A Note on Velar Nasals:
Representation and Derivation in Distributed Morphology

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1   Introduction

Among many phonological phenomena, *rendaku*, sequential voicing, has drawn much attention and been extensively studied in traditional Japanese linguistics and generative phonology. Also of particular interest has been *bidakuon*, *ga-gyoo bion*, or velar nasals. Hibiya (1988), among others, conducted extensive sociolinguistic research on several phonological characteristics of the Tokyo Japanese including velar nasalization within the framework of the variation theory advocated by Labov.

Within the field of phonology, one of the most radical proposals to determine the well-formed shape of a form was made by Prince and Smolensky (1993), McCarthy and Prince (1995a) and their subsequent works. Labeled the Optimality Theory (henceforth OT), its main tenet is that there are several (many of them universal, presumably) constraints existent, but that they are not absolute but violable. In addition, constraints are ranked and possible forms compete with each other with respect to how they (do not) observe these constraints. And the one that does not violate any constraint, or the one that violates lower-ranked constraint(s) wins over the other candidates.

Application of OT ranges over a vast amount of phonological phenomena of the world. Ito and Mester (2003, 2008, among others) analyze a number of Japanese phonological processes, for example.

Given that variation theory tries to capture linguistic changes caused by such factors as diachronic shift, regional and social differences, interpersonal contact and stylistic preferences, it is quite conceivable that the precise picture can be better captured by dynamic theories like OT, rather than the static nonlinear phonology in the narrow sense of generative phonology. In fact, while narrow syntax is a reflection of pure computational properties of human language (Chomsky 2013, 2015, among others), it has been widely assumed that there may well be a variety of realizations after Spell-Out at sensorimotor system (PF) and conceptual-intentional system (LF). In particular, there are arguments that phonology obeys different principles and procedures from the narrow computational system (Bromberger and Halle (1989), among others).

At the same time, the grammatical theory must ensure that such variation be captured at some component of grammar. In the "lexicalist" framework that assumes the lexicon as a storage for lexical idiosyncrasies, phonological variation may be listed there. But under the proposal of Distributed Morphology (DM) advocated by Halle and Marantz (1993) and subsequent works, information that is supposed to be associated with each lexical item is now "distributed" over subcomponents of grammar, syntactico-semantic features under the terminal nodes in syntax, and the phonological information in the vocabulary items visible at Morphological Structure (MS) after Spell-Out. How, then, variations that we observe in many phonological and morphological processes?

The purpose of this paper is to clarify the locus of variation within DM. Specifically, I propose a feature-based specification for lexical classes in 2.1.1. Then, discussing a lesser-known set of data on velar nasals, I show that the analysis in terms of OT can capture the facts described there. Yet, contrary to Ito and Mester (2003), who attribute variations observed in *rendaku* to "a loss of indexation" (Ito and Mester (2003:149ff)), I argue that variation is caused by a change in feature specification, namely from [-Y] to [+Y]. Crucial to this is the fact that onomatopoeia never undergoes *rendaku* or velar nasalization. It is naturally captured under my feature specification system, where it is this onomatopoeic class of lexical strata that is maximally underspecified. The details of the mechanism will be presented in 3.4.

2   Basic Facts about velar nasals in the Tokyo Dialect

As extensively investigated by Hibiya (1988), realization of word-internal velar nasals [ŋ] in the Tokyo Dialect (henceforth TD) has been subject to variation, its relevant factors consisting of linguistic ones including phonological environments, morpheme class and morpheme boundaries, and socio-economic and contextual ones such as region, generation, gender, social class and utterance style. As pointed out in Hibiya (2002), however, compared to the period when her original survey was conducted, i.e., the mid- to late 1980s, the younger generations of TD no longer retain [ŋ].

In this section I will present the basic facts about velar nasals based on the reflections on my own idiolect, as a native speaker of the (new-) Yamanote (Setagaya ward, the southern part of the 23 wards of Tokyo) version of TD in the late fifties of age. I will also make reference to the observations and an OT analysis made in Ito and Mester (2003, 2008, among others) for the relation between lexical classes and *rendaku*. Accordingly, I will not go into variations among speakers.

2.1   *Lexical classes*   It is well-known that Japanese has four lexical strata in terms of their linguistic behaviors: native Japanese, or *Yamato* (henceforth Y), Sino-Japanese (henceforth SJ), whose basic morphemes are borrowed from Chinese, loan words (henceforth LW), which refer to those borrowings other than from Chinese, and idiophones or onomatopoeia (henceforth ON). There are many phonological, morphological and syntactic processes that are sensitive to these classes with respect to their applications. Semantic differences are also observed with regard to two or more words and/or morphemes whose cognitive meanings are similar but nonetheless have different connotations. This gives pragmatic and stylistic differences in their usages.

2.1.1   *Velar nasals and lexical classes*   The baseline of the Japanese velar nasal is that it never occurs word-initially, regardless of lexical classes. Thus [ŋ] is an allophone of /g/. There are two morphological environments for word-internal /g/, whether the word in question is monomorphemic or multi-morphemic:

(1)   a. agaru [aŋ/*gaɾɯ] 'rise'   b. kagi [kaŋ/*gi] 'key'
        c. kagu [kaŋ/*gɯ] 'smell'   d. ageru [aŋ/*geɾɯ] 'raise'
        e. kago [kaŋ/*go] 'basket'
(2)   a. maagaretto [maag/*ŋaɾetto] 'Margaret'   b. kirugisu [kiɾɯg/*ŋisɯ] 'Kirgiz'
        c. googuru [goag/*ŋɯɾɯ] 'goggle'   d. bagetto [bag/*ŋetto] 'baguette'
        e. kaago [kaag/*ŋo] 'cargo'
(3)   a. tegami (te 'hand' - kami 'paper') [teŋ/*gami] 'letter'
        b. hagire (ha 'edge' - kire 'cut') [hag/*ŋiɾe] 'patch of cloth'
        c. amaguri (ama 'sweet' - kuri 'maron') [amaŋ/*gɯɾi] 'sweet maron'
        d. hizageri (hiza 'knee' - keri 'kick') [hizaŋ/*geɾi] 'knee kick'
        e. tegoro (te 'hand' - koro 'time') [teŋ/*goɾo] 'reasonable'
(4)   a. kigai (ki 'spirit' - gai 'about') [kig/*ŋai] 'morale'
        b. gyoogi (gyoo 'discipline' - gi 'protocol') [gjoog/*ŋi] 'manners'
        c. doogu (doo 'ware' - gu 'ware') [doog/*ŋɯ] 'gadget'
        d. kageki (ka 'extreme' - geki 'radical') [kag/*ŋeki] 'extremist'
        e. kokugo (koku 'nation' - go 'language') [kokug/*ŋo] 'national language'
(5)   a. itagarasu (ita 'board' - garasu 'glass') [itag/*ŋaɾasɯ] 'flat glass'
        b. hachigirudaa (hachi 'eight' - girudaa 'guilder') [hatʃig/*ŋiɾɯda:] 'eight guilders'
        c. peagurasu (pea 'pair' - gurasu 'glass') [peag/*ŋɯɾasɯ] 'a pair of glasses'
        d. haigeezi (hai 'high' - geezi 'gauge') [haig/*ŋeedʒi] 'high gauge'
        e. tekigooru (teki 'enemy' - gooru 'goal') [tekig/*ŋo:ɯ] 'goal of the enemy'
(6)   a. gata-gata [gatag/*ŋata] 'rattle'   b. gito-gito [gitog/*ŋito] 'gleasy'
        c. guru-guru [gɯɾɯg/*ŋɯɾɯ] 'round and round'   d. gera-gera [geɾag/*ŋeɾa] 'laughing'
        e. goro-goro [goɾog/*ŋoɾo] 'rambling'

Examples in (1) and (2) are Y and LW monomorphemic words, respectively. As far as I can tell, there is no SJ or ON morpheme containing word-internal /g/.[1] (3), (4), (5) and (6) are instances of bimorphemic words,[2] from

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[1] I consider *sige-sige* and *sugo-sugo* to be reduplicative forms of Y, rather than ON. My pronunciation of these words is [ʃiŋeʃiŋe] and [sɯŋosɯŋo], respectively.
[2] The notation "-" in (3), (4), (5) and (6) and examples up to 2.3. indicates a morpheme boundary, where morphemes are either free (FM) or bound (BM). Thus, "-" here is simply used for all four combinations, FM - FM, FM - BM, BM - FM, and

Y, SJ, LW and ON.[3] From these data, it is obvious that velar nasalization, informally stated as in a phonemic rule (7), applies only to Y in principle:

(7) $/g/ \rightarrow [\eta]/\# \, x \, \_\_\_ \, y$

Two comments are in order. First, Y examples in (3) have undergone the application of *rendaku* prior to velar nasalization. *Rendaku* is a process that applies to the onset of the second morpheme in a compound when it is a voiceless obstruent.[4] While this process is similar to velar nasalization in that it applies, in principle, to Y morpheme only, it is different in that it takes place in all dialects of Japanese. Schematically, the process is described as below:

(8) $[_{m1} \cdot \, \cdot \, \cdot \, \mu]$ $[_{m2} C \, \mu \, \cdot \, \cdot \,]$ where   m = morpheme
                [+voiced]   [-voiced]   C = consonant
                                                              μ = mora

                        [+voiced]

In other words, this is a subcase of voicing assimilation or spreading of the feature [+/-voiced], which is found in many languages including English:

(9)   a. serve [sɚv]   reserve [rizɚv]   b. solve [salv]   resolve [rizalv]
(10)   a. pick [pik]   picked [pikt]   b. beg [bɛg]   begged [bɛgd]

Descriptively, the Japanese Coda Condition (Ito (1986, 1989)) states that no syllable-final consonantal segments are allowed except for moraic [N], and [-voiced] obstruents when they are linked to the onset of the following syllable as a geminate. It is restated as (11) in Ito and Mester (2003):

(11)   No-Coda: *C/ ___ $]\sigma$

In the case of (3a), (7) applies globally in Japanese (12a), then (7) is activated in the particular group of TD speakers (12b):

(12)   a. $[_{m1} t \, e]$ $[_{m2} k \, a \, m \, i]$
                  [+voiced]   [-voiced]
                                                       (8) Spreading of [+voiced]: applies globally.
                $[_{m1} t \, e]$ $[_{m2} g \, a \, m \, i]$
                                  [+voiced]

                                                       (7) Velar nasalization: applies to the particular group of TD.
            b. $[_{m1} t \, e]$ $[_{m2} \eta \, a \, m \, i]$

One might wonder if there are instances of Y whose onset is /g/. As is well-known, the onset of the majority of Y morphemes is sonorant and [-voiced] obstruents. Of course there are exceptions like (13), some dialectal degree expressions (14), dialectal words (15), words with negative connotation (16) and the onset of the Japanese counterparts of some *wh*-words (17) :

(13)   a. buta 'pig'   b. gake 'cliff'   c. zaru 'colander' d. deru 'go out'
(14)   a. gyoosan 'many, much'   b. gottsui 'very'   c. bari 'very'   d. detan 'very'
(15)   a. game-ni 'mixed stew'   b. dotera 'thick gown'
(16)   a. zurui 'cunning'   b. darui 'tired'   c. gani 'inedible part of a crab'
(17)   a. dotira 'which'   b. doko 'where'   c. doo 'how'
           d. dare 'who'   e. donata 'who (honorific)' f. doitu 'who (perjorative)'

BM - BM. I will come back to the distinction between free morphemes (words) and bound morphemes in 2.3. See note 10 in particular.
[3] All instances of [g] in the SJ examples in (4) bear high tone. I will discuss the effect of tone in 2.2.
[4] *Rendaku* does not apply when a compound is a dvandva, or coordinate compound. Also, well-known as Lyman's Law, *rendaku* does not apply when the second morpheme contains voiced obstruents.

Therefore, in principle, [ŋ] in bimoraic words is always the result of applications of *rendaku*.

The second point has to do with reduplication in Japanese. Reduplication applies to almost all the ON bases. But in addition, reduplication applies semi-productively to Y morphemes (18), and there are many SJ reduplicative expressions, which are lexicalized (19):

(18)   a. hanabana [hanabana] 'flowers'   b. hitobito [çitobito] 'people'
        c. hosibosi [hoʃiboʃi] 'stars'   d. honobono [honobono] 'heart-warming'
        e. takadaka [takadaˉka] 'high(ly)'   f. tukiduki [tsɯkidzɯki] 'months'
        e. samazama [samadzama] 'various'   f. simazima [ʃimadʒima] 'islands'
        g. katagata [kataŋ/*gata] 'people (honorific)' h. kigi [kiŋ/*gi] 'trees'
        i. kuroguro [kɯroŋ/*gɯro] 'pitch black'   j. kotogoto [kotoŋ/*goto] 'things'
        k. kaesugaesu [kaesɯŋ/*gaesɯ] 'thinking back' l. kawarugawaru [kawarɯŋ/*gawarɯ] 'in turn'
        m. kiregire [kireŋ/*gire] 'broken in pieces'
(19)   a. juujuu [dʒuudʒuu] 'sincerely'   b. doodoo [doodoo] 'grand'
        c. tootoo [tootoo] 'rushing (of water)'   d. soosoo [soosoo] 'quick(ly)'
        e. kankangakugaku [kankangakugaku] 'angr(il)y' f. kinkin [kinkin] 'in the near future'
        g. keikei [keikei] 'light(ly)'   h. kookoo [kookoo] 'brilliant(ly)'

As pointed out in fn. 4, *rendaku* does not apply to dvandva, or coordinate compounds, as shown below:

(20)   a. minasigo (mi 'body'- nasi 'nonexistent' - ko 'child') [minaʃiŋ/*go] 'orphan'
        b. oyako (oya 'parent' - ko 'child') [ojak/*ŋ/*go] 'parent and child'
(21)   a. wasibana (wasi 'eagle' - hana 'nose') [waʃib/*hana] 'eagle nose'
        b. mehana (me 'eye' - hana 'nose') [meh/*bana] 'eyes and nose'

Therefore, it is a puzzle that *rendaku* should apply in (18), given that reduplication of the base form derives the meaning of plurality or intensification, as obvious from the glosses and in conformity with reduplication observed in the world's languages in general. Yet, aside from that point, application of *rendaku* obeys the same restriction found in monomorphemic and bimorphemic words, i.e., it applies to Y morphemes only.[5] Thus, it is only natural that [ŋ] is chosen over [g] for speakers like me.

2.1.1   *Representation of lexical classes*   How can the above facts, summarized in (22), be captured in the phonological and morphological theory? As the first approximation, I propose that two diachronic features [±Y] and [±SJ] correctly captures the distributional differences:

(22)

	Y [+Y, -SJ]	SJ [-Y, +SJ]	LW [-Y, -SJ]	ON
Velar nasalization (TD)	ok	*	*	*
rendaku	ok	*	*	*
Compound accent	ok	ok	ok	*

Y is specified as [+Y, -SJ], SJ as [-Y, +SJ] and LW as [-Y, -SJ]. And I assume that ON is maximally underspecified, or not specified for diacritic features. Then, we can capture the facts by stating that *rendaku* and velar nasalization in TD apply to [+Y] elements.

Why do we not simply say that these processes apply to Y, without recourse to such feature specification and reference to [+Y]? As we will see, while SJ and LW are subject to variation depending on their phonological and morphical environments, ON are invariant in that they never undergo *rendaku* or velar nasalization. The proposed feature specification can naturally capture this asymmetry: If variations in SJ and LW are to be captured in terms of change in the specification of [-Y] to [+Y], then the fact that ON is invariant follows naturally, as it does not have any feature specification to begin with. In addition, that ON is maximally underspecified, or it does not have any diacritic features, is conceptually motivated given the very nature of ON.

I will review linguistically-motivated variation in this basic distinction in 2.2, 2.3 and 2.4. In particular, 2.3. presents an OT analysis based on a lesser-known set of data. Then, in Section 3 I observe cases of quasi-linguistic and historical/cultural factors that cause variation.

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[5] There are some SJ reduplicative forms with *rendaku*, such as *hooboo* [hooboo] 'many directions' and *sanzan* [sanzan].

2.2 *Variation due to phonetic factors*   Having shown that in principle it is only Y that undergoes *rendaku* and velar nasalization, there are several phonetic environments where /g/ is realized as [ŋ] even in SJ and LW. The first and most straight-forward case is when /g/ is preceded by /n/:

(23)   a. sekaiginkoo (sekai 'world' - ginkoo 'bank') [sekaig/*ŋinkoo] 'World Bank'
        b. nipponginkoo (nippon 'Japan' - ginkoo 'bank') [nippoNŋ/*ginkoo] 'Bank of Japan'
(24)   a. peagurasu (pea 'pair' - gurasu 'glass') [peag/*ŋɯɾasɯ] 'a pair of glasses'
        b. waingurasu (wain 'wine' - gurasu 'glass') [waiNŋ/*gɯɾasɯ] 'wine glass'

/g/ in (23b) and (24b) are preceded by /n/, in contrast with (23a) and (24a), and are realized as [ŋ]. Since this is completely phonetically conditioned, there is no need for feature change or any operation: This is a case of nasal assimilation.

Second, according to Hibiya's (1888) survey, [g] is favored when preceded by high vowels /i/ and /u/. Again, this is a phonetic phenomenon. She cites Chen and Wang (1975), who argues that lower vowels induces opening of the velum, resulting in higher tendency of nasalization. Then she argues that "the higher the soft palate is during the phonation of a preceding segment, the more likely it is for the following /g/ to disfavor the nasal realization."(Hibiya (1988: 73). Examples of this description are as follows:

(25) a. kokusaigakkoo (kokusai 'international' - gakkoo 'school') [kokɯsaig/*ŋakkoo] 'international school'
     b. bijutugakkoo (bijutu 'art' - gakkoo 'school') [bidʒɯtsɯg/*ŋakkoo] 'art school'
     c. shoowagakkoo (shoowa 'Showa' - gakkoo 'school') [ʃoowag/*ŋakkoo] 'Showa school'
     d. shimanegakkoo (shimane 'Shimane' - gakkoo 'school') [ʃimaneg/*ŋakkoo] 'Shimane school'
     e. kangogakkoo (kango 'nursing' - gakkoo 'school') [kaNŋoŋ/?gakkoo] 'nursing school'

As Hibiya (1988) points out, correlation between the vowel height and [g/ŋ] is not perfect, with high vowels favoring [g].

The third factor concerns pitch/tone. Hibiya (1988) reveals a weak correlation between pitch and [g/ŋ]. According to her survey and analysis, there is a tendency that high pitch induces [g]. As far as my idiolectal variation goes, it is correct: While in (4), where the syllable containing /g/ bears a high tone and thus it is pronounced as [g], the examples in (26) with a low tone on the syllable with /g/ tend to be pronounced with [ŋ] , although [g] is not entirely impossible:

(26)   a. kokugai (koku 'country' - gai 'outside') [kokɯŋ/$^{(?)}$gai] 'abroad'
        b. kaigi (kai 'meeting' - gi 'argue') [kai ŋ/$^{(?)}$gi] 'meeting'
        c. kagu (ka 'house' - gu 'ware') [kaŋ/$^{(?)}$gɯ] 'furniture'
        d. higeki (hi 'sad' - geki 'play') [çiŋ/$^{(?)}$eki] 'tragedy'
        d. kaigo (kai 'mediate' - go 'protect') [kai ŋ/$^{(?)}$go] 'elderly care'

Some minimal pairs are given below:

(27)   a. kagaku (ka 'low' - gaku 'chin') [kag/*ŋakɯ] 'lower chin'
        b. kagaku (ka 'change' - gaku 'study') [ka¯ŋ/$^{(?)}$gakɯ] 'chemistry'
(28)   a. kageki (ka 'extreme' - geki 'violent') [kag/*ŋeki] 'extremist'
        b. kageki (ka 'song' - geki 'play') [ka¯ŋ/$^{(?)}$geki] 'opera'
(29)   a. kigai (ki 'spirit' - gai 'about') [kig/*ŋai] 'morale'
        b. kigai (ki 'danger' - gai 'harm') [ki¯ŋ/$^{(?)}$gai] 'harm'

Now, as Hibiya (1988) demonstrates, it is often the case that more than one factor for variation are at play. One such example is (30), where the expected contrast due to the difference in tone is erased or neutralized because of another phonetic factor, i.e., the preceding syllabic nasal [N]:

(30)   a. sangaku (san 'industry' - gaku 'academia') [saN*g/ŋakɯ]
        b. sangaku (san 'industry' - gaku 'academia') [sa¯Nŋ/$^{(?)}$gakɯ] 'industry and academia'

/ga/ in (30a) bears a high tone, so it is expected to be pronounced with [g]. Yet, since the preceding syllable has a coda [N], /g/ is nasalized and realized as [ŋ] as described above.

2.3   *Variation due to a phonological factor*   In this section I would like to draw attention to a small number of examples that seem not to have been observed concerning velar nasal variation. There is an interesting case of SJ word-internal /g/ which is pronounced with [ŋ] despite its lexical class. According to my idiolect, the examples in (31) have [ŋ] word-internally:

(31)   a. gigi (gi 'dout' - gi 'justice') [giŋ/*gi] 'doubt'
         b. gogo (go 'noon' – go 'after') [[goŋ/*go] 'afternoon'

I argue that this is a clear case of OCP effects. It has been widely assumed that the OCP, informally stated as a ban on two adjacent identical elements, can trigger as well as block application of phonological rules.[6] In (31), compounding of two phonologically identical morphemes is a blatant violation of the OCP.

However, the picture is not so simple. First, as we have seen above, Japanese is abundant with total reduplication not only with ON (6) but also with Y (18) and SJ (19). In the case of Y reduplication, we may be able to salvage the reduplicated forms from the OCP violation because application of *rendaku* alters the phonological content of the second, reduplicated element. But *rendaku* does not apply to SJ and ON, so the base, or the first element and the reduplicated one, or the second element, remain identical. One might want to claim that the OCP of the sort we are dealing with applies only to monomoraic root, as the roots of the examples in (6) and (19) (and (18)) are all bimoraic. This does not work, however, since there are many SJ reduplications of monomoraic roots, which are well-formed:

(32)   a. kiki(-tosita) (ki 'happy') 'very happy'   b. koko (-no) (ko 'individual') 'each'
         c. soso(-tosita) (so 'neat') 'very neat'   d. ruru(tosite) (ru 'thread') 'in detail'

Furthermore, there are many non-reduplicative words containing two identical syllables in Y, SJ and LW:

(33)   a. titi [tʃitʃi] 'father'   b. haha [haha] 'mother'
         c. zizi [dzidzi] 'grandfather'   d. baba [baba] 'grandmother'
         d. mimi [mimi] 'ear'   e. nana [nana] 'seven'
(34)   a. kiki (ki 'machine' - ki 'utensil') [kiki] 'machinery'
         b. kiki (ki 'danger' - ki 'occasion') [kiki] 'crisis'
         c. baba (ba 'horse'- ba 'place') [baba] 'paddock'
         d. zizi (zi 'time'- zi 'thing') [dzidzi] 'current events'
         e. sisi (si 'city' – si 'history') [ʃiʃi] 'city history'
         e. juju (ju 'give'- ju 'receive') 'giving and receiving'
(35)   a. papa [papa] 'daddy'   b. mama [mama] 'mummy'

I argue that this situation is best implemented by OT apparatus. Specifically, the OCP for voicing is embodied as No-D^2_m (two voiced obstruents are disallowed in one morphological domain) in Ito and Mester (2003), which is revised as OCP$_{(VOI)}$ (Ito and Mester (2008)). Ito and Mester (2008) proposes another constraint IDENT-SJ (SJ output must be identical to its input) : This is independently motivated by the fact that postnasal voicing of [-voiced] obstruents (stated as a constraint No-NC$_○$) is obligatory for Y but does not apply to SJ. And the ranking of the relevant constraints is as follows:

(36)   OCP $_{(VOI)}$ ≫ IDENT-SJ ≫ No-NC$_○$

In addition to the above constraints, I propose that there is a constraint No-VD^2_F: This rules out two occurrences of velar voiced obstruents in a foot.[7] Since this constraint is more specific than OCP$_{(VOI)}$, it seems natural to assume that the former is ranked higher than the latter.[8] Then a revised ranking is given in (37), and the tableaux in (38) illustrate how (31) [giŋi] is chosen over [gigi], while [kiki] is the best candidate for (32a) and (34a) (No-NC$_○$ is omitted, as it is irrelevant here). Now, in judging whether a candidate obeys IDENT group of constraints, I tentatively adopt a "cumulative" way used in Ito and Mester (2003:95ff) for No-D: For

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[6] Lyman's Law can be seen as a blocking effect of the OCP: Application of *rendaku* would lead to two voiced obstruents on [voice] tier (with underspecification of [voice] for sonorants), thus the process ends up not being applied.
[7] [ŋ] is a sonorant, as it is nasal.
[8] OT is radically different from lexical phonology in that it is not rule-based, but constraint-based. Thus it may well not be appropriate to make reference to such meta-principles as 'the Elsewhere Principle' in the sense of Kiparsky (1973). Yet conceptually there should be some principled way to determine ranking, or array of constraints.

example, they regard a candidate *naga zode* as an instance of triple violation of N-D, since it contains three voiced obstruents. Thus, in (38b) where the input is /kiki/, *[kigi] and *[giki] are evaluated * for IDENT-SJ, as there is one disparity in [voice] feature; *[kiŋi] gets ** because [ŋ] is [+voice][+nasal] as opposed to /k/, which is [-voice][-nasal]; *[gigi] is also evaluated ** because of [+voice] on two occurences of /g/; and *[giŋi] are evaluated ***, as [g] is [+voiced] while /k/ is [-voiced], and [ŋ] is [+voice][+nasal] while /k/ is [-voice][-nasal]. This is crucial for distinguishing between two or more candidates that are otherwise the same in terms of violation of other constraints:

(37)   No-VD^2_F ≫ OCP$_{(VOI)}$ ≫ IDENT-SJ ≫ No-NC$_○$

(38) a.

/gi-gi/$_{SJ}$	No-VD^2_F	OCP $_{(VOI)}$	IDENT-SJ
gigi	*!	*	
☞ giŋi			*

b.

/ki-ki/$_{SJ}$	No-VD^2_F	OCP $_{(VOI)}$	IDENT-SJ
☞ kiki			
kigi			*!
kiŋi			**!
gigi	*!	*	**
giŋi			***!
giki			*!

Now, in order to ensure that [kiŋi] is the output in (18h), repeated here as (39), two more constraints are needed. One is REALIZE-M(ORPHEME), which is proposed in Ito and Mester (2003, 2008). They argue that the essence of *rendaku* resides in the existence of a linking morpheme R, and that REALIZE-M requires that R be non-null at the output. This constraint is ranked lower than IDENT-F[9] (the output of LW must be identical to the input) or IDENT-SJ in their analysis, in effect ensuring that *rendaku* applies only to Y. Another constraint is NASALIZE-/g/ [$_m$ x__], where m is a morpheme boundary. This embodies velar nasalization for Y. Since this constraint is relevant only for Y on a par with REALIZE-M, this should also be ranked lower than IDENT-SJ. Thus, ranking is shown in (40), and the tableau for (39) is given in (41) (IDENT-F, IDENT-SJ and No-NC$_○$ are omitted since they are irreverent here):

(39)   kigi [kiŋ/*gi] 'trees'
(40)   IDENT-F ≫ No-VD^2_F ≫ OCP $_{(VOI)}$ ≫ IDENT-SJ ≫REALIZE-M ≫NASALIZE-/g/ [$_m$ x__]
           ≫No-NC$_○$ ≫IDENT-Y

(41)

/ki-ki/$_Y$	No-VD^2_F	OCP $_{(VOI)}$	REALIZE-M	NASALIZE-/g/ [$_m$ x__]	IDENT-Y
kiki			*!		
kigi				*!	*
☞ kiŋi					**
giki			*!		*
gigi	*!	*		*	**
giŋi					***!

Furthermore, there is a minimal contrast (42), where the ranking in (40) plays a crucial role:

(42)   a. tyoojuugiga (tyoo 'bird' - juu 'animal' - gi 'playful' - ga 'picture') [tʃoodʒɯɯg/*ŋiŋ/*ga]
                                 'playful drawings of birds and animals kept in Kozanzi Temple, Kyoto'
           b. giga [gig/*ŋa] 'giga'

(42a) is SJ, while (42b) is LW. /ga/ is pronounced [ŋa] in the former, [ga] in the latter. This contrast is correctly captured by the above constraints and ranking (IDENT-Y is omitted, as it is not relevant here):

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[9] "F" here stands for "foreign word" in Ito and Mester (2003, 2008). I use their name for this constraint, but the readers are advised to distinguish "F" in the proposed constraint No-VD^2_F where "F" refers to "foot" from this.

(43) a.

/gi-ga/$_{SJ}$	IDENT-F	No-VD^2_F	OCP $_{(VOI)}$	IDENT-SJ	REALIZE-M	NASALIZE-/g/ [$_m$ x__]
giga		*!	*			*
☞giŋa				*		
kiga				*		*!
kiŋa				**!		
gika				*		

b.

/gi-ga/$_F$	IDENT-F	No-VD^2_F	OCP $_{(VOI)}$	IDENT-SJ	REALIZE-M	NASALIZE-/g/ [$_m$ x__]
☞giga		*!	*			*
giŋa	*!					*
kiga	*!					*
kiŋa	**!					
gika	*!	*				

There is one problem: At this point this analysis cannot distinguish between [giŋa] and *[gika] in (43b), as both have one violation of IDENT-SJ. Yet given that it correctly determines the grammatical output.

One additional comment is in order. /gi/ in (42a) is pronounced with [gi]. The fact that there is no variation for [ŋi] is due to the type of the preceding boundary: *choojuu* 'birds and animals' and *giga* 'playful paintings' are both free morphemes, or words. Thus there is a word boundary in between. On the other hand, the two morphemes *gi* 'playful' and *ga* 'picture' are bound morphemes, so the boundary between them is not a word boundary but a morpheme boundary. As shown in Hibiya (1988), [g] is preferred for /g/ following a word boundary. This will be taken up in more detail in 2.4.

One may wonder if there are words with more than two morae that fall into this group. The only examples I have come up with at this point are (44):

(44)   a. gagaku (ga 'elegant' - gaku 'music') [gaŋ/*gakɯ] 'traditional Japanese court music'
          b. gigaku (gi 'technique' - gaku 'music') [giŋ/*gakɯ] 'traditional Japanese play'

As we will see in Section 3, there are a considerable number of SJ that have come to be treated as Y with respect to *rendaku* and velar nasalization because of the historical and/or cultural background(s) of each word. Thus, (44) could be seen as one of them. However, there is evidence that such historical and cultural factors may not be the (only) decisive factor. As we see in (45), [g] is acceptable, with slight variation with [ŋ] in my idiolect:

(45)   a. sarugaku (saru 'monkey' - gaku 'music') [saɾɯg/^{ʔ}ŋakɯ] 'old Japanese funny dance and play'
          b. noogaku (noo 'field' - gaku 'music') [noog/$^{(ʔ)}$ŋakɯ] 'Noh play'

Given that all words in (44) and (45) are quite old, it is inconceivable to claim that only (44) are influenced by historical/cultural factors. Furthermore, the examples in (44) are in minimal contrast with those in (46):

(46)   a. kagaku (ka 'change' - gaku 'study') [kag/^{ʔ}ŋakɯ] 'chemistry'
          b. kigaku (ki 'instrument' - gaku 'music') [kig/^{ʔ}ŋakɯ] 'instrumental music'

It is because the examples in (46) do not violate No-VD^2_F. Thus it is safe to conclude that the examples in (44) are the cases of No-VD^2_F violation. The current analysis picks out the right output, as shown in the tableau in (47) (IDENT-F is omitted, as it is irrelevant here):

(47)

/ga-gaku/$_{SJ}$	No-VD^2_F	OCP $_{(VOI)}$	IDENT-SJ	REALIZE-M	NASALIZE-/g/ [$_m$ x__]
gagakɯ	*!	*			*
☞gaŋakɯ			*		

2.4 *Variation due to morphological factors*   There are morphological environments that affect realization of /g/. First, Hibiya (1988) distinguishes bimorphemic words containing a morpheme boundary (+) and those

containing a word boundary (#).[10] According to her, /g/ after a word boundary tend to be pronounced with [g], as opposed to the realization as [ŋ] after a morpheme boundary. The clearest cases are SJ numeral classifiers:[11]

(48)   goo (of address, size, room number, volume number, home-run number, and so on)
          kyuugoo (kyuu 'nine' + goo 'size') [kjɯɯŋ/$^?$goo] 'size 9'

Now, there are some morphemes that behave differently in accordance with the function they bear. One such example is *gakkoo* 'school'. Since it is a full-fledged word, /g/ is pronounced as [g] when it is preceded by another free morpheme, as in (25), repeated here with revised notations in (49):

(49) a. kokusaigakkoo (kokusai 'international' # gakkoo 'school') [kokɯsaig/*ŋakkoo] 'international school'
     b. bijutugakkoo (bijutu 'art' # gakkoo 'school') [bidʒɯtsɯg/*ŋakkoo] 'art school'
     c. shoowagakkoo (shoowa 'Showa' # gakkoo 'school') [ʃoowag/*ŋakkoo] 'Showa school'
     d. shimanegakkoo (shimane 'Shimane' # gakkoo 'school') [ʃimaneg/*ŋakkoo] 'Shimane school'
     e. kangogakkoo (kango 'nursing' # gakkoo 'school') [kaNŋoŋ/?gakkoo] 'nursing school'

But this morpheme behaves as a 'quasi-bound morpheme' in (50) and is pronounced with [ŋ], since it has almost lost its independence as a word and functions as a 'subcategorizer/classifier:'[12]

(50)   a. shoogakkoo (shoo 'small' + gakkoo 'school') [ʃooŋ/*gakkoo] 'primary school'
          b. chuugakkoo (chuu 'middle' + gakkoo 'school') [tʃɯɯŋ/*gakkoo] 'middle school'
          c. kootoogakkoo (kootoo 'high' + gakkoo 'school') [kootooŋ/?gakkoo] 'middle school'

In addition, there is a special type of academies and colleges in Japan designated as *daigakkoo*, asi in *booei daigakkoo* 'National Defense Academy' and *booei ika daigakkoo* 'National defense Medical College'. It is hard to analyze the internal structure of this word, but it tends to be pronounced with [ŋ] in (51a), and with [g] when it means (hypothetically) 'big school', as in (51b). This is on a par with examples in (50) and (49), respectively:

(51)   a. daigakkoo (daigaku 'college' + koo 'school') [daiŋ/(?)gakkoo] 'academy/college'
          b. daigakkoo (dai 'big' # gakkoo 'school') [daig/*ŋakkoo] 'big school'

Similar examples are *ga* 'picture' and *go* 'language'. As the complements of verbal compounds, they retain their independence as a morpheme, resulting in preference of [g] (52). On the contrary, when they serve as subcategorizing, or classifying tokens within one type, they tend to be pronounced with [ŋ] (53):[13]

(52)   a. sakuga (saku 'produce' + ga 'picture') [sakɯg/*ŋa] 'producing of pictures'
          b. zoogo (zoo 'create' + go 'word') [dzoog/* ŋo] 'coinage/coind word'
(53)   a. saimituga (saimitu 'minute' + ga 'picture') [saimitsɯŋ/?ga] 'miniature painting'
          b. yoga (yoo 'western' + ga 'picture') [jooŋ/?ga] 'western painting'
          c. eego (ee 'English' + go 'language') [eeŋ/*go] 'English'
          d. doitugo (doitu 'Germany' + go 'language') [doitsɯŋ/*go] 'German'
          e. huransugo (huransu 'France' + go 'language') [ɸɯransɯŋ/*go] 'French'

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[10] A morpheme boundary here refers to a boundary between two bound morphemes (BM - BM), and a free morpheme (word) and a bound morpheme (FM - BM). A word boundary is a boundary between two free morphemes (FM – FM), and a bound morpheme and a free morpheme (BM – FM). See note 2 for comparison.

[11] Some numeral classifiers such as *kai* 'floor' and *ken* 'house' (but not *kai* 'time/inning' and *ken* 'case') are optionally voiced after *san* 'three'. But it is because of postnasal voicing, or the constraint against [-voiced] obstruents after a nasal (No-NC$_O$ in OT (Ito and Mester 2003, 2008, among others)). Thus, when the onset is pronounced with [ŋ], this is just the result of nasal assimilation, not variation. Yet, this constraint is ranked high for Y, but not for SJ or LW. Thus the reason for the optional application of No-NC$_O$ may be some functional reasons, such as distinguishing *kai* 'floor' and *ken* 'house' from *kai* 'time/inning' and *ken* 'case', which do not undergo postnasal voicing after *san* 'three'.

[12] While I definitely prefer [ŋ] for (50a) and (50b), the contrast is less clear in (50c). This may well have to do with the fact that while the first morphemes in the former two are bound, the one in the latter is a free morpheme. So not only the nature of the 'edge' boundary of the second element but also that of the first element should be a factor for variation. I will leave this for further research.

[13] In contrast with (53c), (53d) and (53e), I tend to pronounce the following with [g], occasionally with [ŋ], to a varying extent: *girisyago* [giriʃa$^{(?)}$g/ŋo] 'Greek', *taigo* [taig/$^{(?)}$ŋo] 'Thai', *raosugo* [raosɯg/$^?$ŋo] 'Laotian'. Besides interference from possible phonetic factors such as high vowels for the latter two, it may well be variation driven by the familiarity factor. I will discuss this in Section 3.

In passing, Hibiya (1988) notes that the conjunctive *ga*, the nominative case marker *ga*, an approximate particle *gurai*, a verbal suffix *garu* and an adjectival suffix *gati* are pronounced with [ŋ]. Some other examples of the same category include another approximate particle (for time) *goro* and a nominalizing suffix *ge*.

Yet it is only natural that they should be pronounced with [ŋ] because they all belong to Y. Hibiya points out that these are function words, or closed class items. This means that they are less "salient" in terms of the notion of "salience" that she proposes, resulting in [ŋ]. Now this seems to be the two sides of the same coin: In general, closed class elements least likely to be borrowed.[14] Thus, most of them are native vocabulary items, which are less salient in the lexicon of the native speaker. [15]

2.5 *Salience for variation*   As I discussed above, Hibiya (1988) ingeniously introduces the notion of "salience" to make a generalization behind variations caused by various factors. According to her claim, the word-internal /g/ in more salient items/environments tends to be pronounced [g]. Her notion of "salience" can be extended to lexical class: LW is the most salient, while Y is the least salient, with SJ in the middle due to the fact that they were borrowed much earlier than LW in general and have been used for a long period of time.[16] In fact her survey reveals that [g] is preferred to [ŋ] much more in Y + SJ (Y followed by SJ word) than in SJ + SJ (SJ followed by SJ word). Based on this fact, she argues that "a switch from a nataive japaense element to a Sino-Japanese element within a compound might well increase the consciousness on the part of a speaker of the existence of boundary (Hibiya (1988:76)."

Phonetically, high vowels and high tones also constitute salient environments. From the morphological point of view, word boundaries are more salient than morpheme boundaries. And among word boundaries, those between two morphemes from distinct lexical classes induce more [g].

All the above is subsumed under default versus marked realizations of /g/. Namely, word-internally [ŋ] is a default realization, which is embodied by the fact that /g/ in Y morphemes are pronounced that way. The other morpheme classes are 'foreign' and in that sense they are salient. Thus in principle /g/ in SJ, LW and ON are pronounced [g]. But other environments give rise to salience, or marked situations, leading to variation between [g] and [ŋ].

3   Some variations in *rendaku* and their implications for the theory of grammar

In this section I briefly overview the cases where *rendaku* applies to SJ and LW. Just like velar nasalization, *rendaku* is applied only to Y in principle. This is embodied by constraint ranking proposed in Ito and Mester (2003, 2008) where REALIZE-M, the constraint ensuring voicing of the voiceless obstruent onset of the second element, is ranked lower than IDENT-F and IDENT-SJ but higher than IDENT(-Y). There are, however, several factors that alter this basic situation, which will be shown below.

3.1 *Phonotactic similarity*   The first factor concerns phonotactic similarity. Most basic Y vocaburary consists of light syllables, as in (54) (nouns) and (55) (verbs). Long vowels and diphthongs are found among nouns but most of them are derived from verbs, which have either an underlying consonant or an onset consonant in their older forms (56). By the same token, verbs themselves with such heavy syllables may well be the result of inflection or historical change (57). A subtype of adjectives end with a long vowel [ii], diphthongs [ai], [oi] and [ui], but they developed from prenominal forms [iki] , [aki], [oki] and [uki], respectively (58). With respect to nasal coda, there are only a handful of words (59)[17], along with the inflected forms of verbs (60). And geminates are restricted to the inflected forms of verbs (61) and some adverbial expressions that are either derived from a sequence of light syllables (62) or have a kind of association with ON (63) :

(54)   a. sakura [sakura] 'cherry blossam'   b. hikari [hikaɾi] 'light'
(55)   a. aruku [aɾɯkɯ] 'walk'   b. nagameru [naŋameɾɯ]
(56)   a. tatakai [tatakai] 'war' < tataka(w)u 'compete'   b. toori [too ɾi] 'street' < to(h)oru 'pass'
(57)   a. kau [kaɯ] 'buy' < kawu   b. moosu [moosɯ] 'say (humble)' < mowosu

---

[14] Function words are omitted quite often in Japanese LW as well, as in *sukuranburu eggu* 'scrambled eggs'.

[15] This point is embodied in constraint ranking proposed in Ito and Mester (2003, 2008): Difference in salience is the reason that within the IDENT group of constraints in Japanese, IDENT-F is ranked highest, followed by IDENT-SJ and with an "unmarked" IDENT, or IDENT-Y at the bottom of the ranking.

[16] This hierarchy in markedness in lexical strata is reflected in constraint ranking in Ito and Mester (2003, 2008): Within IDENT constraints, IDENT-F is ranked highest, the second being IDENT-SJ and IDENT(-Y) applies as default. At the same time, Ito and Mester (2008) refer to the idea of Emergence-of-the Unmarked effect (TETU) proposed by McCarthy and Prince (1995b) and discusses that LW may obey some constraints primarily for SJ and Y.

[17] *Tombi* 'black kite' is derived from *tobi*.

(58)	a. utukusii [ɯtsɯkɯʃii] 'beautiful' < utukusiki		b. awai [awai] 'pale' < awaki
	c. hosoi [hosoi] 'thin' < hosoki			d. hurui [ɸɯɾɯi] 'old' < huruki
(59)	a. tonbo [tombo] 'dragonfly'			b. kangaeru [kaNŋaeɾɯ]
(60)	a. yonde [jonde] 'reading' < yomu			b. shinde [ʃinde] 'dying' < sinu
(61)	a. hasitte [haʃitte] 'running' < hasiru			b. tamotte [tamotte] 'keeping' < tamotu
(62)	a. yappari [jappaɾi] 'as expected ' < yahari		b. kossori [kossoɾi] 'secretly' < kosori
(63)	a. sappari [sappaɾi] 'refreshed'			b. kikkari [kikkaɾi] 'on time'

On the contrary, along with monomoraic morphemes (64), there are many SJ bimoraic morphemes with long vowels (65), diphthongs (66) and those with underlying coda consonants (67): [18]

(64)	a. ka [ka] 'excess' 'summer' 'temporary' etc.		b. si [ʃi] 'city' 'private' 'death' 'asset' etc.
	c. hu [ɸɯ] 'not' 'common' 'add' etc.			d. ge [ge] 'below' etc.
	e. ko [ko] 'each' 'old' 'door' etc.
(65)	a. tsuu [tsɯɯ] 'pass' 'pain' etc.			b. koo [koo] 'go' 'sail' 'light' 'high' etc.
(66)	a. kai [kai] 'meet' 'shellfish' 'times' 'revise' etc.	b. tei [tei] 'bottom' 'house' 'boat' 'constant' etc.
(67)	a. ket [ket] 'decide' 'lack' 'blood' etc.			b. sok [sok] 'foot' 'prompt' 'urge' etc.
	c. sen [sen] 'line' 'select' 'special' etc.

There are many SJ compounds with geminates. They are the ones with morphemes like (67) whose coda is an obstruent as their first element:

(68)	a. kessin (ket 'decide' + sin 'mind') [keʃʃiN] 'make up one's mind'
	b. sokkyoo (sok 'promt' + kyoo 'raise') [sokkjoo] 'impromptu'

They are geminated in order to meet the Japanese Coda Condition (11), repeated here as (69):

(69)	No-Coda:	*C/ ___]σ

With these as basics, let us observe the following. There are some SJ that undergo *rendaku*, as in (70):

(70)	a. kiku [kikɯ] 'chrysanthemum'	siragiku (siro 'white' # kiku) [ʃiɾaŋikɯ][19] 'white chrysanthemum'
	b. kesi [keʃi] 'poppy'		hinagesi [hina 'princess' # kesi] [çina ŋeʃi] 'red poppy'
	c. kasi [[kaʃi] 'river bank'	uogasi [uo 'fish' # kasi] [uo ŋaʃi] 'fish market'

As discussed in Takayama (1999) and Ito and Mester (2003, 2008), they are treated as Y despite their etymological origin because they are similar to Y in that they are composed of light syllables.
	There are some instances of LW that behave the same way. The most-known example is (71):

(71)	karuta [kaɾɯta] 'Japanese card game'	irohagaruta (iroha 'alphabet' # karuta) [iɾahaŋaɾɯta]

Karuta is a 16th-century loan word from Portuguese *carta*. Due to the Japanese Coda Condition (69), an epenthetic vowel /u/ is inserted after the syllable /car/. As a result of resyllabification, the output is [ka. ɾɯ.ta], which conforms to Y syllable structure. Interestingly, Japanese has borrowed another word with roughly the same meaning from English, i.e. *kaado* 'card'. But presumably because of the combination of having a heavy syllable and being a recent loan, this word never undergoes *rendaku*, and therefore, no velar nasalization, needless to say.
	No matter the origin of these words, in examples in (70) and (71), /k/ is voiced and changed into /g/ by application of *rendaku*. This means that, as argued by Takayama (1999) and under my proposal based on features given in 2.1.1., the membership of these words are changed into Y. Then it is natural that /g/ in these compounds surfaces as [ŋ] in my idiolect, as they are Y and therefore velar nasalization also applies.

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[18] There are many homonyms in Chinese morphemes. The glosses given are represented by different Chinese characters.
[19] There is another phonological process that were active in Old Japanese involved in this compound, namely, umlaut /o/ → /a/. In fact *siragiku* appears in an old song sung by Oosikousi-no Mitune circa 859-925):
Kokoro-ate-ni orabaya oramu hatusimo-no okimadowaseru siragiku-no hana
'Shall I pick some white chrysanthemums by guessing, which are indistinguishable due to the first frost.'

3.2   *Historical and cultural immersion*   As is well-known, there are many SJ that undergo *rendaku* (and subsequent velar nasalization when *rendaku* gives rise to /g/). Some examples are given below:

(72)   a. hon [hoN] 'book'   bunkobon (bunko 'bookcase' # hon) [bɯŋkoboN] 'small paperback'
                                               shohanbon (shohan 'first print' # hon) [ʃohaNboN] 'first-print book'
        b. kaisha [kaiʃa] 'company'   kabusikigaisha (kabusiki 'stock' # kaisha) [kabɯʃikiŋaiʃa] 'co. limited'
                                               kogaisha (ko 'child' # kaisha) [koŋaiʃa] 'subsidiary'
        c. toohu [tooɸɯ] 'tofu'   kinudoohu (kinu 'silk' # toohu) [kinɯdooɸɯ] 'fine tofu'

These are "common Japanese" as labeled in Ito and Mester (2003: 150ff.). They are used quite frequently in contemporary Japanese. But in addition, a vast number of SJ with *rendaku* are found in Old Japanese, may of which are related to Buddhism and the Court:

(73)   a. zenze (zen 'previous' - se 'world') [dzendze] 'previous life'
        b. gyooja (gyoo 'religious training' - sha 'person') [gjoodʒa] 'pilgrim'
        c. jooja (joo 'prosperous' - sha 'person') [dʒoodʒa] 'prosperous person'
        d. sangai (san 'three' - kai 'world') [saNŋai] 'previous, current and future lives'
        e. joobon (joo 'upper' - hon 'quality') [dʒooboN] 'of upper spiritual quality'
        f. seigaiha (sei 'blue' - kai 'ocean' - ha 'wave') [seiŋaiha] 'blue ocean wave'
                                               (the title of *gagaku* 'traditional court music' and fabric pattern)

There are also a handful of LW that behave the same way:

(73)   a. kappa 'cape' < capa (Portuguese) [kappa] amagappa (ame 'rain' # kappa) [amaŋappa] 'rain cape'
        b. kooto 'coat' < coat   [kooto] amagooto (ame 'rain' # kooto) [amaŋooto]
                                                       'rain coat for Japanese kimono'
        c. buranketto 'blanket' < blanket [bɯraŋketto] akagetto (aka 'red' # ketto) [akagetto]
                                                       'red blanket typically worn by students from countryside'
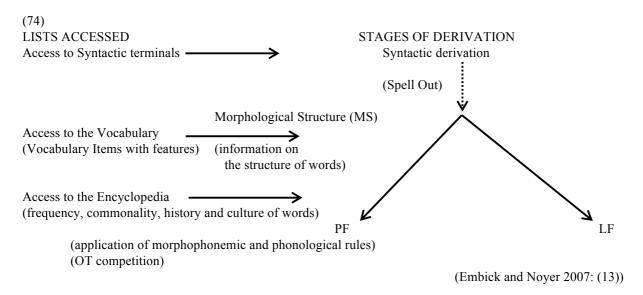
These are different from the examples in 3.1. in that they do not share phonotactic similarity with Y. Nonetheless, these are so deeply immersed in Japanese history and/or culture that they came to be treated as Y on the part of the native speakers.

3.4   *The locus of variation in the theory of grammar*   Now, what kind of mechanism ensures the above variations? As I discussed in 2.1.1., I propose that the fundamental apparatus is two binary features [±Y] and [±SJ]. In principle, *rendaku* and velar nasalization target vocabulary items with [+Y]. Yet due to linguistic and non-linguistic factors as we have seen, [-Y] of some SJ and LW vocabulary items is changed into [-Y], resulting in application of the processes in question.

    But where in the grammar does feature change take place? Within the organization of DM, insertion of vocabulary items (VI) into the syntactic terminal nodes with matching syntactico-semantic features is executed at MF after the Spell-Out. Since the information on syntactic and word-internal structures is visible all the way down to PF in DM, such factors as morpheme and word boundaries is available and retained during the course of derivation. This takes care of salience due to boundaries.

    Then, the derivation has an access to encyclopedia, which stores information on frequency, commonality and history and culture of words. Encyclopedia is supposed be owned by each speaker and continuously revised with their linguistic experiences. So idiolectal variations can be registered and reflected on the derivation. Thus, this stage of derivation is where feature change is executed.

    Derivation proceeds with the morphological and phonological information on the terminal nodes and enters into PF. At PF, universal and language-specific morphophonemic and phonological rules apply. Variations due to phonetic and phonological factors are derived here. The course of derivation is schematically shown in (74):

(74)
LISTS ACCESSED   STAGES OF DERIVATION
Access to Syntactic terminals ⟶   Syntactic derivation

                                                                                    (Spell Out)

                            Morphological Structure (MS)
Access to the Vocabulary ⟶
(Vocabulary Items with features)   (information on
                                          the structure of words)

Access to the Encyclopedia ⟶
(frequency, commonality, history and culture of words)
                                                                            PF   LF
           (application of morphophonemic and phonological rules)
           (OT competition)

                                                                            (Embick and Noyer 2007: (13))

3.5   *Comparison with alternative models in OT*   Ito and Mester (2008:91ff) discusses two competing theories to capture synchronic variations, language acquisition and language change. One is what they call "Indexed Faithfulness", under which constraints are indexed for lexical strata and the output is chosen by making reference to the index of the input and the relevant constraint. The other implementation within OT is so-called "co-grammar" approach. Under this approach, constraints are not specified for lexical strata, but there are multiple arrays of constraints for each lexical stratum which run parallel.

While I do not go into the details of differences, if my understanding of DM is correct, my proposal with feature specification has affinity with the former. It is particularly so because DM assumes a single-engine hypothesis, and the correspondence-theoretic approach envisioned in "Indexed Faithfulness" is akin to this, rather than co-grammar approach. As I mentioned before, however, the crucial difference between OT and my proposal with respect to expression of lexical strata is whether it is executed by indices or it is implemented by feature specification. Two big advantages of my feature specification are: First, it incorporates ON as well, and second, the way features are specified naturally captures the complete absence of application of *rendaku* and velar nasalization in ON, as well as some variations in SJ and LW in terms of feature change.

4   Conclusion

I reviewed observations and analysis made by Hibiya (1988) on velar nasals in Section 2, pointing out some different interpretations for some cases, and presenting a new set of data and their OT analysis in 2.3.in particular. Then, based on the proposed feature specification system in 2.1.1., I discussed in Section 3 how such information is provided and represented. I also argued for two separate sources/loci of feature and feature change: Information inherently associated with each VI is encoded at MS and may make reference to the internal structure of words. Other linguistic and non-linguistic information/knowledge of VI is stored in the encyclopedia, and it may cause feature change in the course of derivation.

While there are many loose ends and problems that remain unsolved. However, as Embick (2010) discusses in detail, local and global approaches to phonology and morphology should be carefully compared. In particular, when it comes to variation as we have seen, it may not suffice to apply local rules separately to capture general tendencies behind phenomena. Such notions as markedness and salience may be better embodied by global approaches utilizing some apparatus of OT.

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