

A Theory of Voicing

Shosuke Haraguchi

Meikai University
Urayasu, JAPAN

1. Introduction

In this paper I aim to develop a theory of voicing and discuss its implication in Optimality Theory (OT). I assume that a variety of voicing processes are divided into two classes, phonological processes and phonetic ones, which are handled by two different components of phonology and phonetics, respectively. I also assume that the universal constraint system of OT governs at the level of phonology only and has no direct relationship with phonetic processes, which are handled by (language-particular) phonetic rules that provide us with instructions for particular phonetic implementation of sound units. To put it differently, major changes in sound structure are restricted in phonology and phonetic changes are minor low-level automatic ones, which are explained by physical manipulations vocal organs.

Based on these assumptions, I will discuss a number of theoretical implications. Especially, I will claim that this framework has a number of implications in Optimality Theory (OT). In fact, it eliminates unnatural or *ad hoc* markedness constraints and theoretical devices and it makes the constraint system of OT more restricted than before. It thus helps us understand sound processes more profoundly. As a concrete example to illustrate this, consider the following optional vowel reduction cases in English.

- (1) a. sentimentality
- b. sentimɲtality
- c. chocolate
- d. choc'late

Kager (1999) attempts to handle this phenomenon by introducing a markedness constraint REDUCE, shown in (2)

- (2) REDUCE:
Vowels lack quality.

and discusses free ranking of this markedness constraint and a faithfulness constraint Ident-IO. He claims that since these two constraints are freely ranked with each other, we can account for the optional reduction of a vowel in (1). However, it seems clear that this phenomenon is a phonetic process and that the reduced versions and non-reduced ones are not freely interchangeable but the reduced ones are used in a certain speech style only, that is, in informal or casual fast speech. In the present framework that distinguishes the component of phonology and that of phonetics, (1a) and (1c) are the outputs of phonology and it will be directly realized as a phonetic form in formal and or careful speech. I assume that English has an optional phonetic rule that applies in informal or casual fast speech and deletes a weak vowel of a word-internal dactylic structure SWW.

- (3) VOWEL WEAKENING:
A weak vowel of a dactylic structure SWW is weakened (=deleted).

Assuming this phonetic rule applies to the output of phonology in a relevant speech style, we have the outputs in (1b) and (1d). Since this phonetic process is dependent on speech style or speed, we can conclude that it should be handled by a phonetic rule. If this is the case, then we can dispense with the unnatural constraint from phonology and reduce the number and kind of possible markedness constraints.

Returning here to the main stream of discussion, voicing processes in general are divided into three classes: (I) voicing processes which turn voiceless consonants into their voiced counterparts, (II) devoicing processes which convert voiced segments (vowels, glides, liquids, nasals, and/or consonants) into their voiceless counterparts, and (III) voicing exchange processes which reverse the voiced sounds to voiceless ones and voiceless sounds to voiced ones (see Alderete 1999 and the references therein). I claim that processes of these three classes are further divided into two: namely phonological processes and phonetic ones.

2. Voicing

Let us begin our discussion with the examination of voicing processes. Voicing is applicable to voiceless consonants only. This is because all other sounds are voiced by nature: voiced consonants, vowels, glides, nasals, and liquids. I will first discuss three phonological voicing processes, namely, *Rendaku* and Assimilative Voicing (or Nasal Obstruent Voicing) in Japanese and *s*-Voicing in English. Then, I will proceed to a phonetic voicing process, namely, Automatic Word-internal Voicing in Tohoku dialects and Makurazaki dialect in Kagoshima Prefecture.

2.1. *Rendaku* Voicing

The first example of voicing is *Rendaku* or Sequential Voicing. This is a well-known voicing process in Japanese that applies to compounds only. As observed by Otsu (1980) and Harguchi (1999) among others, previous studies have shown that

- (4) (a) *Rendaku* applies to compounds only, the second member of which consists of a native Japanese word or a Japanized loan word.
- (b) It conforms to Motoori Norinaga's Law or the so-called Lyman's Law, which is a special case of OCP.
- (c) It does not apply to coordinate structure or Dvandva compounds.
- (d) The second member of a compound is on the right branch.

I will restrict my attention to the fact that this voicing is phonological and that there is no exception to Motoori Norinaga's Law in (4b).

The very fact that this voicing is restricted to a certain syntactic lexical class called compounds suggests that this is a phonological process. In addition to this, it is regulated by a large number of factors, some of which are formalized as phonological constraints. Furthermore, it has a number of exceptions particular to lexical items (e.g., *kata-kana* cf. *hira-gana/ma-gana/manyou-gana* etc.). These observations will be enough to regard this voicing as phonological.

Let us now turn to the examination of the often-claimed exceptions to Lyman's Law or Motoori Norinaga's Law. It is widely believed that there are a few exceptions or counterexamples to this law. Based on Kindaichi's observation, Otsu (1980) cites only four cases: (5), (7a), (8), and (9a_{ii}c).

Consider first the following exception or apparent counterexample to Motoori Norinaga's Law:

- (5) hun-jibaru '(emphasizer)-tie' hun + sibiru Otsu (1980)

Note, however, that this is not a case of *Rendaku* but a case of Nasal-Obstruent Voicing (NOV) or Assimilative Voicing to be discussed later. Thus this example is irrelevant to the law in question. Notice incidentally that the fact that NOV does not conform to Motoori Norinaga's Law but *Rendaku* conforms to the law is accounted for if we assume the following constraint ranking.

- (6) NOV >> Motoori Norinaga's Law >> *Rendaku*

Consider next the examples in (7):

- (7) a. nawa-basigo 'rope-ladder' nawa + hasigo Otsu (1980)
 b. dan-basigo 'stair-ladder' dan + hasigo (a case of NOV)
 c. kyuujo-basigo 'saving-ladder' kyuujo + hasigo

What is remarkable here is that *hasigo* 'ladder' is originally a compound or at least a complex morpheme. This means that the word *hasigo* is allowed to undergo *Rendaku* and to have two voiced obstruents, because the domain of Motoori Norinaga's Law is restricted to a stem or a simplex word:

Consider now the example in (8), which is reported to be a case against Motoori Norinaga's Law:

- (8) rei-degami 'thanks-letter: letter of thanks' < rei + tegami
 Otsu (1980)

However, example (8) is impossible in my and others' judgment and should be excluded from the case of *Rendaku* of Present-day Japanese. (In addition to this, note that *tegami* is a compound formed by *te* 'hand' and *kami* 'paper', which means that even if this example turned out to be acceptable, it is beyond the scope of this law in question. Notice also that example (8) is not acceptable because Left Branch Condition (LBC) blocks the compound word *tegami* from undergoing *Rendaku*. Thus, example (8) is not relevant to the law in question.)

Consider other apparent counterexamples to Motoori Norinaga's Law that are illustrated in (9b), and compare them with the examples in (10).

(9) *X-sabu-roo* and Rendaku (or Assimilative Voicing):

a. Assimilative Voicing:

X = CVN: heavy syllable (=one syllable and two moras):

- (i) a. nin-zabu-roo < nin + sabu-roo
 b. kan-zabu-roo < kan + sabu-roo
 c. sin-zabu-roo < sin + sabu-roo
 d. rin-zabu-roo < rin + sabu-roo
 e. ken-zaburoo < ken + saburoo
- b. *Rendaku*: X = CVV: heavy syllable (=one syllable and two moras):
- (ii) a. dai-zabu-roo < dai + sabu-roo
 b. tyoo-zabu-roo < tyoo + sabu-roo
 c. syoo-zabu-roo < syoo 'correct' + sabu-roo Otsu (1980)
 d. syoo-zabu-roo < syoo 'small' + sabu-roo
 e. soo-zabur-oo < soo + sabu-roo

(10) *X-saburoo* and no *Rendaku*:

X = otherwise:

(i) X = CV: one light syllable (=one mora):

- a. yo-sa^ˈbu-roo < yo + sabu-roo
 b. ko-sa^ˈbu-roo < ko + sabu-roo
 c. ki-sa^ˈbu-roo < ki + sabu-roo
 d. gi-sa^ˈbu-roo < gi + sabu-roo

(ii) X = CVCV: two light syllables (two moras):

- a. tama^ˈ-sabu-roo < tama + sabu-roo
 b. mata^ˈ-sabu-roo < mata + sabu-roo
 c. oto^ˈ-sabu-roo < oto + sabu-roo
 d. tomi^ˈ-sabu-roo < tomi + sabu-roo
 e. hiko^ˈ-sabu-roo < hiko + sabu-roo

(iii) X = CVCVCVY: three light syllables (three moras) or more:

- a. tikara-sa^ˈbu-roo < tikara + sabu-roo
 b. urutoraman-sa^ˈbu-roo < urutoraman + sabu-roo

(where the mark (ˈ) indicates that the syllable preceding the mark is accented.)

As is clear from these examples, the cases that do not undergo voicing are accented, while those that undergo voicing are unaccented. This is a good case which shows that the presence or absence of accent affects *Rendaku*. It seems that these examples in (9b) and (10) suggest that the absence of accent is a necessary condition for *Rendaku*.

It should be emphasized that son's names normally do not undergo *Rendaku*. Taking this observation in mind, consider now the examples in (11).

(11) Sabu-roo 'third-man > the third son's name'

This is derived as illustrated in (12):

(12) Samu-roo > (San-roo) > Sabu-roo 'third-man > the third son's name'

Assuming that *Rendaku* applies at the level of the underlying form *samu-roo*, and assuming also that it applies before changing into *sabu-roo* by denasalization, the words in (9b) are not exceptions or apparent counterexamples to Motoori Norinaga's Law.

Based on these observations so far, we conclude that there is no exception or apparent counterexample to Motoori Norinaga's Law.

Let us now consider the above discussions and their implications for Optimality Theory (OT). It is commonly observed that the markedness constraints usually rank higher than the faithfulness constraints, as illustrated in (13).

(13) Markedness constraints >> Faithfulness constraints (Faith)

Among the markedness constraints are *Rendaku*, Motoori Norinaga's Law, LBC, No Voiced Geminate, etc. Thus, in unmarked cases, these constraints rank higher than the Faithfulness constraints (Faith, in short).

(14) *Rendaku*, Motoori Norinaga's Law, LBC, No Voiced Geminate, etc.
>> Faith

Since the application of *Rendaku* is assumed to be unmarked in compounds and Motoori Norinaga's Law, No Voiced Geminate, and others block its application, the unmarked ranking of these markedness constraints with respect to Faith should be as indicated in (15).

(15) Cases in which Rendaku applies:

Motoori Norinaga's Law, No Voiced Geminate, etc. >> *Rendaku* >> Faith

Most of the compounds whose head consists of native Japanese words and a number of Japanized words of Sino-Japanese origin and foreign loan words are subject to this ranking.

On the other hand, compounds in which *Rendaku* do not apply and all the simplex words have a ranking in which Faith ranks higher than *Rendaku*, as illustrated in (16).

(16) Faith >> *Rendaku*

Mimetics, most of the foreign loans, a large number of Sino-Japanese, and a small number of Yamato words can be analyzed as being subject to this ranking.

As we have seen in Haraguchi (1999), a number of factors such as LBC, coordinate structure, a number of semantic factors, etc. block *Rendaku*. This indicates that these markedness constraints incorporating these factors in an appropriate way rank as high as Motoori Norinaga's Law and rank higher than *Rendaku*. As far as I can check, there seems to be no compelling evidence to determine the relative ranking among all these markedness constraints. Thus, I tentatively conclude that the markedness constraints blocking *Rendaku* have no difference in ranking.

Based on the observations so far we can safely conclude that *Rendaku* Voicing is a phonological process and that there is no exception or apparent counterexample to Motoori Norinaga's Law.

2.2. Assimilative Voicing in Japanese

As Ito and Mester (1986) observed, Nasal Obstruent Voicing (NOV) normally applies to Yamato or native Japanese words. Notice, however, that this process is also applicable to a number of borrowed words on condition that they are fully Japanized.

As illustrated in (17), NOV applies to simplex Yamato words.

(17) (i) Yamato:

- | | | | | |
|----|--------|-------------|-----|---------|
| a. | tombo | 'dragonfly' | cf. | *tompo |
| b. | unzari | 'disgusted' | | *unsari |

- c. kangae 'thought' *kankae
- (ii) Yamato's Verbal Inflection:
- d. yon-da 'read-Past' < yom-ta *yon-ta
- e. sin-de 'die-Preverbal' < sin-te *sin-te

Thus there is no word containing a nasal-voiceless obstruent sequence with some exceptional cases. In addition to *Rendaku*, what is called Nasal Obstruent Voicing (NOV) by Ito et al. (1995) is another voicing process. These two are similar in their functions in that both of them are voicing processes. However, there are a number of differences between Nasal Obstruent Voicing (NOV) and *Rendaku*.

Let me cite just one difference between the two. They are different in that *Rendaku* is restricted to apply to compounds only while NOV applies to other cases as well, such as verbal inflections, as well as to some compounds.

NOV is said to be due to a constraint *NT, which bans the voiceless obstruent immediately following a nasal:

- (18) *NT (=Nasal Obstruent Voicing (NOV)):
Post-nasal obstruents must be voiced in Yamato.

Kager (1999: 61ff) states this constraint in a more general way:

- (19) *NC̥:
No nasal plus voiceless obstruent sequences.

NOV is regarded as one of the typologies of *NC̥ effects listed in (20).

- (20) A typology of *NC̥ effects
- | | | | |
|----|--------------------|----------------------------|---------------------------------------|
| a. | Nasal substitution | *NC̥ >> Linearity-IO | 'No coalescence' |
| b. | Nasal deletion | *NC̥ >> Max-IO | 'No deletion' |
| c. | Vowel epenthesis | *NC̥ >> Dep-IO | 'No epenthesis' |
| d. | Post-nasal voicing | *NC̥ >> Idnet-IO(ObsVoice) | 'No obstruent voicing' (<i>sic</i>) |
| e. | Denasalization | *NC̥ >> Ident-IO(nasal) | 'No denasalization' |

Japanese is classified as a case of (20d), i.e., post-nasal voicing.

This constraint does not hold in Sino-Japanese, Mimetic, and Foreign. (Ito and Mester 1993: 3, Ohono no date: 2). Thus consider the following examples:

- (21) (i) Sino-Japanese:
- | | | | | |
|----|---------|--------------------|---------|--------------|
| a. | Kan-too | 'Kanto (District)' | kan-doo | 'impression' |
| b. | kan-poo | 'Chinese medicine' | kan-boo | 'cold' |
| c. | kan-koo | 'sight seeing' | kan-goo | 'gynander' |
- (ii) Mimetic and/or Foreign:
- | | | |
|----|-------------|---------------------------|
| d. | kin-kon-kan | '(sound of a bell)' |
| e. | pin-pon | 'Ping-Pong: table tennis' |
| f. | tempura | 'tempura' |

Native Japanese words in (17) do not permit the Nasal-Voiceless Obstruent sequence, while Sino-Japanese, Mimetic, and Foreign words in (21) all tolerate the Nasal-Voiceless Obstruent sequence.

Second, NOV is, for example, applicable to the result of High Vowel Deletion, as illustrated in (22).

- (22) a. tukueru 'attach'
- b. humi-tukueru (踏みつける) 'stump + attach: '
- c. hun-zukueru (踏んづける) '(=b)'

Rendaku is not applicable to the compound in (22b), but NOV is applicable to (22c).

Note that there are a number of exceptions that are not subject to this voicing (NOV). The examples in (23), (24), and (25) are either complex words or compounds and these examples are relatively newly coined words. Taking these into consideration, we can say that these examples pose no problem to my proposal.

- (23) a. patin-ko 'pachinko (a game)'
- b. han-ko 'seal'
- c. mizin-ko 'water flea (a name of a pulankton)'
- d. gatin-ko '(a sound of crashing)'
- e. katin-ko '(a sound signalling the start of action)'
- f. doron-ko 'muddy'
- (24) a. an-pan 'anko + bread (bread containing anko)'

- b. udon-ko 'noodle + flour (flour for making noodles)
- c. tin-po 'penis'
- d. un-ko 'stools'

(25) tenpura 'tempura (originally from Portuguese)'

On the other hand, those in (26) are apparent counterexamples or exceptions to Nasal Obstruent Voicing:

- (26) a. anta 'you' (< anata)
- b. nante 'how' (< nani + te) *nanite
- c. nantoka 'somehow' (<nani + to + ka) *nanitoka
- d. nanka 'such a thing as (< nani-ka (postpositional particle))'
- e. nante 'such a thing as (< nani-te (postpositional particle))'

(Ohono no date: 3)

However, these also pose no problem to the voicing process in question. What we need is just to assume that these are derived at the level of post-lexical stratum or at least ordered after the level of Nasal Obstruent Voicing. This will account for the reason why these words are not affected by the voicing process in question.

Notice incidentally that Nasal Obstruent Voicing is not quite right. It should be named Voicing Assimilation to the Adjacent Voiced Consonant (Assimilative Voicing for short). This is because this type of voicing is not restricted to Nasal Obstruent Voicing, but it is applicable to a voiced consonant and an obstruent which are adjacent to each other, as illustrated in (27).

(27)		Underlying Form		Surface Form	
a.	/b/	tob-ta	>	ton-da	'fly-Past'
b.	/d/ and /z/			Accidental Gap	
c.	/g/	kog-ta	>	ko-i-da ¹	'row-Past'
cf.	/k/	kok-ta	>	ko-i-ta	'fart-Past'
d.	/m/	yom-ta	>	yon-da	'read-Past'
e.	/n/	sin-ta	>	sin-da	'die-Past'

Voicing of an obstruent is not restricted to post nasal position, but it is applicable after the Voiced Consonant position.

2.3. *s*-Voicing in English

Chomsky-Halle (1968) among others discusses an *s*-voicing process in English, based on the following examples. This process is formalized as a rule in (29) that voices [s] in medial position:

- (28) a. resume, resist, resident, resemble, resolve, design, presume, gymnasium, magnesium, cesium, music, rosary, miser, Cartesian, Asia, usual, residue, preserve, deserve, resign, etc.
 b. assist, assemble, assign, assume potassium, etc.
 c. basic, isolate, masonite, gruesome, awesome, etc.
 cf. consist, consign, consume, conserve, insist, misogynist, asylum, parasite, philosophy, metasoma, persist, etc.
- (29) $s \rightarrow$ $[+voice] / V = _V$ (SPE, pp.47, 95, 228)
 $[V, +tense]_V$
 Vk_V

Chomsky and Halle (1968) include examples in (30) as a case of *s*-Voicing.

- (30) a. exist, examine, auxiliary, exasperate, etc.
 b. axis, toxicity, hexameter, annexation, etc.

Since this voicing has a number of exceptions and partly dependent on stress, it should be clear that this voicing is a phonological process. It goes without saying that we need to rethink this process systematically, but I will not be concerned with detailed discussion here because of the shortage of time and space.

2.4. Automatic Word-internal Voicing

Let us now turn to an example of phonetic voicing. It is what we call Automatic Word-internal Voicing. This voicing is found in a number of Tohoku dialects and Makurazaki dialect in Kagoshima.

- (31) Tohoku dialects:
 a. edo < ito 'string'
 b. hadaragu < hataraku 'to work'

- c. kigu < kigu 'listen, hear'

(32) Makurazaki dialect in Kagoshima Prefecture:

- a. Magurazat < Makurazaki '(Place name)'
 b. kada < kata 'shoulder'

Note that this phonetic process applies automatically to word-internal obstruents. Thus it is clearly a phonetic process.

Based on the discussions so far, we can say that whether a process is interpreted as phonological or phonetic is based on the following guidelines:

- (33) a. Phonological processes are lexically. In other words, they are restricted to certain classes of words and have some exceptions. They conform to universal constraints of OT.
 b. Phonetic processes are automatic and they usually have no exceptions. They tend to be affected to the style and/or the speed of speech. They are basically outside of the domain of the universal constraints of OT.

3. Devoicing

Let us now turn to a number of devoicing processes. Devoicing can apply to voiced sounds only. As illustrative examples of phonological voicing, I will discuss a devoicing process in Japanese: Devoicing due to a Constraint of No Voiced Geminate (*VV). Then as examples of phonetic devoicing, I will survey optional Devoicing of Foreign Words, High Vowel Devoicing in Japanese, Word-final Devoicing in German and Dutch, and Liquid Devoicing in English.

3.1. Devoicing due to a Constraint of No Voiced Geminate (*VV)

I will first discuss devoicing due to a constraint No Voiced Geminate (*VV). Consider for example the following examples:

- (1) a. daru-i 'sluggish, exhausted, heavy'

- | | | | | | | | |
|-----|----|----------------|--------------------|---|-------|---|-------------------|
| | b. | ke-daru-i | 'sluggish' | < | ke | + | daru-i |
| | | | | | | | 'feeling' |
| | c. | ma-daru-i | 'slow' | < | ma | + | daru-i |
| | | | | | | | 'timing' |
| | d. | hi-daru-i | /sluggish/ | < | hi | + | daru-i |
| | | | | | | | 'hungry' 'spleen' |
| (2) | a. | kat-taru-i | 'sluggish' | < | kat | + | daru-i |
| | | | | | | | '(prefix)' |
| | b. | sita(t)-taru-i | 'lispings, cooing' | < | sita | + | daru-i |
| | | | | | | | 'tongue' |
| | c. | amat-taru-i | 'cooing' | < | ama-i | + | daru-i |
| | | | | | | | 'sweet' |

It is clear that the underlying form of *daru-i* is /daru-i/ with the initial voiced apical consonant /d/. A careful examination of the examples in (2) shows that the devoicing process under consideration is caused by gemination.

Note that native Japanese words do not permit voiced geminates, as will be discussed below. This is due to the constraint in (3), which works for all the cases except foreign loan words.

- (3) No Voiced Geminate (*VV):
Voiced geminates are prohibited.

$$* \text{C C}$$

$$\vee$$

$$[+\text{voice}]$$

The word *sita-taru-i* (< *sita-darui*) in (2b) can be interpreted as a variant form of *sitat-taru-i*. The latter is derived by subsequent Degemination, which applies optionally to the form with a geminate.

Since the existence of the markedness constraint No Voiced Geminate is already established firmly by Japanese linguists and this devoicing is governed by this constraint, we can safely conclude that the devoicing in question is a phonological process.

3.2. Optional Devoicing of Foreign Words:

Let us now turn to phonetic devoicing processes. Loan words in Japanese are permitted to have two (or more) consonants in a simplex word and they tolerate voiced geminates as well, as illustrated in (4)-(7). However, voiced geminates sometimes undergo devoicing optionally as in (4). This devoicing is restricted to [+stop] consonants or obstruents and it is blocked in the case of continuant [zz] as indicated in (5). Devoicing is also blocked in the cases of (6) and (7).

- | | | | | |
|-----|----|-----------------|----------|------------------|
| (4) | a. | beddo, betto | ‘bed’ | |
| | b. | doggu, dokku | ‘dog’ | |
| | c. | biggu, bikku | ‘big’ | |
| | d. | badʒi, batʃi | ‘badge’ | |
| | e. | budda, butta | ‘Buddha’ | |
| | | | | |
| (5) | a. | jazzi, ?*jattʃi | ‘judge’ | |
| | b. | dazzi, ?*dattʃi | ‘Dudge’ | |
| | c. | guzzu, ?*guttʃu | ‘goods’ | |
| | | | | |
| (6) | a. | eggu, *ekku | ‘egg’ | |
| | b. | kyabbu, *kyappu | ‘cab’ | cf. kyappu ‘cap’ |
| | c. | kiddo, *kitto | ‘kid’ | |
| | | | | |
| (7) | a. | giga, *gika | ‘giga-’ | |
| | b. | gyagu, *gyaku | ‘gag’ | |
| | c. | bagu, *baku | ‘bug’ | |

The examples in (6) have a voiced geminate only and have no other voiced consonants in a word. On the other hand, the examples in (7) have two voiced consonants, but have no voiced geminate. Both of them do not undergo devoicing

This observation suggests that devoicing is permitted if the word contains a voiced consonant and a voiced [+stop] geminate. To put it differently, devoicing is possible if a word violates both No Voiced Geminate and Motoori Norinaga’s Law (or the so-called Lyman’s Law).

- (8) No Voiced Geminate (*VV):
Voiced geminates are prohibited.

* C C
 ∨
 [+voice]

- (9) Motoori Norinaga's Law (or Lyman's Law):
A simplex word can have at most one voiced obstruent.

No Voiced Geminate governs native Japanese words, Sino-Japanese, and mimetics with the sole exception of foreign loan words. It thus excludes the words containing a voiced geminate in a number of Japanese dialects, as illustrated in (10).

- | | | | | |
|------|----|--------|--------------------------------|---------|
| (10) | a. | ip-pon | ‘one (long) piece’ | *ib-bon |
| | b. | kappa | ‘Kappa: an imaginary creature’ | *kabba |
| | c. | kak-ka | ‘Your Highness’ | *kag-ga |
| | d. | tossa | ‘off-hand’ | *tozza |

Motoori Norinaga's Law, which is a version of OCP, blocks a simplex native word to have two or more voiced obstruents. Observe the examples in (11).

- | | | | | | | |
|------|----|--------|------------|---------|-----------|-------|
| (11) | a. | tabi | ‘travel’ | *dabi | | |
| | b. | gyaku | ‘opposite’ | *gyagu | cf. gyagu | ‘gag’ |
| | c. | kuzira | ‘whale’ | *guzira | | |
| | d. | tubu | ‘grain’ | *dubu | | |
| | e. | kugi | ‘nail’ | *gugi | | |

However, loan words permit two or more obstruents in a simplex word as illustrated above. Ito and Mester (1998) propose that this constraint is formalized as self-conjunction of Voiced Obstruent Prohibition (VOP)

- (12) VOP:
*[+voice, -son]

If we apply self-conjunction to VOP, we will have [VOP & VOP], which is represented as VOP2.

(13) VOP2:

No co-occurrence of voiced obstruency with itself.

Note that the conjunction of the two constraints of *VV and VOP2 makes it possible to apply the devoicing process under consideration optionally to loan words. This suggests that these phonological constraints cooperate to bring about devoicing of the geminate phonetically. Note that this devoicing applies automatically if we are not so careful enough to pronounce the words, which suggests that this is not a phonological process but a phonetic process.

Note incidentally that some dialects in Kagoshima and Yakushima permit voiced geminates, as illustrated by the following examples:

(14) Onoaida (尾の間) dialect in Yakushima (屋久島):

- | | | | |
|----|---------|---------|------------|
| a. | kuddyaa | ‘whale’ | (< kuzira) |
| b. | abba | ‘oil’ | (< abura) |

(15) Kagoshima Japanese (鹿児島, Nobuko Kibe, personal communication):

- | | | | |
|----|-------|-------------------|--------------|
| a. | iggo | ‘strawberry’ | (< itigo) |
| b. | maggo | ‘make a mistake’ | (< matiga-u) |
| c. | Madda | ‘(Personal name)’ | (< Matu-da) |
| d. | yabba | ‘town hall’ | (< yaku-ba) |
| e. | teddo | ‘railroad’ | (< tetu-dou) |

These facts suggest that in these dialects the ranking of *VV and Faith is reversed to that in other Japanese:

(16) Faith >> *VV

The difference in ranking of markedness constraints and Faithfulness constraints can handle the dialectal differences in Japanese dialects.

We have seen that a phonetic devoicing is indirectly affected by a conjunction of *VV and Motoori Norinaga’s Law.

3.3. High Vowel Devoicing

High vowels in Tokyo Japanese or more generally dialects of the Kanto District

and others undergo devoicing when they are surrounded by voiceless consonants or preceded by a voiceless consonant and followed by a pause. (Haraguchi 1977, 1982)

(1) High Vowel Devoicing (HVD):

/i,u/ → [-voice] / [-voice, C] _____ ([-voice, C] X)##

This is a phonetic assimilatory process and some linguists claim that the application of the process is dependent on the presence or absence of accent in some dialects or speakers. However, this claim that the devoicing is dependent on accent is not quite accurate, taking into consideration Akinaga's explanation in NHK's Accent Dictionary.

In this relation, it is sometimes claimed that accent shifts due to High Vowel Devoicing. To illustrate this, consider the following example.

- (2) a. aká-i 'red'
 b. aká-kat-tta 'was red'
- (3) a. tanosí-i 'fun, merry'
 b. tanós̄i-kat-ta 'was fun, was merry'

In the example of (3b), it is commonly said that accent shifts to the left because of HVD. However, this observation is not quite correct in that there are a number of examples that do not move accent when HVD works. To see this, consider the cases in (4):

- (4) a. p̄íku- p̄iku ~ p̄ikú- p̄iku 'twitching sound'
 H L L H L
- b. s̄íku- s̄iku ~ s̄ikú- s̄iku 'weep quietly'
 H L L H L
- c. Nagasakí-ken ~ Nagasák̄i-ken 'Nagasaki Prefecture'
 L H H H L L L H H L L
- d. Ibarakí-ken ~ Ibarák̄i-ken 'Ibaraki Prefecture'
 L H H H L L L H H L L
- e. sentakú-ki ~ senták̄u-ki 'washing machine'
 L H H H L L H H L

These examples clearly show accent does not necessarily move when a high vowel is devoiced. The apparent accent shift in (3) can be interpreted as a result of the H tone loss on the voiceless syllable *si*, as illustrated in (5).

- (5) *tanos̥i*-kat-ta
 LH L L

In this example, it looks as if accent was moved one syllable to the left because of the loss of the H-tone on the third syllable *si* as a result of devoicing. However, we can account for this apparent shift of stress in terms of tonal shape. Thus, we can conclude that we have no accent shift in this and other similar cases. This suggests that accent shift, which is a phonological process, does not apply to the result of the phonetic process of HVD. The output tonal shape of tonal delinking and/or subsequent linking and other processes makes us interpret the word to have undergone accent shift. This is exactly what the present theory predicts, regarding the distinction between phonology and phonetics.

3.4. Word-final Devoicing in German and Dutch

It is widely known that the word-final obstruent is devoiced as illustrated in (1). (Kiparsky 19xx)

This process is called as Coda Devoicing by Ito and Mester (1999, 2001):

- (6)
- | | | | | | |
|----------|--------|--------------|-----|---------|-----------|
| /ta:g/ | ta:k | ‘day’ | cf. | təgə | ‘days’ |
| /li:b/ | li:p | ‘dear’ | cf. | li:bən | ‘to love’ |
| /moti:v/ | moti:f | ‘motive’ | cf. | moti:və | ‘motives’ |
| /le:z/ | li:s | ‘read (IMP)’ | cf. | le:zən | ‘to read’ |

To handle this, Kager for example proposes that German and Dutch rank the following constraint higher than the faithfulness constraint.

- (7) ***Voiced-Coda:**
 Coda obstruents are voiceless.
 Kager (1999: 40)

My claim is that this devoicing is a phonetic process and the constraint or rule (7) is a phonetic one that applies to word-final consonants only. This means that if a language has this rule, it always applies to the word-final obstruents. If this way of thinking is correct, we can dispense with the unnatural makedness constraint in (7) and make the constraint system of OT simpler.

3.5. Liquid Devoicing in English

Let us now turn to the final example of phonetic devoicing. It is well known that liquids in English undergo devoicing by assimilation. Thus the liquids /l, r/ is devoiced by the preceding voiceless consonant.

- (8) a. clear [k^hliər]
 b. trick [t^hri:k]

I should be clear that this process is purely phonetic in nature and it should be handled by a phonetic instruction in (9).

- (9) Assimilative Liquid Devoicing (ALD):
 Liquids become voiceless by assimilation to the preceding consonant.

This rule applies to the output of phonological component and turn it to its phonetic counterpart.

4. Voicing Exchange:

As a final class of Voicing, let us now discuss what is called Voicing Exchange. Alderete notes that "the voicing exchange found in the Nilotic language Luo, where the [voice] specification for the stem-final obstruent in the singular is reversed in the corresponding plural." Alderete (1999: 7). To illustrate, consider the following examples cited from Alderete (1999).

- (10) Voicing Exchange in Luo (Gregerson 1972, Okoth-Okombo 1982)

	Singular	Plural	
a.	bat	bed-e	'arm'
	reč	reǰ-e	'fish'
b.	čogo	čok-e	'bone'
	luedo	luet-e	'hand'

To handle this type of voicing Exchange, Alderete (1999: 7) proposes a new type of constraint, Anti-Faithfulness (\neg Faith(voice)), which requires a change of the [voice] specification of the stem-final obstruent. He asserts that "the ranking of this constraint above its related Faithfulness constraint describes the full rotation of the feature observed in Luo."

(11) Voicing Exchange in Luo as Anti-Faithfulness

Input	Output	–Faith(voice)	Faith(voice)
a. /bat/ ⇒	be[d]-e		*
	be[t]-e	*!	
b. /luedo/ ⇒	lue[t]-e		*
	lue[d]-e	*!	

This voicing exchange phenomenon is clearly lexically dependent and thus it should be phonological in nature.

As far as I can see, there seems to no phonetic voicing exchange process in natural language. At least, there is no report to show that there is a phonetic voicing exchange process. I suggest that there exist no such phonetic process in natural language for some reasons unclear to me at present.

It seems that voicing exchange processes are rather restricted in number, and both voicing and devoicing processes are more common. I assert that the latter classes stem from assimilation (or dissimilation). Between these two, it is widely known that assimilation is more natural than dissimilation. In fact, there seems to be no voicing or devoicing process by dissimilation

5. Conclusive Remarks

To summarize briefly, we have seen that the framework of PF should be divided into two components as indicated in (12):

(12)	Phonology	Phonetics
a.	lexical (and some post-lexical) processes	Most post-lexical processes Automatic and dependent on the style and/or speed of speech
b.	Violable constraints	Phonetic instructions

- | | | |
|----|------------------------------|-------------------------|
| | of OT | No radical change |
| c. | permit (apparent) exceptions | No (apparent) exception |

I have shown that various voicing, devoicing and voicing exchange processes of Japanese and other languages are divided into phonological processes and phonetic ones, and that each of them should be handled by different systems. The phonological processes conform to the system of violable constraints of OT but phonetic processes do not conform to them. Phonetic processes are captured as instructions on phonetic implementation of the phonological output.

Finally, I conclude that this conception of phonological and phonetic systems makes each system more concise and natural, and leads us to a deeper understanding of the sound structure of natural languages.

References

- Alderete, John D. (1999) *Morphologically Governed Accent in Optimality Theory*. Ph.D. dissertation, University of Massachusetts at Amherst.
- Chomsky, Noam and Morris Halle (1968) *The Sound Pattern of English*. New York: Harper and Row.
- Fukazawa, Haruka and Mafuyu Kitahara (2001) "Domain-Relative Faithfulness and the OCP: Rendaku Revisited," in Jeroen van de Weijer and Tetsuo Nishihara (eds.) *Issues in Japanese Phonology and Morphology*. Berlin: Mouton de Gruyter.
- Haraguchi, Shosuke (1977) *The Tone Pattern of Japanese: An Autosegmental Theory of Tonology*. Tokyo: Kaitakusha.
- Haraguchi, Shosuke (2000) "On *Rendaku* or Sequential Voicing in Japanese," presented at LP2000, Charles University, Prague. August 21st, 2000.
- Haraguchi, Shosuke (2001) "On *Rendaku*," *On'in Kenkyu (Journal of the Phonological Society of Japan)*. 4, 9-32.
- Ito, Junko and Armin Mester (1986) "The Phonology of Voicing in Japanese: Theoretical Consequences for Morphological Accessibility," *Linguistic Inquiry* 17, 49-73.
- Ito, Junko and Armin Mester (1993)
- Ito, Junko and Armin Mester (1995) "Japanese Phonology," in John Goldsmith (ed.) *The Handbook of Phonological Theory*. 817-38. Cambridge, MA: Basil Blackwell.

- Ito, Junko and Armin Mester (1998) "Markedness and Word Structure: OCP Effects in Japanese," ms. University of California, Santa Cruz. [ROA-255-0498].
- Ito, Junko and Armin Mester (1999) "The Phonological Lexicon," in Tstsuko Tsujimura (ed.) *The Handbook of Japanese Linguistics*. Oxford: Blackwell.
- Ito, Junko, Armin Mester and Jaye Padgett (1995) "Licensing and Underspecification in Optimality Theory," *Linguistic Inquiry* 26:4, 571-613.
- Kager, Rune (1999) *Optimality Theory*. Cambridge: Cambridge University Press.
- Kiparsky, Paul (19xx)
- Ohno, Sachiko (no date) "Synchronically Unified Ranking and Distribution of Voice in Japanese," ms., University of Arizona.
- Otsu, Yukio (1980) "Some Aspects of Rendaku in Japanese and Related Problems," Yukio Otsu and Ann Farmer (eds.) *MIT Working Papers in Linguistics: Theoretical Issues in Japanese Linguistics*. 2, 207-227.
- Vance, Timothy J. (1979) *Nonsense-word Experiments in Phonology and Their Application to Rendaku in Japanese*. Doctoral dissertation, University of Chicago.
- Vance, Timothy J. (1980) "Comments on "Some Aspects of Rendaku in Japanese and Related Problems"," Yukio Otsu and Ann Farmer (eds.) *MIT Working Papers in Linguistics: Theoretical Issues in Japanese Linguistics*. 2, 229-236.