VOWEL EPENTHESIS IN JAPANESE LOANWORD ADAPTATION[1]

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Abstract: It is a generally accepted idea that vowel epenthesis is the main strategy used to repair illicit vowels in Japanese loanword adaptation; however, little attention has been paid to the quality of epenthetic vowels and the processes triggering their occurrence. This paper aims at providing an optimality-theoretic account of the processes that cause each of the five Japanese vowels to surface as epenthetic vowels. All three processes of vowel epenthesis – default vowel epenthesis, consonant place assimilitation and vowel harmony – are defined in terms of feature insertion or feature spreading (Uffmann 2006, 2007). The paper provides as well a quantitative analysis regarding the frequency of epenthetic vowels and epenthesis strategies.

Keywords: default vowel epenthesis, vowel harmony, consonant assimilation, feature spreading

1. Introduction

In Japanese loanwords from Western languages, the epenthesis of a vowel is a strategy to repair input ill-formed syllables. A vowel is inserted word-medially to break banned consonantal clusters (1a), or word-finally to avoid illicit codas present in the etymon (1b) (Kubozono 2002, Uffmann 2006, 2007). The highly constrained syllable structure of Japanese requires syllables to be not bigger than (C)VC or (C)VV, and allows for no coda other than the moraic nasal /N/ (e.g. *kantan* 'simple') or the first half of a geminate consonant (e.g. *katta* 'bought').

(1) Vowel epenthesis as syllable repair strategy
  a. Ru. ***tr****ojka* > [t**o**roika] 'troika'
     Eng. *mar****shm****allow* > [ma**ʃi**maɾo] 'marshmallow'
     Sp. ***cr****edo* > [k**e**ɾe:do] 'creed'
  b. Eng. *sno****b*** > [sɯnobb**ɯ**] 'snob'
     Du. *glas****s*** > [gaɾas**ɯ**] 'glass'

As shown in the examples above, all five vowels of Japanese inventory – /a i ɯ e o/ – can serve as epenthetic vowels. With respect to the phonological processes involved in the selection of the epenthetic vowels, Avram (2005b), Rose and Demuth (2006) and Uffmann (2006, 2007) agree that, crosslinguistically, the quality of the epenthetic vowel is determined by one of the following processes:

(2) Epenthetic vowel quality in loanword adaptation – phonological processes:
  a. Epenthesis of a default vowel
  b. Vowel harmony
  c. Consonantal place assimilation

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The authors mentioned above argue that, crosslinguistically, none of the processes listed in (2) is able to give an uniform account on vowel epenthesis in loanwords within a single language; instead, in different phonological contexts a specific process is preffered or even compulsory. Japanese loanword phonology is no exeption: even though the most frequent strategy is the epenthesis of the default vowel /ɯ/, consonant place assimilation and vowel harmony are accountable for an important number of epenthesis instances.

Studies such as Otaki (2012) and Shoji and Shoji (2014) show that the general strategy of epenthesis consists in inserting the default vowel /ɯ/. Inserting /ɯ/ is possible after all the consonants of the Japanese inventory. In some contexts, though, it triggers the alteration of the preceding consonant (/t, d, h/ + /ɯ/ > [tsɯ, (d)zɯ, ɸɯ]), as an effect of allophonic variation, as in (3a-c); in these contexts, alternatively, the epenthesis of the back vowel /o/ applies, so that the input consonant is preserved unaltered in the output (3d-e). Consonant place assimilation occurs after the palatalized coronals [ʃ, ʧ, ʤ] and triggers the epenthesis of front high vowel /i/ (3f-g). Vowel harmony is found after the voiceless velar /k/, if there is a front vowel to its left or right (3h), occasionally after the laryngeal consonant /h/ (in order to avoid affrication triggered by the epenthetic /ɯ/) (3i) and in the context of the liquid /ɾ/ in older loans only (3j).

(3) Selection of epenthetic vowel quality: contexts and processes
- a. Fr. *omele**tte*** > [omɯɾe**tsɯ**] ‘omelet’
- b. Eng. ***d**rawers* > [**z**ɯɾo:sɯ] ‘drawers’
- c. Ru. *Kaza**x**stan* > [kaza**ɸɯ**sɯtaN] ‘Kazakhstan’
- d. Eng. *die**t*** > [daiet**to**] ‘diet’
- e. Eng. *car**d*** > [ka:**do**] ‘card’
- f. Eng. *chan**ge*** > [ʧe:nʤ**i**] ‘change’
- g. Eng. *ca**tch*** > [kʲaʧ**ʧi**] ‘catch’
- h. Eng. *cake* > [ke:k**i**] ‘cake’
- i. Eng. *Van G**o**gh* > [baŋg**o**hh**o**] ‘Van Gogh’
- j. Du. *kraan* < [k**a**ɾa**N**] ‘tap’

The generalizations presented above are contextualized with a quantitative analysis that takes into consideration epenthetic vowels quality and the phonological settings triggering their occurrence. The corpus, upon which the quantitative analysis is based, contains 1714 loanwords from Western languages such as Dutch, German, French, English, Italian, Portuguese, Spanish and Russian. The adaptation of a subset of 1346 loans (78.5%) implies at least one epenthesised vowel. These 1346 items include 2096 instances of vowel epenthesis. Table 1 confirms the generalizations presented above. More than 70% of epenthesis tokens are represented by the default epenthetic vowel /ɯ/. It is followed by the epenthetic vowel /o/, encompassing 20% of the entire set of epenthesis instances. It should be mentioned, however, that vowel /o/ is a special kind of default epenthetic vowel, occurring in a limited number of phonological contexts (after the consonants /t d h/) and serving a precise purpose: that of preserving the input consonants unchaged in the output. The remaining three vowels /i a e/ cover about 7 % of the entire set of epenthesis instances and are the result of consonant place assimilation (the most part of epenthesis instances of /i/), and vowel harmony, represented by the epenthesis of /a/, /e/ and, marginally, /i/ and /o/.

Vowel	/ɯ/	/o/	/i/	/a/	/e/	Total
Number	1524	420	143	7	2	2096
Frequency	72.70%	20.00%	6.80%	0.33%	0.09%	100.00%

Table 1. Frequency of the epenthetic vowels in Japanese loanwords

Before moving into a detailed presentation of the quantitative data, a remark on the sub-segmental representation is in order. In this paper, we assume the unified feature geometry (Clements and Hume 1995), unique for consonants and vowels (see Fig. 1, section 3). Since the place of articulation plays a major role in our analysis, it is necessary to make the following distinctions. The places of articulation of Japanese consonants are [LABIAL], [CORONAL], [DORSAL]. The inventory of labial consonants consists of [p, b, m, ɸ]. For reasons related to distinct phonological behavior, the coronals are split into two subsets: the plain coronals [t, ts, d, s, z, n] and the palatalized coronals [ʃ, ʧ, ʤ]. The dorsal consonants are [k g]. The consonants [h] and [ɾ] are considered placeless (more on this in 4.3.2 and 4.3.3) and are labeled, for the sake of clarity, as laryngeal and liquid.

2. Empirical considerations and quantitative data

The distribution of epenthetic vowels is set out in Table 2, considering first their quality, and then the contexts that trigger their occurrence: the labials, the coronals, the palatal coronals, the dorsals, the laryngeal and the liquid. In most cases, the epenthetic site is located at the right side of the consonant, except for 17 loans where the epenthetic vowel is a copy from right to left, triggered by the liquid /ɾ/, and three loans where /i/ is inserted before /k/.

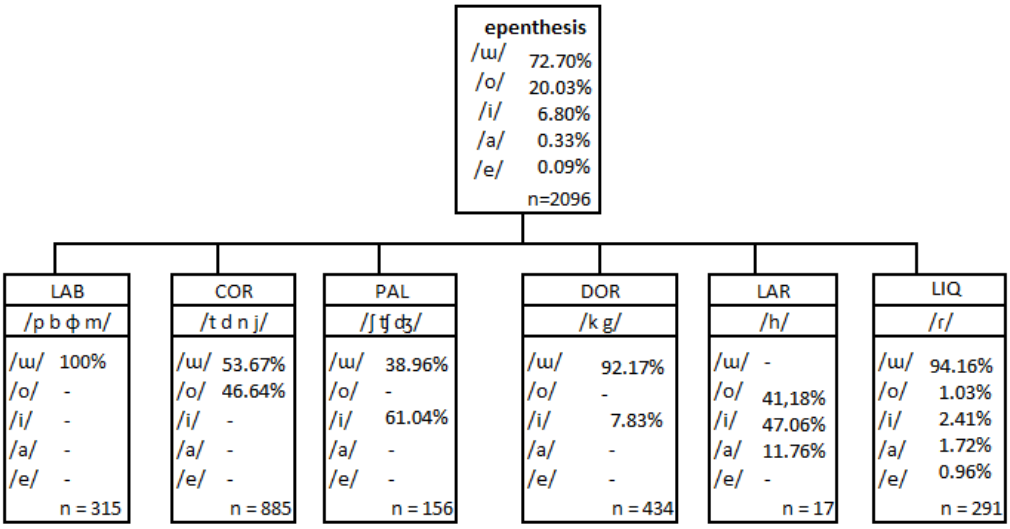


Table 2. The quality and frequency of epenthetic vowels depending on the place of articulation of the preceding consonant

2.1 Vowel epenthesis after labials

Epenthesis after the four labials [m, b, p, ɸ] applies uniformly, exhibiting no variation with respect to the quality of epenthetic vowel, epenthetic site or source language. The examples in (4) illustrate this uniform behavior: all labials trigger the epenthesis of the high back unrounded vowel /ɯ/, to the right of the consonant, irrespective of the source language or the relative time they entered Japanese language (the dates given between the brackets indicate the approximate time these loans were adopted into Japanese, according to Arakawa 1977).

(4) Default vowel epenthesis after labials
- a. Du. *balsem* > [baɾɯsam**ɯ**] 'balm' (1708)
- b. Du. *blik* > [b**ɯ**ɾiki] 'tin plate' (1845)
- c. Du. *trap* > [taɾapp**ɯ**] 'gangway' (1848)
- d. Du. *typhus* > [ʧiɸ**ɯ**sɯ] 'typhus' (1849)

The uniform selection of the default /ɯ/ as the epenthetic vowel renders unique the group of labials, since the rest of consonant groups display variation with respect to the quality of vowels allowed to be epenthesised in their context.

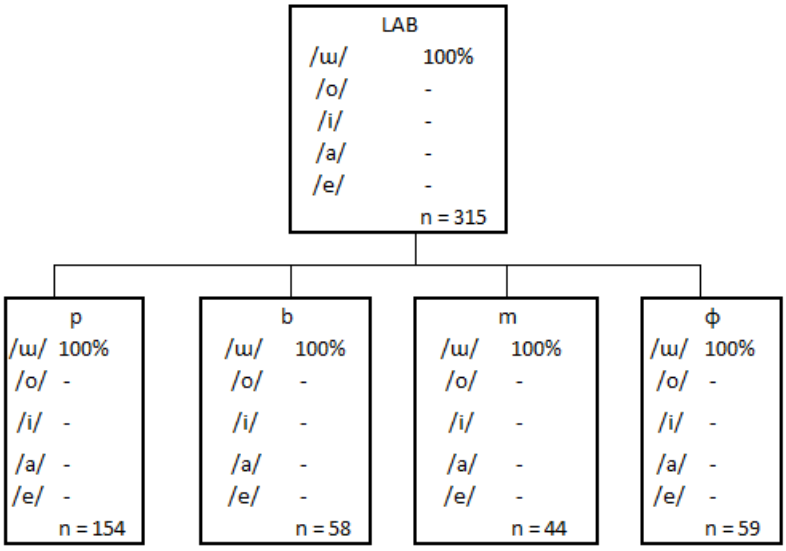


Table 3. Vowel epenthesis after labials

2.2 Vowel epenthesis after coronals

The group of coronals is represented by the obstruents [t, d], the africate [ts], the fricatives [s, z], the nasal [n] and the glide [j].

The consonants /t, d/ surface as [ts, (d)z] when followed by /ɯ/ (Avram 2005a). The alteration of these two source consonants, triggered by the allophonic variation – see

examples in (5) – is avoided by selecting /o/ instead of /ɯ/ as the default epenthetic vowel, as in (6). Since /o/ ensures the preservation of input consonant, it is epenthesised after /t, d/ much more frequently that /ɯ/: 345 instances out of 357 for /t/, and 65 instances out of 66 for /d/, as shown in Table 4.

(5) Default vowel epenthesis and the assibilation of /t/ in older loans
  a. Eng. *shirt* > [ʃatsɯ] (1873)
  b. Eng. *ticket* > [teketsɯ] ‘(1929)

(6) Epenthesis of /o/ after /t, d/
  a. Eng. *straw* > [sɯtoɾo:] (1874)
  b. Eng. *pyramide* > [piɾamiddo] (1867)

After the coronals [s, z, n, j], the epenthetic vowel is without exception the default /ɯ/. It should be mentioned however, that /ɯ/ is inserted after word-final /n/ and /j/ only in loans from French. The general adaptation strategy of syllable-final /n/, as in English loans for example, is the moraic /N /, i.e. one of the two codas accepted in Japanese[3].

(7) Default vowel epenthesis after coronals [s, z, n, j]
  a. Eng. *orchestra* > [o:kesɯtoɾa] ‘orchestra’ (1908)
  b. Eng. *who's who* > [ɸɯ:zɯɸɯ:] ‘Who’s Who’ (1921)
  c. Fr. *madeleine* > [madoɾe:nɯ] ‘madeleine’
  d. Fr. *andouille* > [andɯijɯ] ‘sausage type’

The table below shows the type and distribution of epenthetic vowels after the coronal consonants. The high number of epenthetic /o/ must be linked to the high incidence of the coronal stops /t, d/, which, as a result, are preserved unaltered in the output. The remainder of coronals requires the epenthesis of the default /ɯ/.

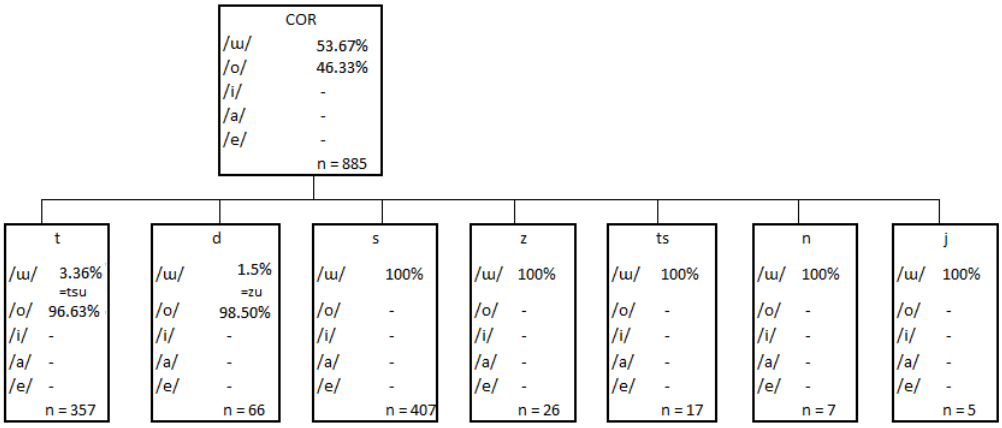


Table 4. Vowel epenthesis after coronals

2.3 Vowel epenthesis after palatals

[3] See Vendelin and Peperkamp (2004) for a discussion about the adaptation of the final /n/ in Japanese loans from French.

In Japanese, the palatalized coronals [ʃ, ʧ, ʤ] are the allophones of the consonants /s, z, t/ before the high front vowel /i/ (Avram 2005a). They differ from the plain coronals in the fact that, as context for vowel epenthesis, the accept both /ɯ/ and /i/, as exemplified below in (8)-(10):

(8) Epenthesis of /i/ and /ɯ/ after [ʃ]
  a. Eng. *brush* > [bɯɾaʃ**i**] 'brush' (1898)
  b. Eng. c*oquettish* > [koketiʃʃ**ɯ**] 'coquettish' (1925)

(9) Epenthesis of /i/ and /ɯ/ (mostly in loans from French) after [ʤ]
  a. Eng. *bridge* > [bɯɾiʤʤ**i**] 'bridge' (1878)
  b. Fr. *collage* > [koɾa:ʤ**ɯ**] 'collage' (1954)

(10) Epenthesis of /i/ (almost, the "default" option) and /ɯ/ (rarely attested) after [ʧ]
  a. Eng. *arch* > [a:ʧ**i**] 'arch' (1878)
  b. Ger. *Kitsch* > [kiʧʃ**ɯ**] 'kitsch'

The data in Table 5 demonstrate that there is an overall preference for the epenthesis of /i/ (comprising more than 61% instances of epenthesis) after [ʃ, ʧ, ʤ]; nevertheless, a detailed analysis of the data reveals that there is an asymmetry concerning the preffered epenthetic vowels among individual palatals: whereas [ʧ, ʤ] are biased toward the epentheses of /i/, after [ʃ] this vowel covers only 16%, being outnumbered by the epenthetic /ɯ/.

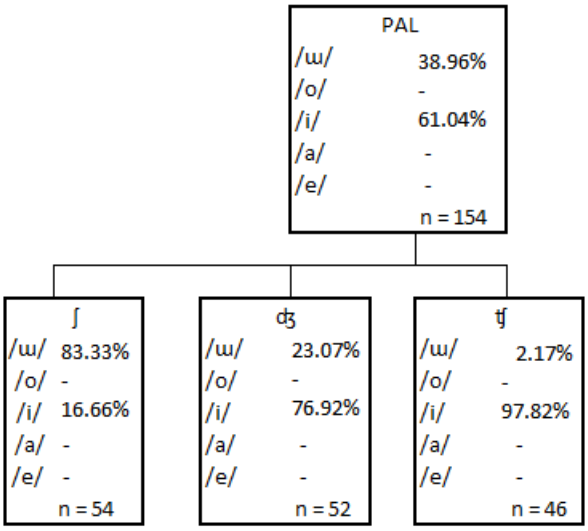


Table 5. Epenthesis after palatals

The epenthesis of both /ɯ/ and /i/ after the palatal coronals [ʃ, ʧ, ʤ] is different in kind to that of /ɯ/ or /o/ epenthesis after /t, d/, since neither /i/ nor /ɯ/ after [ʃ, ʧ, ʤ] are not linked to the avoidance of any consonant feature modification. There is evidence, in

line with the attestation dates accompanying the examples in (8)-(10), that, diachronically, /i/ epenthesis is the first option in the context of palatal coronals.

2.4 Vowel epenthesis after dorsal consonants

The velars /k, g/ have an asymmetric behavior as to what vowel is epenthesised in loanwords after them. The general strategy for both of them is the epenthesis of the default /ɯ/, as in the examples under (11). However, the voiceless velar /k/ allows in a small number of early loans for /i/ epenthesis, if in one of the adjacent syllables a front vowel is found, as in (12); Otaki (2012) suggest that this is the result of vowel harmony[4].

(11) Default vowel epenthesis after /k g/
  a. Du. *doek* > [zɯkk**ɯ**] 'canvas' (1854)
  b. Eng. *wig* > [ɰigg**ɯ**] 'wig' (1884)

(12) Vowel harmony before or after the voiceless velar /k/
  a. Eng. *strike* > [sɯtoɾa**i**k**i**] 'strike' (1879)
  b. Eng. *maxi* > [mak**i**ʃ**i**] 'maxi'

Table 6 confirms that /k, g/ trigger generally the epenthesis of the default vowel /ɯ/ (more than 92% of epenthesis instances), and that /i/ occurs rather marginally:

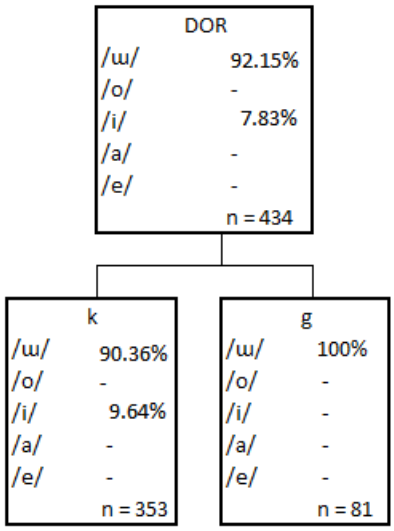


Table 6. Vowel epenthesis after dorsal coronals

2.5 Vowel epenthesis after the laryngeal fricative /h/

[4] However, not all instances of /i/ epenthesis in the context of the voiceless velar /k/ seem to be triggered by a front vowel, as in du. *kalk* > [kaɾɯki̥] 'chalk' (1833). In our corpus, four instances of epenthetic /i/ (out of 34) in the context of /k/, are not preceded, nor followed by a front vowel. Otaki (2012) reports that in his corpus, containing 80 loans with epenthetic /i/, in 65 instances the epenthesis of /i/ is based on vowel harmony.

Up to a point, the lanryngeal fricative /h/, as context for vowel epenthesis in loanwords, has a phonological behavior very similar to that of /t, d/, since /h/, too, is subject to allophonic variation, which forces it to surfaces as /ɸ/ if followed by /ɯ/ (Avram 2005a).

The epenthesis of /ɯ/ after /h/ has the advantage of inserting the most unmarked vowel of Japanese inventory; this, however, comes with the cost of altering the consonant feature for place, as shown in the examples under (13). The epenthesis of /o/ preserves the input consonant, as illustrated in (14), but the vowel is not that close to a genuine default epenthetic vowel.

(13) Epenthesis of /ɯ/ and the labialization of preceding /h/
  a. Ru. *Kazaxstan* > [kazaɸ**ɯ**sɯtaN]
  b. Du. *Groningen* [ro:nɪŋgən] > [ɸ**ɯ**ɾoniŋgeN]

(14) Epenthesis of /o/ after /h/
  Eng. *whippet* > [h**o**ipetto]

Different from the two obstruent consonant /t, d/, but similar to the voiceless velar /k/, the laryngeal fricative /h/ allows for epenthesis based on vowel harmony: the vowel from the syllable that precedes the consonant is copied to the epenthetic site.

(15) Epenthesis based on vowel harmony after /h/
  a. Du. *Maastricht* > [ma:sɯtoɾiç**i**to] ‘Maastricht’
  b. Ger. *Bach* > [bahh**a**] ‘Bach’
  c. Du. *Van Gogh* > [baŋgohh**o**] ‘Van Gogh’

Table 7 shows, however, that quantitatively, the loans as those in (14)-(15) are rather scarce, comprising generally place-names and proper names from German and Dutch. The marginal input of the consonant /h/ does not diminish its character as being one of the few contexts that allow for vowel harmony (and default vowel epenthesis), as a strategy for reparing illegitimate syllables.

	LAR
/ɯ/	19.04% = fu
/o/	33.33%
/i/	38.09%
/a/	9.52%
/e/	—
	n = 21

Table 7. Vowel epenthesis after the laryngeal fricative /h/

2.6 Two types of epenthesis in the context of the liquid /ɾ/

The consonant /ɾ/ is the only liquid of Japanese phoneme inventory and corresponds in loanwords to all types of liquids found in donor languages. As a context for vowel epenthesis, the consonant /ɾ/ is part of the general tendency to insert the default epenthetic vowel /ɯ/, which comprise more than 94% of the 291 epenthesis instances, as shown in Table 8:

	LIQ
/ɯ/	94.15%
/o/	1.03%
/i/	2.409%
/a/	1.71%
/e/	0.68%
	n = 291

Table 8. Vowel epenthesis in the context of the liquid /ɾ/

The examples under (16) illustrate the epenthesis of the default vowel after the adapted [ɾ] in Japanese loanwords:

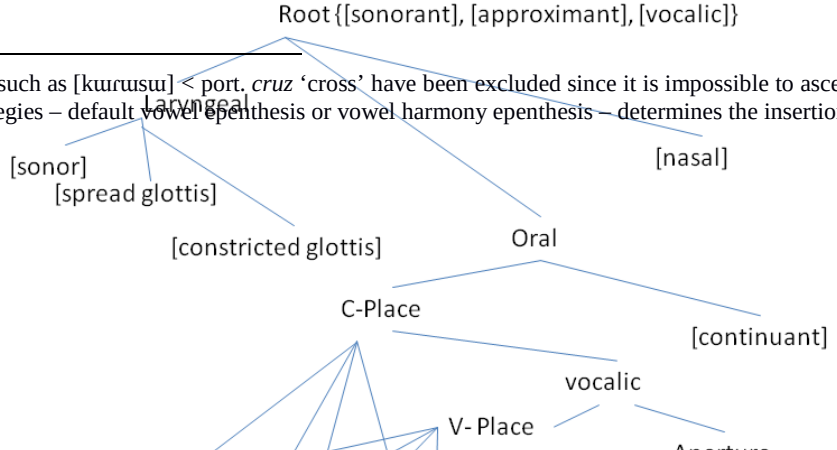
(16) Default vowel epenthesis after [ɾ] < /r/ and [ɾ] < /l/
  a. Du. *he**r**tog* [hɛrtɔx] > [he**ɾɯ**toɸɯ] ‘duke’ (1826)
  b. Eng. *mi**l**k* > [mi**ɾɯ**kɯ] (1870)

The rest of almost 6% is represented by 17 older loans[5] with anticipatory epenthesis, a selection of which is given below in (17). The epenthesis of the vowels /o i a e/ is based entirely on vowel copy to the left of the consonant /ɾ/, a fact that renders unique this context for epenthesis.

(17) Epenthesis as anticipatory vowel copy before adapted /ɾ/
  a. Du. *trap* > [t**a**ɾappɯ] ‘ladder’ (1848)
  b. Por. *sacrifício* > [sak**i**ɾiçiʃo] ‘offering’ (1591)
  c. Por. *ecclesia* > [ek**e**ɾeʃia] ‘church’ (1600)
  d. Por. *profeta* > [p**o**rohe:ta] ‘prophet’ (1592)

3. Japanese consonants and vowels in unified feature geometry

The subsegmental representation of Japanese consonants and vowels assumed here is that of the unified feature geometry (Clements and Hume 1995), which proposes a single set of distinctive features for both consonants and vowels:



[5] Loans such as [kɯɾɯsɯ] < port. *cruz* ‘cross’ have been excluded since it is impossible to ascertain which of the strategies – default vowel epenthesis or vowel harmony epenthesis – determines the insertion of /ɯ/.

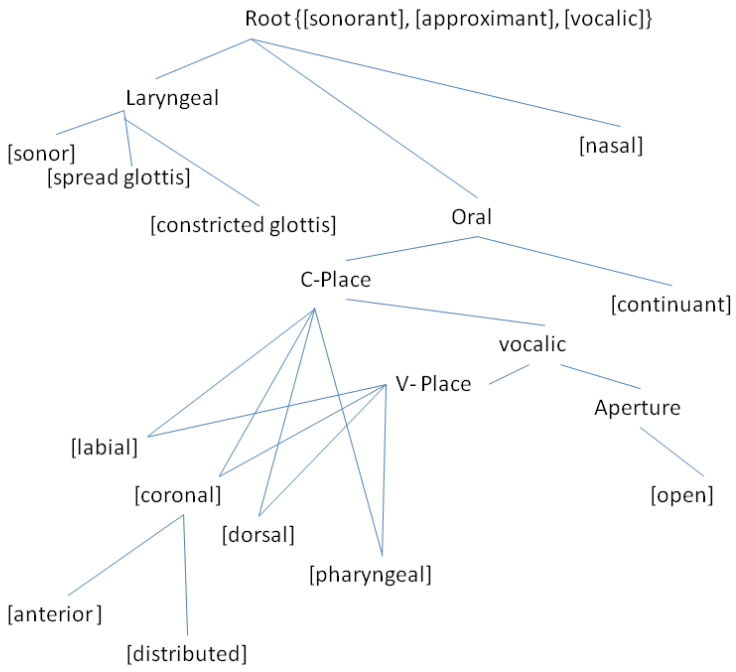
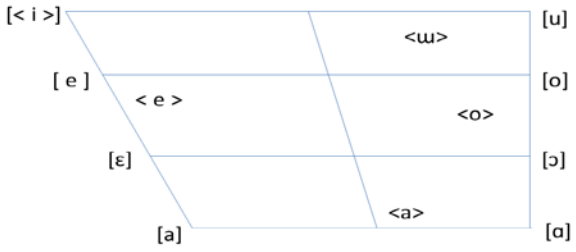


Fig. 1. Feature tree (after Uffmann 2006).

We defined already the consonants of Japanese in terms of their place of articulation as [CORONAL], [LABIAl] and [DORSAL]. The consonants /h/ and /ɾ/ were assumed to be unspecified for the place of articulation and were labeled as laryngeal and liquid.

The five vowels system of Japanese is given in (18). The vowel /ɯ/ is unrounded and occupies a position rather central in the vocalic space. The vowels /e/ and /o/ are somewhat centralized and lowered in comparison to their cardinal counterparts. The central vowel /a/ is higher than the cardinal [a] or [ɑ]; the phonetic correspondent of Japanese /i/ is the cardinal vowel [i].

(18) Japanese vowels in < >, cardinal vowels in [ ] (Vance 2008: 54)



In feature-geometric terms, the vowels of Japanese can be redefined as follows: the frontness of the vowels /i/ and /e/ qualifies them for the feature [CORONAL] (aperture has a separate node and makes the difference in highness between the two, see Fig. 1). The low central vowel /a/ is redefined as [PHARYNGEAL].

Redefining /o/ as [DORSAL] and not as [LABIAL] (the feature-geometric correspondent for [+round]) is less intuitive. Shoji and Shoji (2014) argue that the feature [+round] of the vowel /o/ is not strong enough for playing a decisive role in its phonological behavior, since /o/ is a lax vowel with no prominent lip rounding. This claim is supported by Ladefoged and Maddieson (1996: 293), according to whom, there are languages where the relationship between phonetic dimentions of backness and roundness is relaxed, although it is generally predictable. Uffmann (2007: 138) claims that the gesture of lip rounding is more compatible with the pronunciation of high vowels than that of mid ones, since lip rounding requires a raised position of the jaw, necessary for both lip rounding and the articulation of the high vowels; unlike these, the articulation of non-high vowels requires the jaw to be lowered, a gesture rather incompatible with lip rounding. Therefore, the back vowel /o/ is defined as [DORSAL] based on its backness, a feature that is more prominent than its roundness.

Finally, we consider vowel /ɯ/ to be phonologically unspecified. According to Uffmann (2007: 216), the default epenthetic vowels are prone to be phonologically unspecified for features such as place of articulation. Phonetically, /ɯ/ is the shortest vowel of Japanese inventory and most prone to undergo devoicing, resulting in a vowel perceptually close to zero and articulatory – associated with minimal effort. The high-central position of /ɯ/ is not far from /ɨ/ – un unmarked vowel par excellence and one of the preferred vowels for epenthesis crosslinguistically, together with /i/ and /ə/ (Uffmann 2007: 6, Lee 2008).

The feature-geometric definitions of Japanese vowels are summarized in (19):

(19) Feature geometry features of Japanese vowels

	/a/	/i/	/ɯ/	/e/	/o/
[CORONAL]		✓		✓	
[LABIAL]					(✓)
[DORSAL]					✓
[PHARYNGEAL]	✓				
[open]	✓			✓	✓

4. Vowel epenthesis: autosegmental operations. An optimality-theoretic analysis

Default vowel epenthesis, place assimilation and vowel harmony can be accounted for in terms of operations provided by autosegmental phonology (Goldsmith 1990, Uffmann 2006, 2007). Default vowel epenthesis is the insertion in the output of a feature without correspondent in input (20a). The remaining two strategies represent the spreading of an underlyingly existent feature: the spreading occurs locally in consonant assimilation (20c) or at distance, in case of vowel harmony (20b).

(20) Epenthesis operations

a.	b.	c.
insertion of a default vowel	vowel harmony	consonant assimilation
T	T	T
V C (V)	V C (V)	V C (V)

Each epenthesis operation implies advantages and disadvantages, which, according to Uffmann (2006, 2007), can be summarised as follows. Default vowel epenthesis is realised by inserting new phonological material into surface representations: while each association line remain connected to a single segment (which is an advantage), there are segments without correspondence in input (which, in turn, is a disadvantage). Vowel harmony and consonantal place assimilation avoid the disadvantage of new phonological material being inserted into surface representations by spreading a feature of an underlyingly existent consonant or vowel to the epenthetic site; however, this operation involves the multiple association of a single feature, which is an disadvantage. Moreover, while the consonant feature spreading occurs locally, between adjacent segments (advantage), vowel harmony consists in spreading a vowel feature at distance, by letting a consonant to intervene (disadvantage). As for the disadvantage of consonant assimilation, it refers to sharing a feature between heterogeneous segments, a consonant and a vowel. Uffmann (2006: 1096, 2007: 303) renders all these disadvantages (which, as Optimality Theory assumes, must be avoided) in the form of constraints, as defined in (21)-(24).

(21) DEP(F) all output features have correspondents in input (do not insert features!)

(22) *MULTIPLE the nodes are dominated only by a single node (do not associate a single feature to multiple segments!)

(23) *SKIP the interaction (spreading) is local (do not skip segments in multiple associations!)

(24) *LINKAGE(C,V) the place of articulation can not be simultaneously associated to a C-Place and a V-Place (do not spread features between heterogeneous segments!)

With the constraints defined in (21)-(24), the typology of all three vowel epenthesis strategies can be modelled. The relative dominance relationship between DEP(F) and *MULTIPLE accounts for both feature insertion and feature spreading. If *MULTIPLE dominates DEP(F), the epenthesis of new phonological material into the surface

representation is preferred (see the hierarchy in (25)). Conversely, if DEP(F) dominates *MULTIPLE, as in the hierarchy in (26), the feature spreading is favored. Once the feature spreading has been selected as the main strategy for epenthesis, local place assimilation or vowel harmony apply according to the dominance relationship between *SKIP and *LINKAGE(C,V). If *SKIP dominates *LINKAGE(C,V) – see (27), local consonantal place assimilation is a better strategy since *LINKAGE(C,V), the constraint that bans shared features between consonants and vowels, has a lower position in hierarchy and, thus, its violation is a less serious offence than the violation of *SKIP. Likewise, the reversed dominance between these two constraints, where *SKIP is dominated by *LINKAGE (C,V), as in (28), favors vowel harmony.

(25)	*MULTIPLE >> DEP(F)	default vowel epenthesis
(26)	DEP(F) >> *MULTIPLe	feature spreading
(27)	*SKIP >> *LINKAGE(C,V)	consonantal place assimilation
(28)	*LINKAGE(C,V) >> *SKIP	vowel harmony / non-local feature spreading between vowels

In line with the typology of vowel epenthesis processes and the optimality theoretic constraints defining them, we proceed in the following sections to the analysis of vowel epenthesis in Japanese loanword adaptation.

4.1 Default vowel epenthesis

Optimality Theory assumes a purely phonological definition of default epenthetic vowels, using the notion of markedness: the vowels usually occuring as default epenthetic ones are least marked, i.e. they violate only the constraints that occupy, crosslinguistically, the most demoted positions in grammatical hierarchies. In this line, Uffmann (2007: 216) notes that default vowel epenthesis, as main strategy of reparing illicit syllables in loanwords, is only possible if the host language has un unmarked vowel such as /ɨ, ə, i/, devoid of phonological specifications (place of articulation, lip rounding). Since Japanese /ɯ/ is close – articulatorily and perceptually – to the central vowel /ɨ/, we consider /ɯ/ not being specified for features at the subsegmetal level.

Additional evidence for the unmarkedness of /ɯ/ comes from Lombardi (2002) analysis. Her survey of vowel quality selected for default epenthesis in several languages shows that, crosslinguistically, vowel systems can assign umarkedness either to low vowels or to non-low vowels. Lombardi (2002: 5) argues that in a system where non-low vowels are unmarked (as it is the case of Japanese) the implicational generalizations from (29) hold true.

(29) Unmarked non-low vowels (Lombardi (2002: 5)), adapted and completed considering the assumptions of the unified feature geometry

a. High vowels are less marked than mid or low ones
*[−high] / *[+open] (/ *[PHARYNGEAL]) >> *[+high] / *[−open]

b. Back vowels are less marked than the front ones

*[−back] / *[CORONAL] >> *[+back] / *[DORSAL]

c. Unrounded vowels are less marked than to round ones
*[+round] / *[LABIAL] >> *[−round][6]

Based on the implicational hierarchies in (29), we posit the following markedness scale of Japanese vowels, which confirms the assumption that /ɯ/ is the least marked vowel of the entire Japanese vowel inventory. Indeed, /ɯ/ is the least marked since it is [+high] (as required in (29a), it is [−back], as required in (29b), and [–round], as required in (29c).

(30) Markedness scale of Japanese vowels:

/a/ >>	/e/ >>	/o/ >>	/i/ >>	/ɯ/
[+low]	[+high,-low] [−back]	[+high, −low] [+back]	[+high] [−back]	[+high] [+back]
[PHARYNGEAL]	[CORONAL] [+open]	[DORSAL]	[CORONAL] [−open]	Ø

Conjoining the scale from (30) with the anti-epenthesis constraint DEP(F), a new scale is obtained, referring to the likelihood of a vowel to function as default epenthetic one in loanword adaptation: a position toward the right end of the scale correlates with a less marked vowel and with a higher likelihood of that vowel to function as default epenthetic one.

(31) DEP(a) >> DEP(e) >> DEp(o) >> DEP(i) >> DEP(ɯ)

Since vowel epenthesis is a strategy used to repair illicit syllables, a hierarchy of loanword adaptation must include the constraints on syllable structure. We will refer to both *COMPLEX and *CODACOND, as SYLLSTRUC (see (32)): a syllable with complex margins or codas other than the moraic nasal or the first half of a geminate is not possible in Japanese.

(32) Syllable structure in Japanese: SYLLSTRUC

a. *COMPLEX complex syllable margins are not allowed

b. *CODACOND syllable codas, other than /N/ (moraic nasal) or /Q/ (first half or a geminate consonant) are not allowed

The hierarchy for default vowel epenthesis introduced in (25) is repeated in (33), where it is completed with the constraint on syllable structure. SYLLSTRUC has no conflictual relationship with *MULTIPLE since each of these two constraints pertain to

[6] The feature [-round] has no correspondend in feature geometry, which assumes place of articulation as being unary ([LABIAL], [CORONAL], [DORSAL], [PHARYNGEAL]), in contrast to [±round], [±high], etc.

different phonological domains: syllable structure (the representational domain) and feature spreding (operational domain). Both SYLLSTRUC and *MULTIPLE dominate the anti-epenthesis constraint DEP(F).

(33) SYLLSTRUC, *MULTIPLE >> DEP(ɯ)

The tableau in (34) illustrates the functioning of the hierarchy given in (33). The suboptimal candidates (34b) and (35c) incur each one violation: of syllable structure constraint (SYLLSTRUC) and, respectively, of the constraint that militates against feature spreading (*MULTIPLE); as a result, the candidates (34b)-(34c) are ill-formed as outputs for the input *knob* from English. The optimal candidate (34a), too, incurs a violation, namely of the anti-epenthesis constraint DEP(ɯ), but the overall cost is minimal within this hierarchy, due to the low position of the violated constraint.

(34) Default vowel epenthesis

	/nɒb/	SYLLSTRUC	*MULTIPLE	DEP(ɯ)
a. ☞	nobɯ			*
b.	nob	*!		
c.	nobo		*!	

Recall that a special case of default vowel epenthesis occurs after the consonants /t, d, h/, which, as contexts for vowel epenthesis, allow for two options: (i) insertion of the default vowel /ɯ/, that triggers the modification of consonantal manner of articulation (assibilation: /t, d/ + /ɯ/ > [tsɯ (d)zɯ]) or place of articulation (labialisation: /h + ɯ/ > [ɸɯ]) or (ii) epenthesis of the back vowel /o/, which does not trigger any consonantal feature modification[7]. In order to account for these two types of outcomes, two constraints from the IDENTITY family need to be posited, constraints that militate for the preservation of input segment features, as defined in (35)-(36):

(35) IDENT[PLACE] the place of articulation of output consonants is identic with their corresponding consonants in input

(36) IDENT[cont] the manner of articulation of output consonants is identic with their corresponding consonants in input

The hierarchy that accounts for the assibilation of /t d/ and the labialization of /h/ when followed by the epenthetic /ɯ/ is provided in (37). The effect of ranking IDENT[PLACE] and IDENT[cont] as low as DEP(ɯ) is that both epenthesis of /ɯ/ and consonant alteration in the output represent a minimal offence within this hierarchy.

(37) Hierarchy for epenthesis of /o/ after /t, d, h/
SYLLSTRUC, *MULTIPLE >> DEP(o) >> IDENT[PLACE], IDENT[cont], DEP(ɯ)

[7] The vowel /o/ is selected as default epenthetic one after /t, d, h/, since the vowel /i/ (which is the second less marked vowel after /ɯ/, acording to the scale in (30)), would still trigger allophonic changes, forcing /t d h/ to surface as [ʧ, ʤ, ç]; the vowel /o/ is the following less marked vowel in the scale, after /i/.

In tableau (38), for English *shirt* and Russian *Kazaxstan*, both candidates (38a) are optimal, since the constraints they violate are ranked lowest: the anti-epenthesis constraint DEP(ɯ) and the constraints on the correspondent consonant identity IDENT[PLACE] and IDENT[cont], if violated, do not jeopardize the selection of candidates (38a) as optimal. The candidates (38c) are of special interest, since they illustrate the alternative of /o/ epenthesis, the special kind of default epenthesis, occurring only after /t d, h/: within the given hierarchy, where the constraint DEP(o) is ranked higher than DEP(ɯ) and IDENT[PLACE], IDENT[cont], any candidate with epenthesis of /o/ is less harmonic than those were the default /ɯ/ is epenthesised. The sole candidate (38d), illustrating the epenthesis triggered by local consonant assimilation – both /ʃ/and /i/ are defined as [CORONAL] – is ill-formed since it violate a high-ranked constraint, *MULTIPLE, the one that militates against multiple association of a single distinctive feature. Finally, both candidates (38b) are crucially ill-formed since they do not meet the requirements of the undominated constraint on syllable structure, SYLLSTRUC.

(38) Epenthesis of default /ɯ/ after /t, d/, resulting in consonant assibilation

input	output	SYLL STRUC	*MULTIPLE	DEP(o)	DEP(ɯ)	IDENT [cont]	IDENT [PLACE]
ʃɜːt	a. ☞ ʃa:**tsɯ**				*	*	
	b. ʃa:**t**	*!					
	c. ʃa:t**o**			*!			
	d. ʃa:**ʧi**		*!			*	
kazaxstan	a. ☞ …**ɸɯ**sutaN				**		*
	b. …**h**staN	*!*					
	c. …**ho**sutaN			*!	*		

Recall, however, that /ɯ/ epenthesis after /t, d, h/ accounts only for a small number of epenthesised vowels in these contexts. More than 95% of epenthetic vowels after /t, d/ and about 33% after /h/ are represented by /o/. These figures show that the pressure toward preserving the input consonant unaltered in the output is strong and that the tableaux in (34) and (38) account for only a small part of vowel epenthesis grammar.

This parallel grammar is embodied by an hierarchy where the fidelity constraint militating for consonant preservation dominate all anti-epenthesis constraints (DEP(o), DEP(ɯ), etc.

(40) Hierarchy for epethesis of /o/ after /t, d, h/
SYLLSTRUC, *MULTIPLE >> IDENT[PLACE], IDENT[cont] >> DEP(o) >> DEP(ɯ)

The tableau (41), for English *smart*, French *étude* ‘study’, and English *white*, shows that the reranking from (40) accounts for the major strategy of inserting /o/ after /t, d, h/, as default option, thus avoiding the altering of the consonants as effect of allophonic variation. All three candidates (41a) are optimal since they incur the least serious violation, that of DEP(o). The epenthesis of the default /ɯ/ in the candidates (41c) triggers the violation of the higher ranked constraints IDENT[PLACE] and IDENT[cont], resulting in less harmonic outputs than those in (41a). The two candidates (41d), where the epenthetic vowel is based on consonant place assimilation, are even more ill-formed

since they violate the undominated constraints *MULTIPLE and IDENT[cont] (precisely those constraints, the violation of which is avoided by /o/ epenthesis in all three optimal candidates (41a)). Finally, the candidates (41b) violate the requirements of the undominated constraint on syllable structure, SYLLSTRUC.

(41) Epenthesis of vowel /o/ after /t, d, h/ and the preservation of input consonant quality

input	Output	SYLLSTRUC	*MULTIPLE	IDENT [cont]	IDENT [PLACE]	DEP(o)	DEP(ɯ)
smɑːt	a☞ sɯma:**to**					*	
	b sma:t	*!					
	c sɯma:tsɯ			*!			*
	d sɯma:ʧi		*!	*			
etyd	a☞ eʧɯ:**do**					*	
	b eʧɯ:d	*!					
	c eʧɯ:zɯ			*!			*
	d eʧɯ:ʤi		*!	*			
hwaɪt	a☞ **ho**ɰaito					*	
	b hɰait	*!					
	c ɸɯɰaito				*!		*

4.2 Local assimilation

Local consonant assimilation, as strategy for determining the quality of the epenthetic vowels, occurs by spreading the consonant place of articulation to the epenthetic site. In Japanese loanwords adaptation, it accounts for more than 60% of the epenthesised vowels after the palatal consonants [ʃ, ʧ, ʤ].

The hierarchy given in (42) accounts for vowel epenthesis occurring through spreading the consonant place of articulation. The anti-epenthesis constraint DEP(ɯ) occupies a relatively high position, ensuring this way that no material without correspondence in input can be inserted in output[8]. *SKIP, the constraint that renders ill-formed the candidates with epenthesis through non-local spreading, is placed on the same level as DEP(ɯ). The lowest position occupied by *LINKAGE(C,V) and *MULTIPLE guarantees that feature spreading between adjacent consonants and vowels and spreading in general are penalized minimally.

(42) SYLLSTRUC >> DEP(ɯ),*SKIP >> *LINKAGE(C,V), *MULTIPLE

In tableau (43), for English *brush*, all three candidates remaining after the elimination of candidate (43c) as ill-formed from the point of view of syllable structure violate at least one of the relatively dominant constraints DEP(ɯ) and *SKIP. Candidate (43b) violates DEP(ɯ) twice; candidate (43c) incurs one violation of DEP(ɯ) for

[8] Since the constraint DEP(ɯ), which bans the epenthesis of the vowel most likely to be used as default epenthetic one, is relatively highly ranked in the hierarchy (42), the rest of dependency constraints from the scale in (30), banning the default epenthesis of the other vowels of Japanese inventory, were dismissed in the hierarchy in (42).

epenthetic /ɯ/ after /b/ and one violation of *SKIP for paragogic /a/ after /ʃ/, copied from the preceding syllable. The candidate (43a) is optimal, even if its surface form implies one violation of DEP(ɯ) (for /ɯ/ epenthesised after /b/), one violation of *LINKAGE(C,V) and one violation of *MULTIPLE, both for the paragogic /i/. Being low-ranked, both *LINKAGE(C,V) and *MULTIPLE are not able to jeopardize the well-formedness of the candidate (43a).

(43) Epenthesis based on place of articulation spreading

	/brʌ ʃ/	SYLLSTRUC	DEP(ɯ)	*SKIP	*LINKAGE (C,V)	*MULTIPLE
a. ☞	bɯraʃi		*		*	*
b.	bɯraʃɯ		**!			
c.	braʃ	*!*				
d.	bɯraʃa		*	*!		*

Tableau (43) above shows how a vowel having the same place of articulation as the preceding consonant is selected for epenthesis in loanword adaptation, but does not provide an answer to the question why the occurrence of this phenomenon is confined to the context of the three palatal coronals [ʃ, ʧ, ʤ]. According to the hypothesis advocated by Uffmann (2007: 91), this confinement is related to the the markendess of the places of articulation. Rendered as the scale in (44), the markedness of the different places of articulation increases from right to left, [CORONAL] being the least marked feature of its kind.

(44) Markedness scale of the places of articulation
*PHARYNGEAL >> *DORSAl >> *LABIAL >> *CORONAL

From the scale in (44), it can be inferred that the consonants allowing for consonantal assimilation are the least marked with respect to their place of articulation. In conjunction with *LINKAGE(C,V), the rewritten markedness scale in (45) indicate that the likelihood of a place of articulation to spread diminishes toward its right end and vice-versa. In Japanese loanword adaptation, the only place of articulation that spreads is the least marked one, namely [CORONAL][9].

(45) Spreading likelihood of the place of articulation
*LINKAGE(C,V)/phar >> *LINKAGE(C,V)/dor >> *LINKAGE(C,V)/lab >> *LINKAGE(C,V)/cor

In the light of the above mentioned, the hierarchy in (42) must be completed with the detail concerning the fact that only the least marked place of articulation allows for consonant place of articulation to spread. This detail consists in the refined constraint *LINKAGE(C,V)/cor, that penalizes the spreading of even the least marked places of articulation, [CORONAL]. The upgraded hierarchy is repeated in (46).

[9] The subset of [ʃ, ʧ, ʤ] stands apart from the rest of coronals as being [-anterior] and the constraint *LINKAGE(C,V)/cor refers to them only.

(46) SYLLSTRUC >> DEP(ɯ), *SKIP >> *LINKAGE(C,V)/cor, *MULTIPLE.

4.3 Vowel harmony

It has been shown that the hierarchy that accounts for vowel harmony as a strategy for epenthesis is *LINKAGE(C,V) >> *SKIP. This hierarchy implies that a feature shared by two vowels, even if separated by a consonant (*SKIP), is preferred to a feature shared by adjacent, but heterogeneous segments (*LINKAGE(C,V)). According to Uffmann (2006, 2007), vowel harmony can occur only if the intervening consonant has a low sonority. In this respect, a sonority scale is proposed (47), where the positions on its right positively correlate with a higher likelihood for vowel harmony epenthesis to occur.

(47) Sonority scale
*vowel >> *[sonorant] >> *[fricative] >> *[obstruent] >> *[laryngeal]

Conjoining the scale in (47) with the constraint *SKIP, a new scale is obtained (48): it predicts that, when spreading a vowel feature to the epenthetic site, the likelihood of a consonant to be skipped increases if it is positioned toward the right end of the scale. The last two positions on the right end of the scale are occupied by the laryngeal fricative /h/ and the velar voiceless /k/, exactly those segments that represent two of the three phonological contexts allowing for vowel harmony to occur in loanword adaptation.

(48) *SKIP/V >> *SKIP/son >> *SKIP/fric >> *SKIP/obstr >> *SKIP/lar

We turn now to the analysis of each of the three contexts that allow for epenthesis based on vowel harmony: the voiceless velar /k/, the laryngeal fricative /h/, and the liquid /ɾ/.

4.3.1 The voiceless velar /k/

In Japanese loanword adaptation, the voiceless velar /k/ allows for vowel harmony, whereas its voiced counterpart /g/ is completely opaque to it.

Uffmann (2007: 83-84) reports the exceptional behavior of dorsals in Shona, where the default strategy for epenthesis is local consonant assimilation; nevertheless, after [k, g, ŋ] epenthesis occurs as effect of vowel harmony. The author accounts for this behavior in terms of the high resistence of this place of articulation to spread, as posited by the markedness scale, that we provided above in (44). Uffmann reports that [DORSAL], being a highly marked place of articulation, is lost in a number of phonological process. For example, in Japanese loans from English, consonants [k g] followed by the front open vowel /æ/ undergo palatalization, as in *candy* [kændi] > [kʲandi:]. In the same vein, Yamane (2013: 51) reports that in the speech of elderly Japanese men, the voiceless velar /k/, under the influence of the subsequent low / pharyngeal vowel /a/, is pronounced as a uvular or pharyngeal consonant – [ħ, q]; the author cites the following examples /ɯakatta/ > [ɯaħatta, ɯaqatta] ‘I did understand’, /okotta/ > [oħotta, oqotta] ‘I got angry’. Vowel harmony, as a marginal strategy for epenthesis in loanwords reminds,

according to Ichikawa (1930: 183), cited in Shoji and Shoji (2014: 6), of the grammar of old Japanese, where a front vowel triggered the epenthesis of /i/ and a back vowel triggered the epenthesis of /ɯ/.

We posit the hierarchy in (49) as being able to account for epenthesis based on vowel harmony. It features the refined constraint *LINKAGE(C,V)/dor, which penalizes the local spreading of the feature [dorsal]: being ranked in dominant position to DEP(ɯ), it renders ill-formed every candidate where the highly marked feature [DORSAL] would spread locally, from consonant to vowel. The constraints *MULTIPLE and *SKIP are ranked low, so that they do not crucially influence the well-formedness of the candidates where epenthesis is based on vowel harmony.

(49) SYLLSTRUC >> *LINKAGE(C,V)/dor >> DEP(ɯ) >> *MULTIPLE, *SKIP, *LINKAGE(C,V)/dor

The activity of the hierarchy in (49) is illustrated in the tableau (51), for English *expo*. Candidates (51a) and (51c) are ruled out, since they do not meet the requirements of two highly ranked constraints: SYLLSTRUC and DEP(ɯ). The remaining ones violate the anti-spreading constraints: candidate (51d), where the feature [DORSAL] spreads from consonant to vowel, is even more ill-formed than (51c), due to the relative high position of *LINKAGE(C,V)/dor. The candidate (51b) is optimal, because the epenthesis of /i/, based on harmony with the vowel in the preceding syllable (they share the feature [−back]), violates two constraints that are ranked low: the constraint against multiple associations (*MULTIPLE) and the constraint against spreading at distance (*SKIP).

(51) Epenthesis of /i/, based on vowel harmony after the voiceless velar /k/

	/ekspəʊ/	SYLLSTRUC	*LINKAGE(C,V)/dor	DEP(ɯ)	*MULTIPLE	*SKIP
a.	ekspo	*!*				
b. ☞	ekisɯpo				*	*
c.	ekɯsɯpo			*!		
d.	ekosɯpo		*!		*	

In the context of the voiceless velar /k/, vowel harmony applies either from the left to the right, as in (51b), or from right to the left. Since the epenthetic vowel is always /i/, if there is a front vowel in the preceding or following syllable, we conclude that the feature that spreads is [CORONAL]. Recall that [CORONAl] is the least marked place of articulation, according to the scale introduced above in (44). This effect can be captured if the scale of place markedness is conjugated with *MULTIPLE; the new scale, provided below in (52), implies that the likelihood of a place of articulation to spread decreases from right to left.

(52) *MULTIPLE/phar >> *MULTIPLE/dor >> *MULTIPLE/lab >> *MULTIPLE/cor

To complete the hierarchy in (49), used in the tableau (51), the constraint *MULTIPLE must be splitted: in (53), on a par with *SKIP we find *MULTIPLE/phar, the constraint that penalizes the copy of /a/ as epenthetic vowel; on a lower position is ranked the constraint *MULTIPLE, which bans the spreading of the remaining vowels.

(53) Only the feature [coronal] participates in vowel harmony in context of /k/

SYLLSTRUC >> *LINKAGE(C,V)/dor >> DEP(ɯ) >> *MULTIPLE/phar, *SKIP >> *MULTIPLE

In the following tableau, for English *taxi*, (54c) and (54e) are the candidates that illustrate the directionality effect in vowel harmony in the context of /k/. Candidate (54e) loses because the vowel that is copied into the epenthetic site is a highly marked one, a movement penalized by *MULTIPLE/phar. In contrast, candidate (54c) wins since the featurethat spreads, [CORONAL], is the least marked one and, therefore, incurs a much less serious violation within the given hierarchy, that of the low ranked constraint *MULTIPLE.

(54) Epenthesis if /i/ towards the left

	/tæksɪ/	SYLLSTRUC	*LINKAGE(C,V)/dor	DEP(ɯ)	*MULTIPLE/phar	*SKIP	*MULTIPLE
a.	takʃi	**!					
b.	takɯʃi			*!			
c. ☞	takiʃi					*	*
d.	takoʃi						
e.	takaʃi				*!	*	

As already noted, the voiceless and the voiced velars behave asymmetrically with respect to vowel epenthesis strategies: while /k/ allows for vowel harmony (although sparingly, in older loans), the voiced counterpart /g/ is completely opaque to this process. We propose to capture this asymmetry by splitting the position occupied by obstruent consonants set in the sonority scale, as in (55). Within the new version of the scale, the voiced obstruents (*[obstr/[+voice]]) dominantes the plain obstruents (*[obstr]), which means that the first ones are more marked and, in conjuction with *SKIP (see the scale in (56)), are less likely to allow for epenthesis based on vowel harmony. The transparency of consonant /k/ to vowel harmony is expressed by the the constraint *SKIP/obstr/dor, positioned on a lower place within the scale (followed only by *SKIP/lar referring to the laryngeal /h/, to be discussed in next section).

(55) Refined sonority scale
*V >> *[son] >> *[fric] >> *[obstr/[+voice]] >> *[obstr] >> *[obstr/dor] >> *[lar]

(56) Refined scale concerning the likelihood of consonants to be skipped in vowel harmony
*SKIp/V >> *SKIP/son >> *SKIP/fric >> *SKIP/obstr/[+voice] >> *SKIP/obstr >> *SKIP/obstr/dor >> *SKIP/lar

In order to capture the blocking of vowel harmony after the voiced velar /g/, the constraint *SKIP/obstr/[+voi] is integrated high within the hierarchy (57), repeated from (53) and completed, on the same position as *LINKAGE(C,V)/dor.

(57) Voiced velar /g/ opaque to vowel harmony
SYLLSTRUC >> *LINKAGE(C,V)/dor, *SKIP/obstr/[+voice] >> DEP(ɯ) >> *SKIP >> *MULTIPLE

The table in (58) shows how this newly introduced constraint rules out the candidate (58c), where the vowel harmony is blocked by the intervening high-sonority consonant /g/.

(58) Blocked vowel harmony means default vowel epenthesis

	/wɪg/	SYLLSTRUC	*Linkage(C,V)/ dor	*Skip/obstr/ [+voice]	DEP(ɯ)	*Skip	*MULTIPLE
a.	ɯig	*!					
b. ☞	ɯiggɯ				*		
c.	ɯiggi			*!		*/obstr	*cor
d.	ɯiggo		*!				*cor

Note, however, that the tableau in (58) accommodates the epenthesis of the default vowel /ɯ/ (covering almost 73% of the instances of epenthesis analysed in this paper) using the hierarchy that accounts for feature spreading. The tableau in (59) illustrate the alternative analysis – a more straightforward one – of /ɯ/ inserted after voiced velar /g/ and, of course, elsewhere where the default vowel epenthesis is applied.

(59) The alternative analysis for /ɯ/ epenthesis after /g/

	/wɪg/	SYLLSTRUC	*MULTIPLE	DEP(ɯ)
a.	ɯig	*!		
b. ☞	ɯiggɯ			*
c.	ɯiggi		*!	
d.	ɯiggo		*!	

The tableaux in (58)-(59) are evidence for the existence of two co-phonologies, active in the selection of epenthetic vowel: feature insertion and feature spreading. We consider that extra-linguistic forces have imposed, diachronically, the default vowel epenthesis as main strategy even in those contexts that allow for feature spreading, as in the generalized epenthesis of /ɯ/ after /k/. However, vowel harmony in loanword adaptation, although marginal, is evidence for the diverse possibilities of Japanese grammar and, of course, of its limits.

4.3.2 The laryngeal fricative /h/

The epenthesis based on vowel harmony after /h/ uses the same hierarchy that favors non-local feature spreading, discussed in the preceding section. The tableau in (60), for German *Bach*, features an additional undominated constraint – *HU, a constraint that rules out any candidate (here, candidate (60c)) containing the sequence */hɯ/, impossible in Japanese and forced, therefore, to surface as [ɸɯ]. Both candidates displaying default vowel epenthesis (60c)-(60d) are ruled out by the highly ranked DEP(ɯ). The candidate (60b), having its epenthetic vowel copied from the preceding syllable, wins, even if the two low-ranked anti- spreading constraints are violated.

(60) Vowel harmony epenthesis after /h/

	/bax/	SYLLSTRUC	*HU	DEP(ɯ)	*SKIP	*MULTIPLE
a.	bah	*!				
b. ☞	bahha				*	*
c.	bahɯ		*!	*		
d.	baΦɯ			*!		

4.3.3 The liquid consonant /ɾ/

Vowel harmony accounts for only about 6% percent of epenthesis instances occuring in the context of the liquid consonant /ɾ/. This behavior is surprising if the sonority scale in (55) is taken into account: according to it, the liquid consonant /ɾ/, as a sonorant, must represent a context that blocks non-local feature spreading. We hypothesise that the key for this exceptional behavior must lie outside the position of /ɾ/ within the sonority scale. In this respect, Labrune (2004) claims that /ɾ/ in Japanese is an inert, transparent consonant that lacks phonological content: (i) it is the only consonant that never geminates, (ii) it never undergoes palatalization in mimetics, (iii) it never acts as assimilation trigger, although it is often the assimilation target, as in *wakaranai* > *waka**n**nai* 'I don't understand', and (iv) its phonetic realizations are subject to a wide variation. We consider that the liquid /ɾ/ allowing for vowel copy in loanwords is another evidence for its phonological transparency, i.e. its state of being devoid of phonological features.

The tableau in (61), for Dutch *kraan* 'tap', shows that the hierarchy accounting for non-local feature spreading captures the well-formedness of the candidate (61b), where the epenthetic site is filled by the vowel /a/, copied from the right side of the intervening consonant /ɾ/.

(61) Anticipatory vowel copy triggered by liquid /ɾ/

	/kra:n/	SyllStruc	*Linkage(C,V)/dor	Dep(ɯ)	*Multiple/phar	*Skip	*Multiple
a.	kɾaN	*!					
b. ☞	kaɾaN				*	*	
c.	kɯɾaN			*!			
d.	koɾaN		*!				

4.4 Two co-phonologies

We argued that all strategies used for vowel epenthesis – default vowel epenthesis, consonant place assimilation and vowel harmony – can be accounted autosegmentally in terms of two processes: feature insertion and feature spreading. The hierarchy for default vowel epenthesis, repeated below, captures the fact the input consonant preservation is more important than the selection of the most unmarked epenthetic vowel, which is /ɯ/; it accommodates this way the "default" status of /o/ as epenthetic vowel after /t, d, h/, which, if followed by /ɯ/, would be subjected to allophonic variation rules.

(62) Default vowel epenthesis
SYLLSTRUC, *MULTIPLE >> IDENT[PLACE], IDENT[cont] >> DEP(o) >> DEP(ɯ)

The hierarchy for feature spreading in (63) summarizes the individual hierarchies pertaining to local assimilation and vowel harmony, as strategies for vowel epenthesis.

(63) Epenthesis by feature spreading
SYLLSTRUC, *HU >> *LINKAGE(C,V)/dor, *SKIP/obstr[+voi] >> DEP(ɯ) >> *MULTIPLE/phar, *SKIP >> *MULTIPLE, *LINKAGE(C,V)/cor

Tableau (64) presents an overview of all contexts that use feature spreading for vowel epenthesis. *MULTIPLE is ranked low, so that feature spreading is not drastically penalized and, therefore, allowed to surface in outputs. We find in low position, too, the constraint *LINKAGE(C,V)/cor – it militates against spreading between consonants and vowels and, being ranked low, ensures the well formedness of [bɯɾaʃi] as output for English *brush*. *MULTIPLE/phar dominating *MULTIPLE captures the directional effect illustrated by candidate [takiʃi] as output for English *taxi*, where the spreading feature is [CORONAL] (vowel /i/), as opposed to [pharyngeal] (vowel /a/) in the suboptimal candidate *[takaʃi]. The constraint DEP(ɯ) dominates these constraints as predicted by the typology of constraints dominance relationship (see section 3); still, it is dominanted by four constraints that crucially define the well-formedness in terms of syllable structure (SYLLSTRUC), phonotactics (*HU), contexts prohibiting spreading of marked features (*LINKAGE(C,V)/dor for the spreading of [DORSAl]) and contexts prohibiting non-local feature spreading (accross voiced obstruent /g/, expressed by *SKIP/obstr[+voi]).

(64) Hierarchy for feature spreading as strategy for vowel epenthesis in loanwords

input		output	SYLL STRUC	*HU	*LINK (C,V)/ dor	*SKIP/dor [+voi]	DEP (ɯ)	*MULT/ phar	*SKIP	*MULT	*LINK (C,V)/cor
/kra:n/	a.	kraN	*!								
	b. ☞	kaɾaN						*	*/liq		
	c.	kɯɾaN					*!				
	d.	koɾaN			*!						
/tæksɪ/	a.	takʃi	*!								
	b.	takɯʃi					*!				
	c. ☞	takiʃi							*/fric	*/cor	
	d.	takoʃi			*!					*/dor	
	e.	takaʃi						*	*/obstr !		
/wɪg/	a.	ɯig	*!								
	b. ☞	ɯiggɯ					*				
	c.	ɯiggi				*!				*/cor	
	d.	ɯiggo			*!						
/bax/	a.	bah	*!								
	b. ☞	bahha						*	*/lar		
	c.	bahɯ		*!			*				
	d.	baɸɯ					*!				
/brʌʃ/	a. ☞	bɯɾaʃi					*			*/cor	*
	b.	bɯɾaʃɯ					**!				
	c.	braʃ	*!*								
	d.	bɯɾaʃa					*	*!	*/fric		

5 Conclusions

This paper has examined vowel epenthesis in Japanese loanwords on two levels: (i) a corpus-based quantitative survey that showed the share of each epenthetic vowel and the kind of operations used to determine the quality of epenthetic vowels, and (ii) an optimality-theoretic analysis of the processes that account for vowel selection. These processes were defined using the autosegmental operations of feature insertion for default vowel epenthesis, and feature spreading for place assimilation and vowel harmony.

We have shown with quantitative data that, indeed, the default vowel epenthesis is the main process involved in determining the quality of epenthetic vowels. The status of epenthetic vowel /o/ was reconsidered and defined as default epenthetic vowel, confined, however, to certain contexts – after /t, d, h/, where it serve the faithful adaptation of input consonants.

Feature spreading, in both its manifestations – consonant place assimilation and vowel harmony, account for only a minor share of loanwoards in our corpus and occurs rather marginally in contemporary loanword adaptation. Nevertheless, it highlights the fact that loanwords in Japanese are the product of two co-phonologies. Certain contexts vowel epenthesis allow for both default epenthesis and feature spreading, whereas others require default epenthesis only. This observation is congruent with the general tendency of loanword phonology in contemporary Japanese to adopt the epenthesis of default vowels in all phonological contexts.

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