior of speakers, in numerous cases diverge from the true etymological origin of the items in question. Thus certain Yamato items, like *fude* "brush" or *uma* "horse", are in fact probably very early (and nowadays unrecognizable) borrowings from Chinese, mediated through Korean (see Sansom 1928, pp. 29–30), etc.

5 Japanese is by no means alone in possessing a rich and intricate system of this kind. For example, Mohanan (1986, pp. 80–83) points out that in Malayalam several phonological rules are sensitive to the distinction between Sanskrit and Dravidian lexical items. This distinction is productively applied to newly coined items (on the basis of the overall phonological "type" of the item, as defined by various lexical constraints of the kind investigated in this article for Japanese). The Sanskrit/Dravidian distinction is superimposed, as an independent classification, onto a lexical phonology itself organized into several levels of affixation. And just as there is no "Sanskrit level" or "Dravidian level" in Malayalam, there is also no "Yamato level" or "Sino-Japanese level" in Japanese. Rather, such morpheme classifications exist and operate independent of any level distinctions (see also Inkelas and Orgun 1993).

6 A similar affiliation of a constraint with both Yamato and Mimetic, to the exclusion of the two other strata, is manifested by the *#R-constraint: Yamato and Mimetic stems never show initial [r]. On the other hand, Sino-Japanese stems (like *raku* "ease") and foreign words (like *raǰio* "radio") with initial [r] are not at all uncommon. But there is some legitimate basis for doubting the synchronic validity of this constraint (thus forms like *risu* "squirrel" or *riŋgo* "apple" are usually regarded as Yamato in spite of their initial [r]).

7 It goes without saying that there are constraints that hold even in the Foreign vocabulary, e.g., basic syllable structure restrictions, as evidenced by the massive "epenthesis" occurring in loans (*kurisumasu* "Christmas", *sutoraiki* "strike", etc.). We will return to this issue below.

8 Thanks to John McCarthy, Jaye Padgett, and Alan Prince for helpful discussion on these issues.

9 Further problems arise if the binarity of morpheme class features as depicted in (5) is at all taken seriously. If every morpheme class feature [F] allows both [+F] and [–F] as values, this makes the implausible prediction that the complement of every morpheme class should automatically also constitute a "natural" morpheme class.

10 It should be noted that "core" and "periphery" do not correspond to "lexical" and "postlexical," in the sense of lexical phonology. Both core and periphery are lexical.

11 This is comparable to the derivational and level-oriented weakening of constraints known from lexical phonology, where the abstract point of reference is always the beginning of the derivation, and distance is being measured from there (see the end of section 3 and note 5 for further discussion).

12 Following standard transcriptional practice for Japanese, the symbol [u] is used for the labial unrounded [ɯ], and [f] for the bilabial fricative [ɸ].

13 The larger circle may not be coextensive with the entire lexicon. In certain highly anglicized pronunciations, younger speakers use the unaffricated coronal before [u] (*duu itto yuaserufu* "do-it-yourself", *duu-wappu* "doo-wop (music)"), which might indicate that for such speakers there is still an outermost lexical area beyond the □TSU-circle.

14 Denoted here, following standard usage, by [š, ž, č, ǰ], but realized in Japanese as "prepalatal": [ɕ, ʑ, etc.], in particular before front vowels (see Vance 1987 and Keating 1991).

15 If CPlace and VPlace are (partially) comprised of the same features, this statement can be simplified in various respects. Since our present goal is not the exploration of feature-geometric microstructure, we have adhered to a conservative set of features and minimal node structure (cf. McCarthy 1988, and work cited there). On the role of VPlace and feature unification issues, see Broselow and Niyondagara 1989, Clements 1991, Gnanadesikan 1993, Hume 1992, Keating 1991, Lahiri and Evers 1991, Mester and Itô 1989, Ní Chiosáin and Padgett 1993, Pulleyblank 1989, Selkirk 1993, and others.

16 The onglide [y] in a source word is treated in the same way as the vowel [i], so that SOURCE (tyu/dyu/syu] → LOAN [ču/ju/šu]: *čuubu* "tube", *šičuu* "stew", *čuurippu* "tulip", *juusu* "deuce/juice", *šuururearisumu* "surréalisme".

17 In this form, the constraints have resulted in a kind of "palatality reversal": The source palatal [ǰ] appears as the alveolar [z] before [e], and the source alveolar [t] appears as the palatal [č] before [i].

18 In more familiar notation with traditional coefficient variables, (24) is equivalent to (i):

(i) $*\begin{bmatrix}\text{Coronal}\\ \alpha\text{anterior}\end{bmatrix}\begin{bmatrix}\text{VPlace, }-\text{back}\\ \alpha\text{high}\end{bmatrix}$

19 Unaccentedness is a hallmark of nativeness (loanwords usually receive antepenultimate accent, see McCawley 1968, 1977), and the word is written in hiragana (or kanji) and not in katakana, the usual way of rendering western loans.

20 In the same category belongs an observation about the *TI-restriction attributed by Vance (1987) to B. Bloch: The quotation marker *to-yuu*, consisting of the complementizer *to* followed by *yuu* "to say", is in casual speech often contracted to *tʸuu*, but not to the fully palatal *čuu*. Other casual speech contractions of this kind include provisional forms like *tatakeba* → *tatakʸaa* "if *pro* hit(s)", *hanaseba* → *hanasʸaa* "if *pro* talk(s)", *kateba* → *katʸaa* "if *pro* win(s)" (Hasegawa 1979; Martin 1975; Miyara 1980; Poser 1988; Shibatani 1990; Vance 1987).

21 The sequences *[yi] and *[wu] are ruled out for independent OCP-related reasons (McCarthy and Prince 1986; Hayes 1989). Both are universally disfavored sequences

(Maddieson and Precoda 1992). See also Komatsu (1981, pp. 21–53) for a useful discussion of the historical development of glide-initial moras.

22 This item is clearly marked as extremely peripheral since it contains the affricate [t^s] preceding a vowel different from [u]; moreover, this alveolar sibilant remains unpalatalized in spite of the following high front vowel.

23 This is somewhat reminiscent of the on-glide analysis of the English [y] in Borowsky 1986, where the on-glide is analyzed in conjunction with the vowel [u] (building on the proposal in Chomsky and Halle 1968). In English pronunciations of Japanese place names, we find a very similar effect: The city name *Kyoto* is usually pronounced by speakers of American English with a vocalized *i* in a separate syllable [kióʊroʊ], but vocalization is less prone to occur for the island name *Kyushu* [k^{y}ú:šu:], because the on-glide [y] can appear before the vowel [u] in English, but not before [o]. An interesting case is the name of the *Ryukyu* islands [riyú:k^{y}u:], where only the first [y] is required to vocalize (since the sequence [r^{y}u] is not established in English).

24 This may be in a process of flux in Japanese, since many younger speakers (who are conversant in English) incorporate the nonpalatal [si] quite often in spontaneous usage of English words in Japanese. We hypothesize that asymmetries in the influx of nonpalatalized coronals before [i] are a reflection of a general tendency of sibilants to palatalize in this environment.

25 The sequential CV-constraints that we have seen throughout this section ($^{\square}$FU, $^{\square}$TSU, *ČE/*TI, *YE, *SI) can be conceived of in various ways. One of the most attractive possibilities, in our view, is to think them as demisyllable constraints. A demisyllable, in the sense of Fujimura (1979, 1989), is a set of unordered feature specifications: the syllable core is divided into initial and final halves – demisyllables – each of which can contain only one specification of the place of articulation. Fujimura argues that order specification of segments is redundant within demisyllables, as minimal integral units. Whether the feature incompatibilities themselves that make up the substance of the palatality constraints can be partially or totally reduced to the Obligatory Contour Principle (a possibility explored in Itô and Mester 1991) is somewhat unclear. A slightly different line of attack would be to try to reduce the sequential CV-constraints to segmental constraints, by forcing a projection of the relevant vocalic features onto the preceding consonant. Such a feature-geometric "compression" might be carried out, for example, by positing a general principle of CV-linkage requiring all demisyllabically integrated CV-units to be vocalically linked. All of these points are in need of further investigation, a task that goes beyond the limits of this presentation (thanks to Linda Lombardi and Jaye Padgett for helpful discussion of these and other issues).

Blackwell Handbooks in Linguistics

The Handbook of Phonological Theory *Edited by John A. Goldsmith*

First published 1995

Blackwell Publishers
238 Main Street
Cambridge, Massachusetts 02142
USA

108 Cowley Road
Oxford OX4 1JF
UK

Library of Congress Cataloging-in-Publication Data

The handbook of phonological theory / [edited by] John A. Goldsmith.
p. cm. — (Blackwell handbooks in linguistics ; 1)
Includes bibliographical references and index.
ISBN 0-631-18062-1
1. Grammar, Comparative and general—Phonology. I. Goldsmith, John A., 1951- . II. Series.
P217.H27 1995
414—dc20 94-13006
CIP