A catalogue of phonological opacity in Japanese: Version 1.0*

Shigeto Kawahara

Abstract

Phonological opacity involves a generalization that cannot be stated solely by reference to surface structures. The classic, non-derivational version of Optimality Theory hence does not predict the presence of phonological opacity, as it is surface-oriented. As one possible response to this problem, a thesis has been advanced to the effect that opacity may not exist as a productive synchronic process. Regardless of whether this strong statement is true to human languages or not, it seems clear that empirical status of phonological opacity needs to reexamined. In this theoretical context, this paper is intended to (i) offer a catalogue of cases of phonological opacity found in Japanese and (ii) provide information about how likely each case is as a productive pattern in the synchronic phonology of Japanese. This catalogue generally does not attempt to argue for a definitive answer for each case, but instead provides information that can be used to argue for one way or the other, so that each researcher can evaluate the likelihood of the reality of each opaque pattern.

*As readers will see, this paper is partly about reexamination of the empirical foundation of what I worked on in my BA thesis submitted to International Christian University in 2002 (Kawahara, 2002). I am pleased to see that my BA thesis was something that was worth looking back at, after more than 10 years. I would like to take this opportunity to thank Jaye Padgett and Jen Smith once again, who guided me through the writing process back in 2001 when I was a visiting undergraduate student at the University of California, Santa Cruz. I am also grateful to John McCarthy, who has influenced my thinking about phonology throughout my graduate career at UMass—it was fortunate that my career coincided with the time when John was entertaining many ideas about opacity (in particular, Sympathy, Comparative Markedness, Harmonic Serialism, and OT-CC). This paper is a result of the confluence of these seeds planted inside of me during my career as a student, and my recent interests on reexamination of the quality of phonological data—the second factor has been much inspired and influenced by the discussion with Paul de Lacy, Bruce Hayes, John Kingston, Jaye Padgett and Joe Pater. This is a catalogue, and I expect that I will keep updating it. When you cite this paper, please make clear the version number. This phonemic transcriptions in this paper follow a widely adopted analysis, except where phonetic details are crucial. This paper is supported by JSPS Kakenhi grants #26770147 and #26284059.

1 Introduction

Phonological opacity involves a generalization that cannot be made solely by reference to surface structures. The classic, non-derivational version of Optimality Theory (OT: Prince & Smolensky 2004) hence does not predict the presence of phonological opacity, as OT is surface-oriented (see in particular Tesar 2014 for a recent discussion).[1] One type of response proposed by the proponents of OT is to amend the theory, for example, by incorporating derivation back into OT (McCarthy 2007 *et seq*). Another response takes the prediction of the classic OT seriously, and pursues the idea that those opaque patterns that are not predicted by OT may not actually exist. The latter position is crystalized into the thesis that opacity may not exist as a productive synchronic process, as in (1).

(1) The Thesis of No Productive Opacity in Phonology:
Phonological opacity does not exist as a synchronically productive phonological pattern. In other words, synchronically, phonological opacity is not psychologically real.

Sanders (2003) explicitly declares this thesis and explores its consequence in Optimality Theory. Green (2004) suggests that "[t]he results [of his analysis of Tiberian Hebrew] suggest the possibility that all crosslinguistic instances of apparent opacity can be explained in terms of the phonology-morphology interface and that purely phonological opacity does not exist" (p. 37). Mielke et al. (2003) emphasize the role of historical explanation for opacity, and deemphasize the necessity of explaining opacity synchronically. The thesis in (1) also follows from the True Generalization Condition of Natural Generative Phonology, which requires phonological generalizations to be perfectly surface-true (Hooper, 1976). See McCarthy (2007) for discussion and a reply to the thesis in (1) (pp. 1-3 and 12-13).

Whether the thesis in (1) is correct or not, it seems important to reexamine the empirical foundation of opaque patterns in general. Pater and McCarthy (2014) propose to examine more carefully whether opacity exists or not in the synchronic patterns of natural languages. This paper agrees that the quality of phonological data should be more carefully examined (de Lacy, 2009, 2014; Kawahara, 2011, 2015). Bruce Hayes in passing mentions some statement to this effect in his "50 Years of Linguistics at MIT", which succinctly summarizes the problem: "We don't understand the opaque languages well enough. In particular, I don't think we fully understand the degree to which the opaque pattern is internalized by language learners, and it is more time to do checking".[2] Padgett (2010) also says:

[1] Since the focus of the paper is not to construct a theory of opacity, these descriptions are very much oversimplified. See, for example, Baković (2011) who argue that not all cases of opacity may speak against the classic Optimality Theory.

[2] `https://www.youtube.com/watch?v=UvQNKTJ598U` (see 9:30-10:00)

> As Vaux (2008) puts it, "Opaque interactions between phonological processes occur in all known natural languages". It is true that facts that linguists can *describe* with derivational opacity are widespread...But apparent cases of opacity can often, perhaps always, be explained *without* positing opacity. Doing so in some cases might come at a cost that is unacceptable to some. But as arguments are made on one side of the debate or the other based on theory-internal criteria or elegance, the central question that ought to be asked—Is derivational opacity psychologically real?—continues to be little asked, because we are unfortunately in a poor position to answer it (emphasis in the original, taken from page 4 of the web version).

I agree that the central question should be whether derivational opacity is psychologically real or not, and that this question should be addressed while or before any theory of opacity is built.

To contribute to address this research question of whether there are any productive cases of synchronic opacity, this paper (i) offers a catalogue of cases of phonology opacity found in Japanese and (ii) provide information about how likely each case is as a productive pattern in the synchronic phonology of Japanese.[3] This paper generally does not attempt to argue for a definitive answer for each case, but instead provides information that can be used for one way or the other as much as possible, so that each researcher can evaluate the likelihood of the reality of each pattern. This paper will also be inclusive, so that it will not miss a potential case of opacity, and/or so that it can explicitly argue that a particular pattern does not have to be treated as opaque.

To facilitate the understanding of each phonological interaction, an SPE formulation (Chomsky & Halle, 1968) of each phonological process is provided, together with references that discuss each pattern and/or the interaction of the two. This paper does not attempt to reproduce or propose an OT analysis, because, again, the focus is the empirical status of each of the opaque patterns; when OT analyses have been proposed in the past, however, this paper tries to cite them as much as possible and describe them briefly. Each section can be read more or less independently of one another.

[3]Two personal motivations to take on this task for Japanese phonology. First, I find my attitude back in 2002 (Kawahara, 2002)—taking any sound-related patterns as productive and phonological—to be problematic (here's my excuse: I was an undergraduate student who was desperate to finish a BA thesis, and I now at least admit that my attitude was wrong). Second, I think I have learned a lot about phonetics and phonology 13 years after writing my BA thesis, and I feel that I am qualified to write a catalogue. Somebody who is well-versed in Japanese phonology should do it anyway.

2 Coda nasalization and emphatic gemination

The two processes are:

(2) Coda nasalization: C_i[+voice] → [+nasal] / _ C_i[+voice]

(3) Emphatic gemination: C_i → C_iC_i in when emphasized.

Coda nasalization is related to the phonotactic restriction that native words, Sino-Japanese words, and mimetic words do not allow voiced geminates (i.e. */bb, dd, gg, zz/). (Voiced geminates are allowed in loanwords: Ito & Mester 1999.) Coda nasalization is observed when an independently motivated gemination process targets a voiced obstruent; the outcome of gemination is a nasal-voiced obstruent cluster. For example, the suffix /-ri/ causes gemination of the stem-final consonants, as in (4); when the target consonant is a voiced obstruent, however, the coda portion appears as nasalized, as in (5) (Ito & Mester, 1986, 1999; Kawahara, 2006a; Kuroda, 1965; Lombardi, 1998; McCawley, 1968).

(4) Gemination associated with /ri-/

a. /pita(-pita)/ → /pi**tt**ari/ 'precisely'

b. /uka(-uka)/ → /u**kk**ari/ 'absent-mindedly'

c. /biku(-biku)/ → /bi**kk**uri/ 'surprised'

(5) Coda nasalization

a. /zabu(-zabu)/ → /za**mb**uri/ 'heavy rain'

b. /nobi(-nobi)/ → /no**mb**iri/ 'leaisurely'

c. /uza/ → /u**nz**ari/ 'fed up with'

Emphatic gemination occurs when speakers express emphasis via gemination (Aizawa, 1985; Kawahara, 2006b, 2013; Kawahara & Braver, 2014; Nasu, 1999).[4] When these processes interact, coda nasalization fails to apply to the outcome of emphatic gemination (Kawahara, 2002), as in (6). Compare /za**mb**uri/ vs. /za**bb**uuN/ and /u**nz**ari/ vs. /u**zz**ai/, each of which share the same root.

(6) Voiced geminates created by emphatic gemination

a. /ya**bb**ai/ 'shit'

b. /hi**dd**oi/ 'awful'

c. /su**gg**oi/ 'extremely'

[4]Speakers can actually lengthen a vowel (e.g. /y**aa**bai/) or both a consonant and a vowel (e.g. /y**aabb**ai/) (Kawahara & Braver, 2013).

d. /u**zz**ai/ 'annoying'

e. /za**bb**uuN/ 'splashing'

As in (7), if emphatic gemination is derivationally ordered after coda nasalization, then we get the expected outcome.[5] Emphatic gemination counterfeeds coda nasalization, because if the order was reversed, it would have fed the coda nasalization process. In other words, coda nasalization underapplies.

(7) Coda nasalization and emphatic gemination

The right ordering			The wrong ordering	
UR	/hidoi/		UR	/hidoi/
coda nasalization	—does not apply—		emphatic gemination	/hiddoi/
emphatic gemination	/hiddoi/		coda nasalization	/hindoi/
SR	[hiddoi]		SR	*[hindoi]

Within OT, Kawahara (2002) argued for a system in which optional variants (i.e. emphatic forms) are required to be identical to canonical forms (i.e. non-emphatic forms), by way of a set of violable faithfulness constraints. The idea is similar to that of Benua (1997), but it applies between canonical forms and more colloquial variant forms (see also Steriade 1997 for a similar idea on "the faithfulness to canonical pronunciation").[6]

One question that can be raised about this opaque interaction is whether emphatic gemination is truly phonological—it could instead be captured as a phonetic implementation rule. One reason to suspect that it may be a matter of phonetic implementation comes from the fact that there can be multiple degrees of lengthening, beyond a usual short-long binary distinction (Kawahara & Braver, 2013, 2014).

[5]Forms like [hindoi] may not be entirely ungrammatical, but they sound like words in a non-Tokyo dialect (e.g. dialects that retain prenasalization, like the Tohoku dialects).

[6]The core observation of Kawahara (2002) was that an optional process that creates a variant form often results in forms that are not otherwise allowed in the language—the observation dubbed as "the emergence of the marked", obviously mimicking the terminology of McCarthy & Prince (1994). The proposed solution was that optional variants are in general protected by a set of special faithfulness constraints that require the identity between these variant forms and their base forms. The evidence was drawn from various languages beyond Japanese, including English, Sea Dayak, Isthmus Nahuat, Mwera, and Ganda. I am unfortunately not in a position to judge the validity of these patterns in languages other than Japanese, but my current impression is that my observation in Kawahara (2002) is at least to some degree undermined by the fact that some of the processes that create these optional variants are phonetic processes rather than phonological alternation. For example, I argued that schwa deletion in English creates a cluster that is otherwise forbidden, such as *tmato*, but schwa deletion in English is demonstrably phonetic gestural reduction (Davidson, 2006) rather than phonological deletion (Hammond, 1999).

However, there are also reasons to suspect that emphatic gemination is phonological as well. First, emphatic gemination by default targets left-most geminable consonant in such a way that it makes the initial syllable heavy (e.g. /pa**tt**a-pata/ rather than /pata**p-p**ata/ 'flipping') (Kawahara, 2006b, 2013; Nasu, 1999), and this directionality preference implies the influence of some sort of prosodic wellformedness (e.g. requiring heavy syllables to be word-initial: Beckman 1998; Zoll 1998). Also, emphatic gemination can avoid kinds of geminates that are marked (e.g. fricative geminates, nasal geminates, and even voiced geminates), when possible (Kawahara, 2006b, 2013; Nasu, 1999). For example, /kune-kune/ 'skewed' and /tubu-tubu/ 'granular' are often geminated as /kune**k-k**une/ and /tubu**t-t**ubu/, respectively, which shows that the gemination pattern avoids kinds of geminates that are phonologically marked.

I also note that when the target of emphatic gemination is /g/, it is possible to get coda nasalization; e.g. /sungoi/ 'super', suggesting that the constraint against geminate /gg/ is not totally inactive in this context; i.e., in a sense, the "wrong ordering" in (7) is not entirely impossible for /g/. We probably would not expect this "re-ordering" if emphatic gemination was purely a matter of phonetic implementation.

3 Postnasal voicing and syncope

The two processes under question are:

(8) Postnasal voicing: C → [+voice] / [+nasal] _

(9) Syncope: V → ϕ in some environments

Postnasal voicing is found across many languages (Pater, 1999). In Japanese, the native vocabulary (also known as Yamato words) almost always follow this restriction in such a way that all consonants after a nasal are voiced (Ito & Mester, 1995, 1999, 2008; Ito et al., 1995, 1999). Post-nasal voicing is observed in the past tense formation, as in (10). The past tense /-ta/ is realized as /da/ after a nasal consonant. Other suffixes that undergo post-nasal voicing are /-tari/ 'continuative', /-tara/ 'conditional', and /-te/ 'gerundive' (McCawley, 1968). Postnasal voicing is also observed in the context of verbal root compounding, as in (11) (Ito & Mester, 1999; Ito et al., 1999).

(10) Postnasal voicing in Japanese: past tense formation

a. /tabe+ta/ → /tabeta/ 'ate'

b. /sin+ta/ → /si**nd**a/ 'died'

c. /kam+ta/ → /ka**nd**a/ 'bit'

(11) Postnasal voicing in Japanese: verb root compounding

a. /hun+sibaru/ → /hu**n+z**ibaru/ 'to bind tightly'

b. /hun+tukeru/ → /hu**n+d**ukeru/ 'to stamp upon'

c. /hun+haru/ → /hu**n+b**aru/ 'to resist'

d. /hun+kiru/ → /hu**n+g**iru/ 'to give up'

Optional syncope more or less sporadically deletes a vowel of some words in casual speech. This syncope process can create a nasal-stop cluster, and Kawahara (2002) points out that even in Yamato-words, post-nasal voicing fails to apply, as in (12).

(12) Optional syncope and (the lack of) postnasal voicing

a. /anata/ → /a**nt**a/ 'you'

b. /nani+ka/ → /na**nk**a/ 'something'

c. /nani+to/ → /na**nt**o/ 'with what'

d. /anosa:/ → /a**ns**a:/ 'hey (very casual)'

e. /ani+san/ → /a**ns**an/ 'brother'

f. /ani+tyan/ → /a**nty**an/ 'brother'

Derivationally speaking, postnasal voicing should precede syncope, so that by the time syncope creates an environment for postnasal voicing, it has missed its chances to apply. In other words, syncope counterfeeds postnasal voicing, or postnasal voicing underapplies.

(13) Postnasal voicing and syncope

The right ordering			The wrong ordering	
UR	/anata/		UR	/anata/
postnasal voicing syncope	—does not apply— /anta/		syncope postnasal voicing	/anta/ /anda/
SR	[anta]		SR	*[anda]

Within OT, Kawahara (2002) offered a solution to this underapplication by using a some sort of output-output faithfulness constraint (Benua, 1997) that requires an optional variant to be identical to the canonical variant.

There are a few concerns about treating this case as a synchronically active process of opacity. First, there are only a handful of examples that instantiate this interaction: those that are shown in (12) are more or less exhaustive.[7] It may also be of some significance that *all* nasal-obstruent clusters created by syncope fail to undergo postnasal voicing.

[7]Let us recall ourselves, however, that six is—or perhaps was—a big number in linguistic argumentation, as Pullum (1991: 85-86) shows convincingly with 6 or 7 examples.

The second problem is that it is debatable whether postnasal voicing is an active synchronic phonological process in Japanese at all. Not only does postnasal voicing fail to apply to non-native words, there are some native lexical items that do not show postnasal voicing (Fukazawa et al., 2002). Moreover, in a nonce verb inflection experiment reported by Vance (1987), only 24 out of 50 participants showed post-nasal voicing in response to a nonce verb /hom-u/: 14 participants just added /ta/ to the whole verb (/homuta/) and 12 deleted the nasal (hota). However, Tateishi (2003) and Fukazawa & Kitahara (2005) argue that postnasal voicing may be active in the adaptation of English plural suffix *'s* in that it is more likely to be borrowed as /zu/ after /n/ (e.g. /jiin+zu/ 'jeans') than after a vowel (e.g. /sokku+su/ 'socks'). Here it seems that we have conflicting pieces of evidence for the productivity of postnasal voicing in Japanese phonology.

On top of this problem, syncope is also a sporadic phenomenon, and as far as I know, nobody has formulated the precise environments in which vowels are syncopated.

4 Epenthesis and velar deletion

This interaction is observed in verbal conjugation patterns, in particular in stems ending with velar consonants, /k, g/. Both types of these stems trigger an epenthesis of /i/ when concatenated with suffixes that begin with /t/, like /ta/ 'past tense'.[8] In addition, velars delete after a stem vowel (in the past tense formation).

(14) Epenthesis: $\phi \rightarrow$ /i/ / [velar] _ C

(15) Velar deletion: [velar] $\rightarrow \phi$ / V _ (in some verbal conjugation environments)

Derivationally speaking, epenthesis needs to precede velar deletion. Velar deletion counterbleeds epenthesis, or epenthesis overapplies. Intuitively speaking, this case is opaque because /k/ triggers the epenthesis of /i/, but it is deleted at the surface; why is it necessary to insert a vowel in the first place if there is no consonant cluster to break up? One answer could be that the vowel is inserted before the consonant gets deleted. This rule-ordering analysis of this opacity within Autosegmental Phonology (Goldsmith, 1976) is found in Davis & Tsujimura (1991).

(16) Epenthesis and velar deletion

[8] McCawley (1968) proposed to change velar consonants first into /h/ and and posited a general rule that inserts a vowel after a fricative and before a consonant. This analysis is motivated by the fact that /s/-final stems also trigger epenthesis; e.g. /kas+i+ta/ 'lend'.

The right ordering			The wrong ordering	
UR	/kak+ta/		UR	/kak+ta/
epenthesis velar deletion	/kakita/ /kaita/		velar deletion epenthesis	/kata/ —does not apply—
SR	[kaita]		SR	*[kata]

One problem about this allegedly opaque interaction is its productivity. It is well-known that verbal conjugation patterns in Japanese are not fully replicated in experiments using nonce words (Batchelder, 1999; Griner, 2005; Vance, 1987, 1991), and it is likely that Japanese speakers simply memorize all the inflected forms.

In the first nonce-word study of verbal conjugation patterns in Japanese, Vance (1987) found that (only) 31 out of 50 participants showed epenthesis when conjugating a nonce verb /hok-u/. Other responses were /hokutta/ (16) or /hota/ (3). A follow-up study by Vance (1991) also shows that Japanese naive speakers do not ambiguously choose the correct past tense form for a /k/-final stem. A later study by Griner (2005) showed even less correct, epenthesis responses, actually about 10%. A consensus that is emerging from these studies is that Japanese speakers have a hard time conjugating /k/-final nonce verbs correctly, raising the doubt that verb conjugation patterns are not rule-governed. To borrow the words of Vance (1991, p. 156), "[his experimental result] is consistent with the claim that even morphologically regular Japanese verb forms are stored in the lexicon."

One can nevertheless argue that as long as there is a single individual speaker who shows expected patterns, that should suffice, because every individual grammar should bear on the architecture of Universal Grammar. However, personally, I find this attitude worrisome, because it can easily lead to a cherry-picking strategy in linguistic argumentation. Also, this sort of strategy can easily lead to the problem of non-replicability. Moreover, even those individuals who conjugate Japanese nonce verbs correctly may have done so via lexical analogy.

Also, it is not necessarily the case that this epenthesis+deletion view is the right analysis, although historically speaking, this is indeed what happened (*/kakitari/ → /kaita/) (Vance, 1987). For example, one could imagine that synchronically speaking, /k/ is mapped directly to /i/ as an extreme case of lenition (Griner, 2005).

Finally, we can formulate the velar deletion as applying to intervocalic position. Then, in the wrong ordering, velar deletion would not apply, unless epenthesis occurs, which may make the rule ordering unnecessary. This case is probably still opaque within OT, because epenthesis is required to "rescue" the coda /k/—most likely from the violation of the CodaCond which prohibits an independent place feature in coda (Ito, 1986, 1989)—but that coda /k/ is deleted at surface; in the words of McCarthy (1999), the cause of epenthesis is

not "surface-apparent".

5 Voicing assimilation and velar deletion

Stems ending with /g/ involve yet another layer of opacity than stems ending with /k/. In addition to the overapplication of epenthesis, the suffix-initial consonants are voiced. This voicing can potentially be analyzed as voicing assimilation caused by /g/ (Davis & Tsujimura, 1991; McCawley, 1968; Griner, 2005).

(17) Voicing assimilation: C → [+voice] / [+voice] _

(18) Epenthesis: ϕ → /i/ / [velar] _ C

(19) Velar deletion: [velar] → ϕ / V_ (in some verbal conjugation environments)

Derivationally speaking, voicing assimilation needs to precede epenthesis, to the extent that we want to keep the voicing assimilation local, rather than allowing it to apply across a vowel (see Gafos 1999).[9] In this view, epenthesis counterbleeds voicing assimilation, and as a result voicing assimilation overapplies. See again Davis & Tsujimura (1991) for the ordering-based analysis of this conjugation pattern.

(20) Voicing assimilation and velar deletion

The right ordering			The wrong ordering	
UR	/kag+ta/		UR	/kag+ta/
voicing assimilation	/kagda/		epenthesis	/kagita/
epenthesis	/kagida/		voicing assimilation	—does not apply—
velar deletion	/kaida/		velar deletion	/kaita/
SR	[kaida]		SR	*[kaita]

Within OT, an analysis using MAX(voice) is offered by Lombardi (1998). In this analysis, even though the host of the [+voice] feature (e.g. /g/) is deleted, the feature itself migrates onto the suffix-initial consonant.

Regarding the quality of this data for phonological argumentation, the same problem as the /k/-final stem arises: whether these "patterns" are actually internalized by native speakers as phonological patterns. A nonce word experiment by Griner (2005) found that only about 30% of the responses involve the "correct" conjugation patterns with both epenthesis and voicing assimilation for /g/-final stems.

[9] Some analyses assume that post-nasal voicing that occurs for /b/-final stems (e.g. /to**b**-u/ → /to**nd**a/ 'flied') is also subsumed by this rule; i.e. voicing assimilation is not triggered by surface /n/ but by underlying /b/ (Davis & Tsujimura, 1991; McCawley, 1968). If this were the case, then the rule should be formulated locally, because /b/-final stems do not yield epenthesis.

6 Rendaku and velar nasalization

The next type of opacity concerns rendaku, and its blockage.

(21) Rendaku: C[-son] → [+voice] in compound initial position.

(22) Lyman's Law: Rendaku is blocked when E2 has [+voice, -son].

(23) Velar nasalization: /g/ → [ŋ] / V_ V

Rendaku is an extremely well-studied morphophonological process in which the initial obstruents of second members of compounds become voiced, as in (24). Lyman's Law blocks rendaku when there is already another voiced obstruent in the second member, as in (25) (there are simply to many references on rendaku and Lyman's Law; see Irwin (to appear) and Vance (2015) and references cited therein.).

(24) Rendaku

a. /oo-tako/ → /oo-**d**ako/ 'big octopus'

b. /oo-sara/ → /oo-**z**ara/ 'big dish'

c. /hosi-sora/ → /hosi-**z**ora/ 'sky with stars'

d. /aka-kami → /aka-**g**ami/ 'red paper'

(25) Blockage of rendaku by Lyman's Law

a. /aka-tamago/ → /aka-**t**amago/ 'red egg'

b. /aka-kabu/ → /aka-**k**abu/ 'red radish'

c. /natu-kaze/ → /natu-**k**aze/ 'wind in summer'

d. /yama-kazi/ → /yama-**k**azi/ 'mountain fire'

In some dialects of Japanese, intervocalic /g/ becomes [ŋ] (Ito & Mester, 1997a; McCawley, 1968; Vance, 1987). This segment [ŋ] is not a voiced obstruent, but it still blocks rendaku, as in [saka-toŋe] 'reverse thorn' and [oo-tokaŋe] 'big lizard'. This interaction is opaque in the sense that the surface [ŋ] acts as if it is a voiced obstruent in that it triggers Lyman's Law, although its surface realization is a sonorant.[10] In other words, the blockage of rendaku due to Lyman's Law overapplies and rendaku underapplies, despite the application of velar nasalization.

(26) Rendaku and velar nasalization

[10]Historically speaking, this opacity makes sense. In Old Japanese intervocalic voiced obstruents were pre-nasalized, and Lyman's Law was thus dissimilation of nasality (Unger, 1975; Vance, 2005). Therefore, it was natural that [ŋ] triggered (old) Lyman's Law, because it was about nasality.

The right ordering			The wrong ordering	
UR	/saka+toge/		UR	/saka+toge/
rendaku velar nasalization	—blocked by LL— /saka+toŋe/		velar nasalization rendaku	/saka+toŋe/ /saka+doŋe/
SR	[saka+toŋe]		SR	*[saka+doŋe]

A sympathy analysis of this opaque interaction has been proposed by Ito & Mester (1997b) and Honma (2001), which is also touched upon by McCarthy (1999). A startal-OT analysis, incorporating the distinction between lexical phonology and post-lexical phonology has been pursued by Ito & Mester (2003)—rendaku is considered to occur in the lexical phonology whereas velar nasalization occurs in the post-lexical phonology.

This interaction is, in my opinion, is probably the most robust case of phonological opacity in Japanese phonology, as long as rendaku can be considered phonological rather than (entirely) lexical (for which, see Kawahara 2015 and Vance 2014, who argue that rendaku is at least partly phonological). There are nevertheless some ways out. One is to posit that /ŋ/ is an obstruent, even at the surface level, although this postulation is phonetically probably not true (i.e. intervocalic [ŋ] does not involve intraoral air pressure rise that would make spontaneous voicing difficult: Chomsky & Halle 1968).[11] One could also argue that velar nasalization is entirely a matter of phonetic implementation, and hence /g/ is /g/ throughout its phonological derivation. This hypothesis would have a problem dealing with the fact that velar nasalization is affected by some morphological conditions (Ito & Mester 1997a and references cited therein). Another way out is to formulate Lyman's Law in such a way that it includes surface [ŋ], but this postulation would miss the generalization that [ŋ] is derived from a voiced obstruent.

Yet another way out is to say that Lyman's Law is about orthography prohibiting two diacritics within a morpheme (see Kawahara 2015 for pros and cons of this view): voiced obstruents, as well as /ŋ/, are written with a diacritic mark in Japanese orthography, and hence triggers Lyman's Law. This formulation of Lyman's Law based on orthography may at first sound absurd to many practicing phonologists, but it does come with virtues. First, it accounts for the fact that Lyman's Law systematically ignores voicing in sonorants, because sonorant voicing is not expressed with a diacritic mark in Japanese phonology. It also accounts for why Lyman's-Law driven devoicing of geminates (Kawahara, 2006a; Nishimura, 2006) also targets the configuration /p...dd.../ (Kawahara & Sano, 2014), because /p/ is also written with a diacritic mark. Finally, there is a certain sense in which rendaku, which is closely related to Lyman's Law, receives a unitary expression in terms of orthography (Vance, 2007, to appear). See Kawahara (2015) for some extensive discussion on this orthographic

[11]This speculation has not been tested instrumentally, however, as far as I know.

explanation of rendaku and Lyman's Law.

7 Compensatory lengthening

Japanese has several cases of compensatory lengthening, and compensatory lengthening is opaque to the extent that (i) it is conceived of as "mora count preservation" (Hayes, 1989) and that (ii) vowels are not associated with moras underlyingly. The two processes involved are:

(27) Mora assignment: V becomes moraic.

(28) A vowel deletes or becomes a glide; a surrounding vowel soaks up its mora.

Some cases of compensatory lengthening in Japanese are illustrated in (29) and (30):

(29) /riu/ → [rjuu]
   a. /bar**iu**m/ → [bar**juu**mu] 'barium'
   b. /arumin**iu**m/ → [arumin**juu**mu] 'alminum'
   c. /op**iu**m/ → [op**juu**m] 'opium'

(30) Labial deletion+glide formation+compensatory lengthening
   a. /r**eba**/ → [r**jaa**] 'if'
   b. /d**ewa**/ → [d**jaa**] 'then'
   c. /kor**e+wa**/ → [kor**jaa**] 'this-TOPIC'
   d. /n**i+wa**/ → [n**jaa**] 'DATIVE-TOPIC'
   e. schematically: /V[-back] C[+labial] a/ → /V[-back] a/ → /Vjaa/

These cases of compensatory lengthening in Japanese has been discussed in a number of pre-OT literature (Miyara, 1980; Poser, 1986, 1988; Shibatani, 1990; Vance, 1987). Illustrative derivations are shown below:

(31) Compensatory lengthening

The right ordering			The wrong ordering	
UR	/riu/		UR	/riu/
moraification glide formation	/ri(μ)u(μ)/ /rju($\mu\mu$)/		glide formation moraification	/rju/ /rju(μ)/
SR	[rjuu]		SR	*[rju]

If mora assignment happens after glide formation, as in the wrong ordering, then there is only one vowel to assign a more to—in this sense, glide formation (partially) counterbleeds mora assignment.[12] Treating compensatory lengthening as a case of opacity appears in several work (Kawahara, 2002; Shaw, 2009; Sprouse, 1997). An easy way out for this case, however, is to say that vowels are underlyingly moraic. This postulation probably does not impinge upon the Richness of the Base hypothesis (McCarthy, 2005; Prince & Smolensky, 2004; Smolensky, 1996), to the extent that vowels are universally moraic—that this restriction is universal, not language-specific. Indeed this postulation may be necessary if moraicity distinguishes glides from vowels.

More problematic is a case in which the deletion of coda consonants would lead to compensatory lengthening, because it is presumably problematic to postulate underlying syllabification (Blevins, 1995; Hayes, 1989; McCarthy, 2003) and assign mora to coda consonants (Shaw, 2009; Sprouse, 1997).

8 Vowel coalescence and exclamative formation

(32) Exclamative formation: stem + /ʔ/

(33) Vowel coalescence: /ai/, /oi/ → [ee]

Japanese speakers can form exclamatives by taking a bare adjectival stem without any inflectional ending, with an additional word-final glottal stop, as in (34). As a result of thie word formation, the present suffix /i/ looks deleted.

(34) Exclamative formation

a. /suppa-i/ 'sour (present)' vs. /suppaʔ/ 'sour!'

b. /sugo-i/ 'great (present)' vs. /sugoʔ/ 'amazing!'

In casual speech, stem-final vowels and the present suffix /i/ can be fused into one long vowel; e.g., /suppai/ → /supee/ and /sugoi/ → /sugee/ (Kawahara, 2002). Exclamative formation can take the output of this vowel coalescence, with the insertion of a glottal stop with concomitant closed syllable shortening; i.e. /suppeʔ/ and /sugeʔ/. The interaction can be considered as opaque, as illustrated in (35).

(35) Vowel coalescence and exclamative formation

[12] A similar problem arises with cases of vowel coalescence, the result of which is usually a long vowel (Hayes, 1990; Kawahara, 2002). If melodic features fuse before mora assignment, then there is only one set of featural melody, and nothing prohibits the resulting melody from receiving only one mora.

The right ordering			The wrong ordering	
UR	/suppai/		UR	/suppai/
vowel coalescence exclamative	/suppee/ /suppeʔ/		exclamative vowel coalescence	/suppaʔ/ —does not apply—
SR	/suppeʔ/		SR	*[suppaʔ]

Exclamative formation would delete the suffixal vowel /i/, and therefore if it applies first, as in the wrong ordering in (35), there is no reason for coalescence to occur; however, vowel coalescence can nevertheless occur (it does not have to—forms like [suppaʔ] are possible). The application of vowel coalescence is therefore not surface-apparent (McCarthy, 1999) in the sense that vowel coalescence occurs without the trigger, the suffixal [i]. This is overapplication of vowel coalescence and counterbleeding opacity.

One way to avoid this opacity is to posit that forms that have undergone vowel coalescence (i.e. [suppee] and [sugee]) are already stored in the lexicon, and exclamative formation applies to these forms. Alternatively, we can deploy an Output-Output faithfulness constraint (Benua, 1997) to "transfer" the vowel quality created by vowel coalescence to the exclamative form.

9 High vowel "deletion" and palatalization

Not many Japanese phonologists would even think the following is a case of opacity, but to the extent that what is usually known as "high vowel devoicing" involves deletion, then it instantiates a case of counterbleeding opacity. Since to the ears of non-native speakers, high vowel devoicing sounds like complete deletion (Beckman, 1982; Beckman & Shoji, 1984), and since a famous introductory textbook uses this sort of interaction to illustrate rule ordering (Tsujimura, 2014), I am going to provide a brief discussion. Let us take palatalization of /s/ before /i/ as an example.[13]

(36) High vowel devoicing: [+high] → ϕ / [-voice] _ [-voice].

(37) Palatalization: /s/ → [ʃ] / _ /i/.

High vowels delete—or devoice—between two voiceless obstruents, and /s/ becomes palatalized before this "deleted" /i/. Therefore, palatalization needs to precede vowel deletion:

(38) Palatalization and high vowel deletion

[13]Other processes that would interact with high vowel deletion include affrication of /t/ before high vowels and patalization of /t/ after /i/.

The right ordering			The wrong ordering	
UR	/sika/		UR	/sika/
palatalization	/ʃika/		high vowel deletion	/ska/
high vowel deletion	/ʃka/		palatalization	—does not apply—
SR	[ʃka]		SR	*[ska]

This counterbleeding opacity is real, only to the extent that the "deletion rule" involves phonological deletion. However, evidence suggests that it is probably better to treat the process as devoicing rather than wholesale deletion. Nakamura (2003) offers electropalatographic evidence which shows traces of the devoiced vowels' oral gestures. Beckman & Shoji (1984) as well as Tsuchida (1994) show that these vowels oral gestures are perceptible at a level that is above chance (see Fujimoto 2015 for a recent overview of high vowel devoicing in Japanese). Moreover, the devoiced vowels count as moraic for the calculation of a bimoraic minimality requirement: a loanword truncation pattern based on a bimoraic template (Poser, 1990) counts devoiced vowels as containing one mora (e.g. [sṵto] 'strike'). It is thus probably safe to conclude that there is no phonological deletion here, hence no opacity.

10 Conclusion

Provided below is a summary table:[14]

Table 1: Opaque patterns in Japanese

Processes involved	Interaction	Notes
coda nasalization & gemination	counterfeeding	is gemination phonological?
postnasal voicing & syncope	counterfeeding	only six examples
epenthesis & velar deletion	counterbleeding	not productive in nonce words?
epenthesis & voicing assimilation	counterbleeding	not productive in nonce words?
rendaku & velar nasalization	rendaku overapplies	are rendaku and LL phonological?
compensatory lengthening	counterbleeding	may not be opaque
vowel coalescence & exclamative	counterbleeding	vowel coalescence lexicaled?
palatalization & vowel deletion	counterbleeding	it may not be deletion

Does opacity exist in the phonology of Japanese as a productive synchronic process? We do not know. Evidence is, as is usually the case with other linguistic argumentation,

[14]I have limited the discussion to Standard, Tokyo Japanese. For possible cases of opacity in other dialects of Japanese, see Kawahara & Hara (2009) (Hiroshima Japanese) and Sasaki (2008) (Mitsukaido Japanese). The reason that I am not including these cases in my catalogue is because I cannot offer additional information beyond those that are reported in the original references.

mixed. My hope in writing this catalogue, however, is "to put out as much as possible on the table", so that other linguists can make more explicit argumentation about the existence of phonological opacity in Japanese (and perhaps beyond).

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