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THE REALIZATION OF [r] IN ENGLISH-BASED LOANWORDS IN JAPANESE
— AN OPTIMALITY-THEORETIC ANALYSIS —

By

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ABSTRACT

THE REALIZATION OF [r] IN ENGLISH-BASED LOANWORDS IN JAPANESE
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The present study is a study of Japanese loanword phonology, and explores the realization of [r] in English-based loanwords in Japanese within the framework of Optimality Theory (Prince and Smolensky 1993).

The major findings of this study are summarized as follows.

First, English-based loanwords with [r] can be categorized into five groups with regard to the realization of the [r] in the output.

Second, we need to distinguish the Perceptual Level from the input, as in Silverman's (1992) model. English onset [r] and coda [r] in the input are perceived differently at the Perceptual Level: onset [r] as [r] and coda [r] as [a].

Third, we need three constraint rankings to account for the realization of [r] in English-based loanwords in Japanese. The three constraint rankings are distinguished with regard to the rankings between the two constraints **[a:]* and *Max-IO*. This supports the claim that 'Loanword', one of the four categories in Japanese lexicon, consists of co-phonologies.

Finally, constraint ranking for 'loanword' has been changing over time. This claim is based on the fact that one of the three ranking applies to the old loanwords, one of them to the new loanwords, and one of them to some of the old and new loanwords with a heavy penultimate syllable in Japanese outputs.

to YOKO

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1. INTRODUCTION

Japanese loanword phonology is one of the well-studied areas in Japanese phonology. Although it has been studied for a long time, aspects of study of this area have been limited to a few phenomena: accent (Suzuki 1995, Kubozono 1994, Kitahara 1996), consonant gemination (Ohye 1967, Ono 1991, Tsuchida 1995), and epenthetic vowels (Lovins 1975, Ohso 1991, Kobayashi et al 1991). This fact means that many phenomena related to loanwords in Japanese remain unsolved, despite the fact that most of the new words that have recently been brought into the Japanese lexicon are loanwords, especially American English loanwords (Kay 1995).

The present study will explore one of the little-studied areas in Japanese loanword phonology, namely the realization of [r] in English-based loanwords in Japanese, in the framework of Optimality Theory.

The major findings of this study will be as follows. First, English-based loanwords with [r] can be categorized into five groups with regard to the realization of the [r] in the output. Second, we need to distinguish the Perceptual Level from the input, and English onset [r] and coda [r] in the input are perceived as [r] and [a] at the Perceptual Level. Third, we need three constraint rankings to account for them. 'Loanword' consists of co-phonologies. Finally, constraint ranking for 'loanword' has been changing over time.

1.1. Introduction to Japanese Loanwords

In this section, we will define terminology relevant to this work and give background information on loanwords in Japanese.

1.1.1. Definition of 'Loanword'

'Loanword' is one of the four main categories in Japanese lexicon along with native Japanese words (*Yamato*), Sino-Japanese words, and mimetic words. Phonological structural restrictions or rules, such as the restrictions or rules against long vowels, geminates, syllable patterns, or sequential voicing (*Rendaku*), apply to each of the categories differently. Each of the categories is defined as follows (Itô and Mester 1995, Tsujimura 1996 among others):

(1) The Definition of the Four Categories

a. Native Japanese (*Yamato*)

'Yamato' is the category of words that are originally Japanese.

b. Sino-Japanese

'Sino-Japanese' is the category of words that are of Chinese origin.

c. Loanword

'Loanword' is the category of words borrowed from foreign languages, except Chinese. Furthermore, most of them are from western languages, especially from English.

d. Mimetic

'Mimetic' words consist of two subcategories. One of them is onomatopoeia: words that are formed by imitating sounds, for example, words depicting animal sounds. The other is ideophones, which is more abstract. Examples of this subcategory are words like *beto-beto* 'sticky', *zara-zara* 'coarse', and *sara-sara* 'rustle'.

We follow this categorization, which means that the category 'loanword' in this work does not include the words borrowed from Chinese.

1.1.2. Types of Loanwords

The history of loanwords in Japanese started in the sixteenth century (Kay 1995: 67), and numerous words from various languages have been brought into Japanese.[1] Main source languages are Portuguese, Dutch, German, French, and American English. Among them, American English is the most powerful source language after World War II (Kay 1995). In the present study, therefore, I will analyze only American English-based loanwords in Japanese.

English-based loanwords in Japanese can be categorized into four groups. The first group is the group consisting only of acronyms and we will label this type as 'acronym loanword'. Loanwords belonging to this group are used only in English abbreviated forms, or acronyms. That is, they are written in alphabet even in Japanese. Examples belonging to this category are given in (2).

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[1] Kojien (Shimmura 1991), one of the most authentic Japanese dictionaries, contains about 220,000 words including common loanwords, and Horiuchi (1996: 3) says that there are much more than 50,000 loanwords in Japanese.

(2) Acronym Loanwords

a. EU	[i:yu:]	'European Union'
b. PR	[pi:a:ɾu]	'public relation'
c. NG	[enuʲi:]	'no good'
d. AI	[e:ai]	'artificial intelligence'

'Full loanword' is the second group. *Katakana* is one of the three syllabaries in Japanese, *hiragana*, *katakana*, and *kanji*, and it is mostly used for loanwords. Loanwords included in this type are never abbreviated and they are always written in *katakana*. Some examples of this group are shown in (3).

(3) Full Loanwords

a. [ɾaʲio]	'radio'
b. [biʲinesu]	'business'
c. [o:buɴ]	'oven'
d. [ʲadᶻu]	'jazz'

The third category is loanwords that are used only in abbreviated forms, which is the property of this type. Long loanwords tend to be abbreviated. Most of them are used in both abbreviated and non-abbreviated forms, but some of them are used only in abbreviated form. The only difference between the loanwords of this group and of 'full loanword' is that those belonging to this category are used only in abbreviated forms whereas the loanwords belonging to 'full loanword' are not. Moreover, loanwords of this

group and 'acronym loanwords' are different in the ways they are abbreviated: the abbreviated forms of the loanwords of this type are written in *katakana*, while the 'abbreviated acronym loanwords' are alphabetically abbreviated. Examples of this are given in (4). (See Itô (1990) for the analysis of loanword abbreviations.)

(4) Abbreviated Loanwords

a. [sukebo:]	'skateboard'	(*[suke:tobo:do])
b. [denomi]	'denomination'	(*[denomine:šon])
c. [konte]	'continuity'	(*[kontinyu:iti])
d. [kompe]	'competition'	(*[kompetišon])

The fourth group of loanwords is 'compound loanwords'. Some loanwords can be compounded with a native Japanese, a Sino-Japanese, or another loanword, and the resulting compounded words are usually used in abbreviated form. Examples of this group are shown in (5).

(5) Compound Loanwords

Native Japanese + Loanword	
a. [čibiti:]	([**čibi**] 'small' + [**ti:**šat^{s}u] 'T-shirt')
b. [dekarake]	([**deka**i] 'big' + [ɾ**ake**tto] 'racket')

Sino-Japanese + Loanword

c. [kintore] ([**kinniku**] 'muscle' + [**tore**:ningu] 'training')

d. [rošiago] ([**rošia**] 'Russia' + [**go**] 'language')

Loanword + Loanword

e. [zenekon] ([**zeneraru**] 'general' + [**kon**torakuta:] 'contractor')

f. [dejikame] ([**dejitaru**] 'digital' + [**kame**ra] 'camera')

Hereafter, the data we will use in this work are only full loanwords, and we will analyze them in the framework of Optimality Theory.

1.2. Adjustments Observed in English Loanwords in Japanese

In this subsection, we will present the adjustments that take place in borrowing English words into Japanese. Before that, however, let us introduce the Japanese phonetic inventory.

1.2.1. Japanese Phonetic Inventory

First, the following is the chart of Japanese consonants. The following is the revised chart of Tsujimura (1996: 16). (See also Block (1950: 107).)

(6) Japanese Consonants

	bilabial	alveolar	alveo-palatal	palatal	velar	uvular	glottal
Stops: [+V]	b	d			g		ʔ
[-V]	p	t			k		
Fricatives [+V]		z	ž[2]				
[-V]	ɸ	s	š	ç			h
Affricates: [+V]		d^z	ǰ				
[-V]		t^s	č				
Approximants:							
Liquid [+V]		ɾ					
Glide [+V]				y	w		
Nasals: [+V]	m	n	ň[3]	ɲ[3]	ŋ	N	

[2] Tsujimura (1996: 19) points out that "some native speakers seem to have [ž] in rapid speech." Bloch (1950) discusses this sound in more detail. Block (1950: 101) argues that "Most phrases containing [ž] are paralleled by otherwise identical synonymous phrases containing [dž] instead; [ž] is less common than [dž], and in the speech of many persons does not occur at all. Examples: [mižíkái] *short*, [nížuu] *twenty*, [sǎn·žuu] *thirty*." Furthermore, Block (1950: 109) mentions that "In three pairs of phones—[g, ŋ],[*g*, *ŋ*],[dž, ž]—the members are in partially free variation with each other, but must nevertheless be kept apart." "Since the alternation between [g, *g*, dž] and [ŋ, *ŋ*, ž] respectively are limited to certain phrases only, and since their common environments do not form a phonetically or phonemically definable set, the three pairs of phones must be treated separately in the phonemic analysis." Block (1950) distinguishes mediovelar and prevelar. The symbols [g] and [ŋ] above indicate mediovelar stop and nasal, whereas [*g*] and [*ŋ*] are prevelar stop and nasal.

[3] As regards to [ň] and [ɲ], Tsujimura (1996: 20) states as following:

"The coarticulation involving the nasal consonants can also be observed before alveo-palatal and palatal consonants. In these situations, the nasal is realized as alveo-palatal nasal [ň] and palatal nasal [ɲ], respectively. Examples include *ken zya* (*nai*) [keň ǰa (nai)] 'it is not a ticket' and *ken ya* (*kane*) [keɲ ya (kane)] 'things like ticket and (money)'."

Among the consonant segments given in (6), Japanese phonemes are /b/, /p/, /d/, /t/, /g/, /k/, /z/, /s/, /h/, /ɾ/, /y/, /w/, /m/, and /n/, and the others are allophones[4]. The distribution of the allophones of each phoneme is shown in (7) (Tsujimura 1996: 29-40, Block 1950).

(7) Consonant Phonemes and Allophones in Japanese

Phoneme	Allophones	
/b/	[b]	
/p/	[ʔ][5]	
	[p]	
/d/	[ǰ]	before /i/
	[d^z]	before /ɯ/
	[ž][2]	before /ɯ/ (in rapid speech)
	[d]	elsewhere
/t/	[č]	before /i/
	[t^s]	before /ɯ/
	[ʔ][5]	
	[t]	elsewhere
/g/	[g]	
/k/	[ʔ][5]	
	[k]	

[4] [m] is a phoneme, but it can also appear as an allophone of /n/. See (7) for the detail.

[5] Block (1950: 107) describes that 'the assignment of [ʔ] to the same phoneme with [p] or [t] or [k] would be wholly arbitrary'.

/z/	[ʒ̃]	before /i/
	[d^z]	before /ɯ/
	[ž][2]	before /ɯ/ (in rapid speech)
	[z]	elsewhere
/s/	[š]	before /i/
	[s]	elsewhere
/h/	[ç]	before /i/
	[ɸ]	before /ɯ/
	[h]	elsewhere
/ɾ/	[ɾ]	
/y/	[y]	
/w/	[w]	
/m/	[m]	
/n/	[m]	before C(bilabial)
	[ŋ]	before C(alveolar)
	[ň][3]	before C(alveo-palatal)
	[ɲ][3]	before C(palatal)
	[N]	word-finally
	[n]	elsewhere

Next, the chart of Japanese vowels is given in (8) (Tsujimura 1996: 18, Nakajou 1989).

(8) Japanese Vowels

	front	central	back
high	i		ɯ[6]
mid	e		o
low		a	

As shown in (8), Japanese has five vowels: high front, high back, mid front, mid back, and low central. Among the vowels, high vowels are devoiced in the following environment (Tsujimura (1996: 28) among others).

(9) Devoicing of High Vowels

$$V \rightarrow \underset{\circ}{V} \; / \; C \_\_\_ \left\{ \begin{matrix} C \\ [\text{-voice}] \\ \# \end{matrix} \right\}$$

$$[\text{+high}] \qquad [\text{-voice}]$$

The rule in (9) ensures that high vowels [i] and [ɯ] are devoiced between voiceless consonants or word-finally.

Henceforth, I will use the symbols [r] and [u] instead of [ɾ] and [ɯ], respectively, for the sake of simplicity. Also, we ignore the difference between voiced and voiceless vowels since it is relevant to the analysis.

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[6] The symbol [ɯ] indicates the unrounded high back vowel. Whereas the lack of lip rounding is more prominent in the Tokyo dialect, the high back vowel tends to be rounded in the Western dialects (Tsujimura 1996: 18; Shibatani 1990: 161). The symbol for rounded high back vowel is [u].

1.2.2. Adjustments Observed in English-based Loanwords in Japanese

Some English phonemes do not exist in the Japanese phonemic inventory and Japanese possible syllable structures are different from English possible syllable structures. Itô (1986) shows that Japanese possible syllable structure is (C)(G)V(V)(C), where G is a glide [y][7] and coda consonant is either the first half of a geminate or a nasal.

These facts lead to a number of adjustments taken place in borrowing English words into Japanese as loanwords. The adjustments are categorized into three groups: phonetic adjustment, epenthetic vowel, and consonant gemination.

The major phonetic adjustments are shown in (10) – (12) below (National Language Institute 1990, Ohso 1991, Tsuchida 1995).

(10) Consonants

English		Japanese	
a. [f]	→	[ɸ]	(fur → [ɸa:])
b. [v]	→	[b]	(view → [b^{y}u:])
c. [θ]	→	[s]	(Ithaca → [isaka])
d. [ð]	→	[z]	(mother → [maza:])
e. [l]	→	[r]	(fly → [ɸurai])
f. [r] (in coda position)	→	the second half of a long vowel, [a:] or [o:]	
			(card → [ka:do])
			(course → [ko:su])

[7] Tsujimura (1996) among others treats the glide [y] as the second articulation of the preceding consonant. In this study, we will adopt this idea and transcribe a palatalized consonant with a superscript [^{y}].

(11) Lax Vowels[8]

	English		Japanese			
a.	[ɪ]	→	[i]	(pin	→	[piN])
b.	[ɛ]	→	[e]	(pen	→	[peN])
c.	[æ]	→	[a]	(rally	→	[rari:])
d.	[ʌ]	→	[a]	(cut	→	[katto])
e.	[a]	→	[a]	(top	→	[toppu])
f.	[ɔ]	→	[o:]	(call	→	[ko:ru])
g.	[ʊ]	→	[u]	(book	→	[bukku])

(12) Tense Vowels

a.	[i]	→	[i:]	(key	→	[ki:])
b.	[o]	→	[o:]	(zone	→	[zo:N])
c.	[u]	→	[u:]	(cue	→	[k^yu:])

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[8] As far as I know, the realization of [ə] has not got attention in the literature and no one has studied it systematically. Interestingly, [ə] in English source words can correspond to all the Japanese five vowels.

a. [ə] → [i] (terminal → [ta:minaru])
b. [ə] → [e] (entrepreneur → [antorepurena])
c. [ə] → [a] (away → [awe:])
d. [ə] → [o] (vision → [bi͡joN])
e. [ə] → [u] (even → [i:buN])

Next, as mentioned above, Japanese possible syllable structure is (C)(G)V(V)(C), where the glide is the second articulation of the preceding consonant, and possible syllable structures in English and in Japanese are different. This leads to the second type of the adjustment: epenthetic vowel. That is, when English words with a consonant cluster or a coda consonant that are prohibited in Japanese are brought into Japanese as loanwords, a vowel based on the rules in (13) is epenthesized between the consonants or after the coda consonant. (Ohso 1991, Kobayashi et al 1991, Jorden et al 1976 among others).

(13) Epenthetic Vowel

a. [o] is inserted after [t] and [d]

(travel → [toraberu])

b. [i] is inserted after [č] and [j]

(bench → [benči])

c. [u] is inserted elsewhere

(three → [suri:])

(noise → [noid^{z}u])

Finally, the last type of adjustments observed is 'consonant gemination'. Although 'consonant gemination' is one of the well-studied topics in the study of Japanese loanword phonology, as mentioned above, it is a complex phenomenon and has not yet been understood completely. Therefore, the rule in (14) (Ohso 1991: 42-45) is not an

absolute one and there are a number of exceptions to it. (e.g. picnic → [pikunikku] (*[pikkunikku])) (See also Tsuchida (1995).)

(14) Consonant Gemination

Consonant gemination occurs when a lax vowel is followed by an obstruent (p, t, k, t^s, č, š, d, g, d^z, or ǰ). (e.g. top → [toppu], bed → [beddo])

1.3. Goals of the Thesis

The present study has three goals. The first goal is to explore the realization of [r] in English-based loanwords in Japanese and analyze it in the framework of Optimality Theory. The second goal is to argue that the category 'loanword', which is one of the four categories of the Japanese lexicon, consists of co-phonologies. Finally, we will claim that the constraint ranking specific to this category has been changing over time.

[r] is a unique segment in English-based loanwords in Japanese in the sense that it is the only consonant whose output in Japanese can be either a vowel, namely the second half of a long vowel, a short vowel [a], a consonant [r], or zero, depending on the position where it appears in the loanwords in Japanese.

When [r] occurs in onset position of the inputs, it always appears as [r] in onset of Japanese outputs, e.g. *ribbon* → [riboN].

When it is in coda position of the inputs, on the other hand, there are four possible corresponding patterns, as shown below.

The first corresponding pattern of coda [r] in English source words is the corresponding pattern where [r] in English is recognized as a second half of a long vowel

[a:] or [o:], e.g. *start* → [suta:to], *pork* → [po:ku]. We call the loanwords of this corresponding pattern as 'long vowel' type.

Not only the location of [r] within both a syllable and a word in English source words, but also the time period when they were borrowed from English is significant in analyzing the realization of [r] in the loanwords in Japanese. English-based loanwords with the same syllabic and moraic structure can have variants with regard to word-final [r], depending on the period they were brought into Japanese. Examples are: old English-based loanword *tower* → [tawa:], new English-based loanword[9] *wafer* → [weha] (*[weha:]). Since this corresponding pattern applies only to the new loanwords, we call the loanwords belonging to this pattern as 'new loanwords'.

In the loanword phenomena introduced thus far, English [r] in coda position of the source words has two possible counterparts in Japanese outputs: either the second half of a long vowel or no apparent counterpart. However, in the third corresponding pattern, the corresponding segment to English word-final [r] of the source words, which is necessarily in coda position, appears in Japanese as a short vowel [a], e.g. *pair* → [pea] (*[pea:], *[pe:]). We call this type of loanwords as 'short [a]' type.

Finally, in the fourth corresponding pattern of coda [r] in English, some loanwords have two variants: one with a word-final long vowel [a:], whose second part is the

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[9] The definition of 'new English-based loanwords' in this work is the loanwords that first appeared in 'Kojien', one of the most authentic dictionaries in Japan, since 1983 (3rd edition), or the loanwords that have not yet been included in 'Kojien' while they are in other newer dictionaries. Most of the new loanwords are computer-related words.

corresponding segment to English [r] of the inputs, and the other with a word-final short vowel where there is no apparent counterpart of [r] of inputs, e.g. *computer* → [kompyu:ta(:)]. This is 'variants' type.

In the present study, we will account for the five types of the data introduced above, namely [r] in coda position, long vowel type, new loanwords, short [a] type, and variants, in the framework of Optimality Theory.

In this work, as mentioned above, all the data are non-abbreviated English-based loanwords in Japanese whose source words contain [r]. The main sources of the data in this work, including the data presented in Appendix, are Akahori (1999) and Horiuchi (1996), whereas we refer to Shimmura (1955, 1969, 1983, 1991) as secondary sources. With regard to the phonetic descriptions of English source words, we draw on Jones (1997), Noory (1965), and Kenyon and Knott (1944, 1953).[10] We ignore voiceless vowels in Japanese because they are irrelevant to the analysis in this study.

This thesis is organized as follows. After introducing theoretical background in chapter 2, chapter 3 presents data and their features. Then, chapter 4 turns to the main point, how the data can be explained in the framework of Optimality Theory. Finally, section 5 presents conclusions.

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[10] In the literature of Japanese loanword phonology, it has been argued that pronunciation plays more important roles than spelling in the process of borrowing. (See Ohso (1991) among others.)

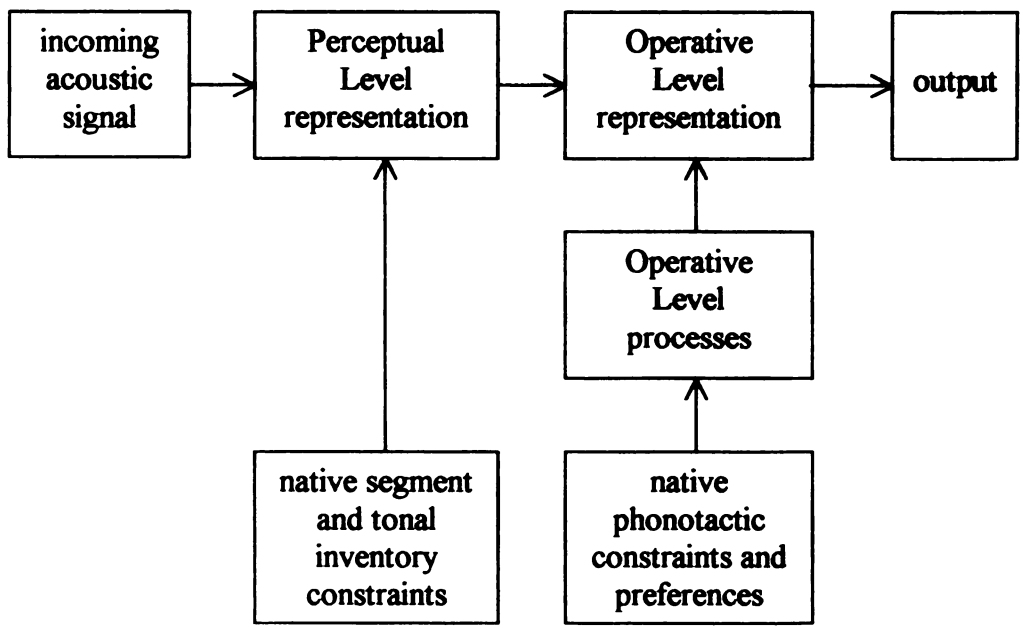
2. THEORETICAL BACKGROUND

This chapter consists of two parts. In the first section, we will introduce Silverman's (1992) idea on the inputs in loanword phonology. Then, in the second section, we will present an overview of Optimality Theory (hereafter OT) (Prince and Smolensky 1993).

2.1. Silverman's Model

In loanword phonology, the nature of inputs is unclear: for instance, it is not clear whether the inputs are phonologically faithful to the source language or they are somewhat affected by the host language. Silverman (1992) assumes that the speakers of the host language have no access to the phonological representation of the source language and provides the following diagram.

(15) Silverman's Model (1992: 293)



In Silverman's model shown in (15), the input is merely a linguistically unanalyzed acoustic signal and the speakers of the host language cannot access to the phonological representation of the source language. At the Perceptual Level, the native segment and tonal inventory constraints apply, and restrict the representation of perceived segments. Then, it is at the Operative Level that "perceived segments may undergo true phonological operations, triggered by native phonotactic constraints" (Silverman 1992: 293). That is, the speakers of the host language perceive the inputs in accordance with the phonological system of the host language and fit "the superficial input into the native phonological system as closely as possible" (Silverman 1992: 289). This model accounts for why the identical input can be "perceived, represented, and ultimately produced in a distinct manner in each language it enters" (Silverman 1992: 289).

There is another hypothesis that plays a role in Silverman's model, which is Perceptual Uniformity Hypothesis. The following is the modified version of Silverman's formulation (1992: 297, 325).

(16) Perceptual Uniformity Hypothesis

At the Perceptual Level, the native segment inventory constrains segmental representation in a uniform fashion, regardless of string position.

However, an input whose acoustic phonetic properties cannot be discerned due to its presence in an impoverished context (a context to be determined on a language-specific basis) is not supplied representation at the Perceptual Level of the loanword phonology.

This hypothesis means that, at the Perceptual Level, an incoming acoustic signal cannot have more than one acoustic correspondent. However, this hypothesis is too strong, as we will seen in chapter 4.

This Silverman's model is one of the pre-OT theories of loanword phonology, but it is adopted in the Optimality-Theoretic analyses of loanword phonology (Tsuchida 1995, Kitahara 1996 among others). In this study, adopting the Silverman's idea in (15), we distinguish incoming acoustic signal and Perceptual Level representation, and assume that the input is merely a superficial non-linguistic acoustic signal and the native speakers of Japanese have no access to the phonological representation of the source language. Moreover, we assume that input /r/ is pronounced as [r] in English, although, in some dialects of English, /r/ can be pronounced as rhoticity or zero.

2.2. Basic Concepts of OT

This section presents an overview of OT, which is adopted in chapter 4 to analyze the data. This chapter will consist of two parts: after some basic concepts and symbols in OT are discussed, we will introduce another significant notion, free variation.

We heavily draw on Kager (1999) as well as Prince and Smolensky (1993) for this section.

2.2.1. Constraints

OT is a widely adopted theory in analyzing loanwords in Japanese, especially English-based loanwords in Japanese (Tsuchida 1995, Kitahara 1996), as well as various phonological phenomena including loanwords in other languages (Yip 1993, Broselow

1999, and others). Furthermore, OT has been employed not only in phonology, but also in other fields such as prosodic morphology (McCarthy and Prince 1993), allomorphy (Mester 1994), and syntax (Grimshaw 1997).

It is the most essential property of OT that it is constraint-based, not rule-based, which means that there are neither rules nor serial derivations, and constraints play crucial roles in this theory. A constraint in OT is understood as a structural requirement, but it is neither an absolute requirement nor necessarily to be satisfied in each case. In other words, an output form may violate some constraints. Furthermore, the constraints in OT are divided into two categories based on their properties.

2.2.1.1. Markedness and Faithfulness

There are two major types of constraints. One of them is 'markedness' constraint. What the idea of 'markedness' suggests is that all types of linguistic structure have one of the two values, marked or unmarked, and the marked value is cross-linguistically avoided but it is necessary to make contrast, whereas the unmarked value is cross-linguistically basic and preferred.

The notion of markedness (constraints) contains three major features to be pointed out. The first crucial property is that the notion of markedness is intrinsically asymmetrical, in the sense that "in sound systems, certain types of structure – segments, segment combinations, or prosodic structures – are universally favored over others" (Kager 1999: 5). For instance, short vowels and open syllables are favored, or unmarked, as compared to long vowels and closed syllables, respectively.

Second, the concept of markedness is intrinsically relative, since whether an element is 'marked' or 'unmarked' is determined solely in comparison to the other elements. To put it differently, one type of element, voiceless obstruents for example, is not enough to be labeled as either 'marked' or 'unmarked', and we can tell that voiceless obstruents are 'unmarked' only in relation to the other type of elements, say voiced obstruents. In that sense the concept of markedness is inherently relative.

The final feature is the feature of markedness constraints. Markedness constraints refer to output forms only, and input forms are irrelevant to them. In that sense, markedness constraints are pure output constraints.

The following is an example of a markedness constraint.

(17) Coda-Condition (Itô 1989: 224)

Codas cannot have independent place of articulation.

The constraint *Coda-Condition* in (17) prohibits codas from having independent place of articulation. Since, in English-based loanwords in Japanese, more precisely in Japanese words of any type, it is highly restricted to have a coda with independent place of articulation, this constraint must be relevant to the analysis of the loanwords in this work. (e.g. *star* → [suta:] (*[sutar]))

The other of the two major types of constraints is 'faithfulness'. Faithfulness constraints are the constraints that are faithful to lexical contrasts and require output forms to preserve the properties of lexical items. Faithfulness constraints play crucial roles from the functional point of view, since any language in the world needs a minimal

amount of formal contrast to express meaning and faithfulness constraints carry the contrasts of meaning.

Another significant aspect of faithfulness constraints, unlike markedness constraints, is that they are not pure output constraints because they refer to elements not only in output form but also in input form. Importantly, however, both markedness constraints and faithfulness constraints refer to output forms and there is no constraint in OT that applies only to elements in inputs. In that sense, OT is an output-oriented theory.

The constraint *I-Contig* in (18) is an example of a faithfulness constraint.

(18) I-Contig (McCarthy and Prince 1995)

Word-medial deletion is prohibited.

I-Contig in (18) is the anti-deletion constraint, which ensures that all the word-medial segments in inputs are preserved in outputs. Since all the word-medial segments of English inputs are preserved in English-based loanwords in Japanese, this constraint must be relevant to the analysis in this work. (e.g. *start* → [suta:to] (*[sutato]))

2.2.1.2. Violability and Universality

As mentioned above, OT is a constraint-based theory, and constraints play a central role in this theory. Constraints in OT have two essential features.

First, constraints are not necessarily to be satisfied and an output form may violate them. However, the violation must be minimal. This property is called 'violability'. Violability suggests that no output form can satisfy all the constraints, while an output

form can satisfy constraints vacuously, and violation of a constraint cannot be the direct cause of ungrammaticality. In other words, constraints are inherently conflicting and the satisfaction of one constraint implies the violation of another.

Second, constraints in OT are assumed to be universal, which is called 'universality' of constraints. Universality implies that we require a mechanism consisting of a ranking of universal constraints to determine the best output of a grammar, in which the constraint ranking is considered to be language-specific.

2.2.1.3. Optimality

As is obvious from its name, 'optimality' is a central basic concept of OT. Then, the next question we might ask is: what is optimality? Kager (1999: 13) answers this question as following:

(19) An output is optimal when it incurs the least serious violations of a set of constraints, taking into account their hierarchical ranking.

Optimality suggests that each output form is the best possible output among an infinite number of output candidates, and the most harmonic in terms of language-specific constraint ranking. Furthermore, since constraints are in principle conflicting, as mentioned in the previous subsection, perfect output form does not exist. Therefore, to determine the best output form and to resolve the conflicts, the idea of 'strict domination' (Prince and Smolensky 1993: 124) is required. The following is Kager's formulation (1999: 22) of it.

(20) Strict Domination: violation of higher-ranked constraints cannot be compensated for by satisfaction of lower-ranked constraints.

2.2.2. Tableaus

In OT, output candidates are evaluated and the best output form is determined in a tableau. A sample tableau (21) is shown below.

(21)

Input	Constraint 1	Constraint 2
a. ☞ Output Candidate A		**
b. Output Candidate B	*!	*

In a tableau, output candidates are shown vertically in the leftmost column in random order, while constraints are given horizontally in the top row in a descending ranking from left to right. For example, Constraint 1 is ranked higher than Constraint 2 in the tableau (21).

Next, we will explain how to read a tableau introducing symbols employed in OT. First, A blank cell indicates that the output candidate of that row (Candidate A in (21)) satisfies the constraint of that column (Constraint 1 in (21)), while violation of each constraint is displayed by an asterisk '*', which is the violation mark in OT. The number of violation marks reveals the number of violations. In (21), for example, Candidate A satisfies Constraint 1 but violates Constraint 2 twice, whereas Candidate B violates both Constraint 1 and Constraint 2 once. Second, the optimal output is marked by the index

'☞' in the leftmost column, which says that the candidate A is the optimal output in (21). Third, the exclamation mark '!' with a violation mark indicates that that violation is fatal. Finally, the shading cells in a tableau show that the violations given in the cells are not relevant in determining the optimal output.

In sum, notwithstanding that Candidate A violates one constraint, namely Constraint 2, it is still the optimal output in the tableau (21), since constraints are violable in OT. Moreover, Candidate A's violation of Constraint 2 is irrelevant to the choice of the output form, since Candidate A satisfies a higher ranked constraint, namely Constraint 1, which is violated once by Candidate B, and the ranking of constraints in OT is strict, as mentioned in (20). Therefore, Candidate 2's violation of Constraint 1 is fatal and Candidate 1's violations of Constraint 2 are irrelevant in determining the optimal output. Therefore, those cells are shaded in tableau (21).

2.2.3. The Grammar in OT

In the previous subsections, we introduced the basic ideas of OT. Now it is time to look at the grammar in OT.

The grammar in OT is an input-output device, as presented in the previous subsections, and its function is to map an input form into an optimal output form. It is presumed that the OT grammar consists of three components, namely Lexicon, Generator, and Evaluator. The following definitions of the components are cited from Kager (1999:19):

(22) Components of the OT grammar

a. Lexicon: contains lexical representations (or underlying forms) of morphemes, which form the input to:
b. Generator: generates output candidates for some input, and submits these to:
c. Evaluator: the set of ranked constraints, which evaluates output candidates as to their harmonic values, and selects the optimal candidate.

Now let us take a closer look at the properties of each component.

First, the Lexicon contains all contrastive properties including not only phonological features but also syntactic, morphological, and semantic features in a language, and it submits the input forms to generator, as given in (22). Moreover, the Lexicon has two more essential properties. One of them is that no constraints restrict the input forms, while faithfulness constraints refer to elements in inputs as well as in outputs. This is called 'Richness of the Base' (Prince and Smolensky 1993: 191). The following is Smolensky's formulation (1996: 5):

(23) Richness of the Base

The source of all systematic cross-linguistic variation is constraint reranking. In particular, the set of inputs to the grammars of all languages is the same. The grammatical inventories of a language are the outputs, which emerge from the grammar when it is fed the universal set of all possible inputs.

'Richness of the Base' says that there is no restriction on inputs, and cross-linguistic variation attributes to the difference of constraint ranking.

The other significant property of the Lexicon to be emphasized is the property relevant to language acquisition. That is, whenever there is no overt evidence of existence of a specific lexical form, the input form is assumed to be identical to the output, since it is the easiest strategy to build a lexicon. This property is called 'Lexicon Optimization' (Prince and Smolensky 1993: 192) and is defined as follows:

(24) Lexicon Optimization

Suppose that several different inputs I_1, I_2..., I_n when parsed by a grammar G lead to corresponding outputs O_1, O_2..., O_n, all of which are realized as the same phonetic form Φ – these inputs are phonetically equivalent with respect to G. Now one of these outputs must be the most harmonic, by virtue of incurring the least significant marks: suppose this optimal one is labeled O_k. Then the learner should choose, as the underlying form for Φ, the input I_k.

The second component of the OT grammar is the Generator, which is often abbreviated to Gen. The essential functions of Gen are to generate all logically possible output candidates and to submit them to the Evaluator to be analyzed, as said in (22). This property of Gen is called 'Freedom of Analysis', and Kager (1999: 20) formulates it as follows:

(25) Freedom of Analysis: any amount of structure may be posited.

'Freedom of Analysis' says that Gen generates all logically possible candidates as far as they "are made up of licit elements from the universal vocabularies of linguistic representation." (Kager 1999: 20)

Finally, the third component is the Evaluator, or Eval. Eval consists of a language-specific hierarchy of universal constraints[11] and determines the most optimal output with respect to the ranking from all logically possible output candidates generated by Gen. In that sense, Eval is the most significant of the three components. Eval has three essential properties besides 'Strict Domination', which is already presented in (20) above.

First, Eval contains all the universal constraints and those constraints are ranked strictly in a language-specific way. Furthermore, the relation of the domination in the ranking is transitive, as illustrated in (26):

(26) Transitivity of ranking

If $C_1 >> C_2$ and $C_2 >> C_3$ then $C_1 >> C_3$ (Kager 1999; 21)

Second, in the process of determining the most harmonic output candidate from all logically possible output candidates submitted by Gen, output candidates can violate constraints minimally to avoid a violation of some higher-ranked constraint. This property is called 'Economy' (Prince and Smolensky 1993: 27), which is defined as follows:

[11] The set of all the universal constraints is called Con (Kager 1999: 21).

(27) Economy: banned options are available only to avoid violations of higher-ranked constraints and can only be banned minimally.

Finally, the third significant property of Eval is 'Parallel-Processing' (Prince and Smolensky 1993: 79) shown in (28):

(28) Parallel-Processing: all possible ultimate outputs are contemplated at once.

In OT, faithfulness constraints and markedness constraints are considerably different in nature but interact with each other in a single language-specific hierarchy. This is due to 'Parallel-Processing', which forms the basis of the phenomena involving interface properties such as the interface between phonology and morphology.

2.2.4. Free Variation

In the previous section, we introduced the basic properties of OT. Next, in this section, we will discuss another essential concept 'free variation', which will play a crucial role in the analysis of this work.

'Free variation' results when two optimal output forms are generated from a single input: e.g. *computer* → [konp^{y}u:ta(:)]. The concept of free variation was first introduced into the field of OT by Prince and Smolensky (1993: 51), although it was as a purely theoretical option, and it has since been discussed in the literature (Kiparsky 1993, Kager 1994, 1997, Reynolds 1994, Anttila 1995, Itô and Mester 1997, and others).

The case of free variation seems to be a serious problem for OT grammar, however. As discussed in the previous section, the OT grammar is an input-output mechanism that selects only one output from all logically possible output candidates as optimal. If this grammar is correct, how can two output forms be optimal? When we look at cases of free variation carefully, we realize that the variation generated through the OT grammar is not unpredictable but the two optimal outputs are quite similar and differ only in a minor respect. Consequently, this difference must be relevant to constraints in the hierarchy. The case of free variation in OT may be interpreted as in (29) (Kager 1999: 406), which is completely different from the idea of 'tied ranking' presented in (30) (Itô and Mester 1997: 433).

(29) Interpretation of free ranking of constraints C_1, C_2

Evaluation of the candidate set is split into two subhierarchies, each of which selects an optional output. One subhierarchy has $C_1 >> C_2$, and the other $C_2 >> C_1$.

(30) Tied Ranking: two (or more) constraints are true equals, in the sense that a violation of neither constraint ever counts as dominating a violation of the other.

The interpretation given in (29) suggests that, since some constraints pairs in the language-specific hierarchy of constraints are freely ranked, the language-specific hierarchy is divided into subhierarchies based on differently ranked constraints and each subhierarchy chooses its optimal output form. Consequently, two optimal output forms

can be selected from a single input form. Simple sample tableaux of free ranking are shown in (31).

(31) Free Ranking

a. Constraint 1 and 2 are freely ranked.

	Constraint 1 ⋮	Constraint 2	Constraint 3
a. ☞ Candidate A	⋮	*	*
b. ☞ Candidate B	* ⋮		

b. Constraint 1 >> Constraint 2

	Constraint 1	Constraint 2	Constraint 3
a. ☞ Candidate A		*	*
b. Candidate B	*!		

c. Constraint 2 >> Constraint 1

	Constraint 2	Constraint 1	Constraint 3
a. Candidate A	*!		*
b. ☞ Candidate B		*	

In (31a)[12], Constraint 1 and Constraint 2 are freely ranked. The tableau (31a) can be interpreted in two ways: (31b) and (31c). The tableau (31b) presents the case where

[12] The dotted line between Constraint 1 and Constraint 2 indicates that the two constraints are freely ranked.

Constraint 1 is ranked higher than Constraint 2. In (31b), since Candidate B violates the highest ranked constraint, namely Constraint 1, but Candidate A does not violate it, Candidate A is the optimal output. The tableau (31c), on the other hand, is the case where Constraint 2 is ranked higher than Constraint 1. Candidate B is selected as the optimal output in this case, since Candidate A violates Constraint 2, which is the highest ranked constraint in (31c), but Candidate B does not.

To conclude, in cases of free variation, the constraint hierarchy can be divided into subhierarchies with regard to the freely ranked constraints, and each subhierarchy selects one optimal output. Importantly, two outputs can be selected as optimal based solely on the freely ranked constraints, and the Constraint 3 in (31) does not affect the selection of the optimal output(s).

Next, Simple sample tableau of tied ranking is shown in (32).

(32) Tied Ranking

a.

	Constraint 1 Constraint 2	Constraint 3
a. ☞ Candidate A	*	*!
b. Candidate B	*	

The tableau in (32) shows the case of tied ranking. Constraint 1 and Constraint 2 given in the same cell in tableau in (32) indicate that those two constraints are equally ranked. In the case of tied ranking, unlike in the case of free ranking, constraint ranking cannot be divided into subhierarchies, which means that only one optimal output is allowed. Interestingly, the optimal output is selected not based on the two tied ranked constraints,

Constraint 1 and Constraint 2 in tableau (32) for example, but based on another constraint, Constraint 3 in (32).

Thus far in this section, we introduced essential properties and concepts of OT. Among the properties and concepts presented, the notion of free ranking is the key concept of analysis in the present study, since, as mentioned in chapter 1, we will analyze the case where two optimal outputs are generated from a single input. In the loanwords belonging to this type, word-final [r] of the inputs, necessarily in coda position, has two possible outputs in Japanese, namely one is the second half of a long vowel and the other is the case of no overt corresponding segment: e.g. *computer* → [konp^{y}u:ta(:)].

3. DATA

In this chapter, we will present the data on the realization of [r] in English-based loanwords in Japanese[13], which we will analyze in the framework of OT in chapter 4.

As mentioned in chapter 1, the data can be categorized into five types based on the properties they have. The five types are shown in (33).

(33) Five Types of English-Based Loanwords with [r]

a. [r] in onset position

b. [r] in coda position

i. Long Vowel Type

ii. New Loanwords

iii. Variants

iv. Short [a] Type

In the sections below, we will introduce each one of the five groups in (33) and present their properties.

3.1. [r] in Onset Position

The first type of data consists of the loanwords whose source words have [r] in onset position. Examples are shown in (34).

[13] More data are given in Appendix.

(34) a. bréak → [buré:ki]

b. ríbbon → [ríboN]

c. trúck → [torákku]

d. cóntract → [kontorákuto]

e. recýcle → [risáikuru]

The corresponding pattern of the loanwords belonging to this type is simple. English [r] in onset position of the source words always corresponds to Japanese [r] in onset position of the corresponding loanwords, and it does not affect the selection of the optimal output forms whether the [r] is in the accented syllable (34a, b, and c) or in the unaccented syllable (34d and e) of English source words, as shown in (34). Moreover, we do not need to have the distinction between the new English-based loanwords and the old English-based loanwords, since there is no difference between new and old loanwords with regard to the corresponding pattern of [r] in onset position.

3.2. [r] in Coda Position

As given in (33), with regard to their corresponding patterns, the loanwords whose English source words have [r] in coda position are divided into four subgroups: Long Vowel Type, Variants, New Loanwords, and Short [a] Type. In the subsections below, we will introduce the four subgroups.

3.2.1. Long Vowel Type

The first subgroup is what is called 'long vowel' type. Examples of this group are given in (35) and (36).

(35) Word-final [r] in coda position

a. sír → [sá:]

b. stár → [sutá:]

c. tówer → [táwa:]

d. órganizer → [o:ganáiza:]

(36) Word-medial [r] in coda position

a. stárt → [suta:to]

b. nórmal → [no:maru]

c. páttern → [pata:N]

d. cartóon → [ka:tu:N]

In the examples belonging to this type, as shown in (35) and (36), English [r] in coda position of inputs corresponds to the second part of a long vowel, either [a:] or [o:], in Japanese outputs, which is necessarily in coda position. To put it differently, it does not affect the selection of the optimal output forms whether English [r] in the source words occurs word-finally (35a-d) or word-medially (36a-d), in the stressed syllable (35a, b, and 36a, b) or in the unstressed syllable (35c, d, and 36c, d).

3.2.2. New Loanwords

The second subgroup also involves loanwords whose English source words have [r] in coda position. The difference between this type and the other three is that this type of loanwords consists only of the new loanwords. First, look at the examples shown in (37).

(37) Word-final [r] in coda position

a. connéctor	→	[konekuta]	(*[konekuta:])
b. wáfer[14]	→	[wéha]	(*[weha:])
c. séquencer	→	[sí:kensa]	(*[si:kensa:])
d. clúster	→	[kurásuta]	(*[kurasuta:])
e. scánner	→	[suk^{y}ána]	(*[suk^{y}ana:])

All the examples in (37) have a short vowel [a] word-finally, unlike the examples of the long vowel type presented in (35) where a long vowel occurs word-finally and input [r] in coda position corresponds to the second half of a long vowel, either [a:] or [o:]. That is, in the examples belonging to this type, input [r] does not have an apparent counterpart in Japanese outputs. However, the examples in (37) do not mean that the new loanwords cannot have an apparent counterpart of input [r] in loanwords in Japanese. Consider the examples in (38).

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[14] As will shown in (87) in chapter 4, this word was borrowed from English twice. In this case, the output means 'a component of a computer', and does not have the other meaning 'a thin biscuit'.

(38) Word-medial [r] in coda position

a. ínternet → [intá:netto]

b. interléave → [intá:ri:bu]

c. wízard → [wíza:do]

d. cómmerce → [kóma:su]

e. insérter → [insa:ta]

The inputs of the examples in (38) have a word-medial [r] in coda position and the correspondence in Japanese outputs is again the second half of a long vowel. This suggests that, in the new loanwords, word-medial English [r] in coda position of the inputs has an apparent counterpart.

As shown in (39), however, it does not mean that word-final long vowels are not allowed in the new loanwords.

(39) a. fáctory → [ɸákutori:]

b. qúeue → [kʸú:]

c. cárry → [kʸári:]

d. jággy → [ǰági:]

Judging from the data above, we conclude that, in the new loanwords, only word-final [r] in inputs cannot have an apparent counterpart in Japanese outputs.

3.2.3. Variants

The third group involves free variation. An English source word in all the groups introduced thus far have a single counterpart in the Japanese corresponding loanword. With regard to English [r] in coda position of the inputs, however, the English source words of the loanwords belonging to this type have two possible counterparts, or free variants, in Japanese. Consider the examples given in (40).

(40) Word-final [r] in coda position

a. élevator	→	[erebé:ta(:)]
b. compúter	→	[komp^{y}ú:ta(:)]
c. prínter	→	[purínta(:)]
d. coódinator	→	[ko:diné:ta(:)]
e. compréssor	→	[kompuréssa(:)]

As shown in (40), the loanwords of this type have two possible outputs: one with a word-final long vowel [a:] as in the case of the long vowel type, and the other with a short vowel [a] word-finally as in the case of the new loanwords.

A common property among the examples in (40) is that the Japanese output has a heavy penultimate syllable. This phenomenon occurs both in the old and new loanwords, and the location of the accent in both the input and the output forms is irrelevant: in the inputs (40a) has the stress on the first syllable, (40b), (40c), and (40e) on the penultimate syllable, and (40d) on the antepenultimate syllable, whereas in the outputs all the words have the accent on the heavy penultimate syllable.[15]

The examples in (40) have a heavy penultimate syllable in the outputs and word-final variability. Loanwords with word-medial input coda [r] and a heavy penultimate syllable in Japanese outputs do not have such variability. Consider the examples in (41).

(41) Word-medial [r] in coda position

a. términator	→	[ta:miné:ta(:)]	(*[tamine:ta(:)])
b. mórphing	→	[mó:ɸiŋgu]	(*[moɸiŋgu])
c. tárget	→	[tá:getto]	(*[tagetto])
d. arcáde	→	[á:ke:do]	(*[ake:do])
e. párking	→	[pá:kiŋgu]	(*[pakiŋgu])

The examples in (41) have the heavy penultimate syllable in the Japanese outputs, as in the examples shown in (40). However, it does not affect the realization of word-medial [r] in coda position of the English inputs, which appears as the invariable second half of a long vowel in the outputs, as in the case of long vowel type and new loanwords.

Moreover, as presented in (42) below, other word-final consonants or vowels in English source words do not have variants in the Japanese outputs, even if their penultimate syllable in the outputs is heavy.

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[15] For accentuation in Japanese, see McCawley (1968), Katayama (1995).

(42) a. wóody → [úddi:]

b. cóokie → [kúkki:]

c. túrkey → [tá:ki:]

d. gécko → [gékko:]

In sum, only word-final [r] of English inputs with output having a heavy penultimate syllable can have variants in Japanese outputs.

Thus far, we have shown that only the words whose outputs have a heavy penultimate syllable can have variants in outputs with regard to the corresponding segment of the word-final [r] in inputs. However, some English-based loanwords with the heavy penultimate syllable do not have variants. For instance, despite the fact that they have the heavy penultimate syllable in Japanese outputs, the latest loanwords[16] in (43), which are collected from Akahori (1999), do not have variants.

(43) a. insérter → [insa:ta] (*[insa:ta:])

b. séquencer → [ši:kensa] (*[ši:kensa:])

c. debúgger → [debágga] (*[debagga:])

[16] We consider the examples in (43) as the latest loanwords since they have not yet been included in the latest 'Kojien' (Shimmura 1991), one of the most authentic Japanese dictionaries.

In the examples in (43), [r] in the English inputs has no apparent counterpart in the Japanese outputs as in the case of the new loanwords, and the English inputs do not have variants in the outputs, despite the fact that the Japanese outputs have the heavy penultimate syllable.

To conclude, although the loanwords belonging to this type have a heavy penultimate syllable in the outputs, there are loanwords without variants, even though they have the heavy penultimate syllable in the outputs. As mentioned in chapter 2, we will propose in chapter 4 that the phenomenon of free variation occurs due to the constraint ranking of OT.

3.2.4. Short [a] Type

In all three types of examples regarding the realization of [r] in coda position of English inputs introduced thus far, [r] has two possible counterparts in Japanese outputs: the second half of a long vowel or no apparent correspondent. In the loanwords belonging to this type, however, [r] in coda position of inputs corresponds to a short vowel [a] in the outputs, as presented in (44) below.

(44) Word-final [r] in coda position

a. dóor → [dóa] (*[doa:], *[do:])

b. flóor → [furóa] (*[furoa:], *[furo:])

c. píer → [pía] (*[pía:], *[pí:])

d. púre → [p^{y}úa] (*[p^{y}ua:], *[p^{y}u:])

e. cáre → [kéa] (*[kea:], *[ke:])

In the examples of (44), word-final [r] in English source words corresponds to a short vowel [a] in Japanese outputs. A common feature among these is that the nucleus of the input syllable of [r] corresponds to [i], [e], [o], or [u] in Japanese outputs. That is, word-final input [r], which is necessarily in coda position, appears as a short vowel [a] in Japanese outputs when the vowel preceding [a] in Japanese outputs is not [a]. This suggests that the nucleus of the syllable of input [r] does not affect the realization of [r] in Japanese and the only possible counterpart of word-final [r] of English inputs is [a], including the case of the second half of a long vowel [a:], in Japanese.[17]

This pattern applies to word-medial [r] in coda position as well. Consider the examples in (45).

(45) Word-medial [r] in coda position

a. cheerléader → [čiarí:da:]

b. géarshift → [giašífuto]

d. áirbus → [eabasu]

In the examples in (45) also, [r] in coda position of the inputs corresponds to [a] when the vowel of the syllable of [r] is not [a] in the outputs. However, there is one difference

[17] I found only two exceptions to this rule: *war* → [wo:] and *encore* → [anco:ru]. The latter pattern is common in loanwords from languages other than English. For example, Russian-based loanwords show this pattern: *мир* [mir] → [mi:ru] 'the name of the space station', *сахар* [saxar] → [saharu] 'sugar'. We will ignore these exceptions in this work, however, since their number is small.

between the case of word-final [r], which is necessarily in coda position, and the case of word-medial [r] in coda position: in the latter case, the second half of a long vowel [o:] is also a possible correspondent, as shown in (46).

(46)	a. pórk	→	[pó:ku]	(*[poaku])
	b. córn	→	[kó:N]	(*[koaN])
	c. fórm	→	[fó:mu]	(*[foamu])
	d. résource	→	[risó:su]	(*[risoasu])

Furthermore, this pattern applies to the new loanwords as well as the old ones.[18]

To conclude, English [r] in onset position of source words always corresponds to [r] in onset position of the Japanese outputs, whereas [r] in coda position has three possible correspondences in Japanese outputs: [a] including the case of the second half of a long vowel [a:], the second half of a long vowel [o:], or zero.

We will analyze these data in the framework of OT in the next chapter.

[18] I found only two new loanwords belonging to this type (*glare* → [gurea], and *software* → [sofutowea]), and both of which have the counterpart of [r] of inputs words-finally.

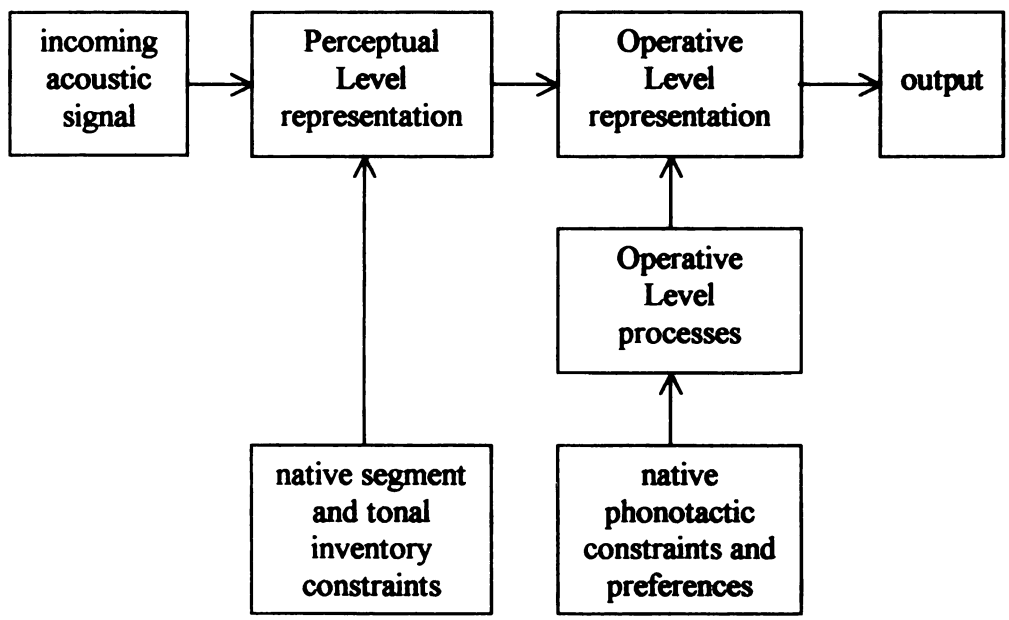
4. ANALYSIS

In this chapter, we will analyze in the framework of OT the five types of the data on the realization of English [r] in the loanwords in Japanese, which were presented in chapter 3.

4.1. The Perceptual Level

In chapter 2, we introduced Silverman's model (1992) of loanword phonology, repeated here as (47):

(47) Silverman's Model (1992: 293)



In this model, the input is merely a linguistically unanalyzed acoustic signal and is distinguished from the perceptual level where the phonological system of the host

language affects the input and fits the input into the native phonological system as closely as possible. Then one question arises: How do Japanese people perceive English [r] at the perceptual level? In Silverman's model, the speakers of the host language do not have access to the phonological representation of the source language, and an incoming acoustic signal cannot have more than one acoustic correspondent in the host language irrelevant of the position it occurs. In other words, no acoustic variation in the output is allowed. This hypothesis is called the 'Perceptual Uniformity Hypothesis', repeated here in (48):

(48) Perceptual Uniformity Hypothesis (=16)

> At the Perceptual Level, the native segment inventory constrains segmental representation in a uniform fashion, regardless of string position.
>
> However, an input whose acoustic phonetic properties cannot be discerned due to its presence in an impoverished context (a context to be determined on a language-specific basis) is not supplied representation at the Perceptual Level of the loanword phonology.

As mentioned in chapter 1, [r] is a unique segment in English-based loanwords in Japanese in the sense that it is the only consonant whose corresponding segment in the output can be either a vowel, a consonant, or zero: onset [r] in inputs always corresponds to onset [r] in outputs whereas coda [r] has three possible corresponding segments, the second half of a long vowel, a short vowel [a], or zero. That is, whereas onset [r] in inputs always corresponds to [r] in outputs, coda [r] in inputs never corresponds to a consonant

in the outputs. Furthermore, the other coda consonants in inputs are preserved in the outputs due to vowel epenthesis, which is a canonical rule to save consonants in inputs, and they always correspond to a consonant in outputs. Importantly, vowel epenthesis applies to another liquid, namely [l], in inputs as well: e.g. *hotel* → [hoteru]. Thus the corresponding pattern of coda [r] is unique, and it is plausible to assume that Japanese people perceive onset [r] and coda [r] in inputs differently at the perceptual level. However, as mentioned above, the Perceptual Uniformity Hypothesis is too strong and cannot explain the peculiarity of [r]. Therefore, in this study, we will weaken Silverman's Perceptual Uniformity Hypothesis, and assume that Japanese people perceive coda [r] in inputs as a short vowel [a] at the Perceptual Level while they perceive onset [r] as [r].

4.2. Constraints

As mentioned in chapter 2, constraints in OT are categorized into two groups: markedness constraints and faithfulness constraints. In the following subsections, we will introduce all the markedness and faithfulness constraints relevant to the analysis of the data in this work.

4.2.1. Markedness Constraints

The notion of 'markedness' is inherently asymmetrical and relative, as mentioned in chapter 2. Moreover, markedness constraints are pure output constraints in the sense that inputs are considered unconstrained by them.

We propose that four markedness constraints play a role in the analysis of the realization of [r] in English-based loanwords in Japanese. The four constraints are presented below.

(49) Coda-Condition (Itô 1989)

Codas cannot have independent place of articulation.

(50) *Complex^{Ons} (Itô 1986)

No complex onset

(51) Spread (+round) (Padgett 1995)

In a sequence of two vowels, the feature [+round] of the first vowel spreads to the second vowel.

(52) *[a:]

No long vowel [a:]

The interpretation of *Coda-Condition* in (49) is that a coda cannot license place features. We assume that this constraint is ranked highest in the hierarchy of constraints in Japanese, since only the first half of a geminated consonant, the second half of a long vowel, and a moraic nasal are possible segments in coda position of Japanese, none of which has independent place of articulation. **Complex^{Ons}* in (50) allows no complex onset. This constraint is also undominated in the constraint ranking of Japanese, since Japanese words never have a complex onset. *Spread (+round)* in (51) is a constraint that

causes the assimilation in terms of the feature [+round]. As mentioned above, we assume that Japanese people perceive coda [r] in inputs as [a] at the perceptual level. When the correspondent of the nucleus of the input syllable of [r] is a short vowel [o] in outputs, however, the correspondent of word-medial coda [r] in inputs appears not as [a] but as the second half of a long vowel [o:] in outputs, as shown in (46). We propose that this phenomenon occurs because the feature [+round] of [o] spreads to the following vowel [a], and this assimilation process happens since word-medial position is not salient enough to preserve the full interpretation of [a]. **[a:]* in (52), which is a member of a constraint family *No Long Vowels* (Rosenthall 1997), prohibits a long vowel [a:]. I assume that the new loanwords cannot have a word-final long vowel [a:] due to this constraint. As shown in chapter 3, in the new loanwords, although other long vowels such as [i:] and [u:] are allowed word-finally, the word-final long vowel [a:] is prohibited. The reason why [a:] is prohibited word-finally might be due to the phonetic fact that [a] has the greatest sonority, or the longest, between the five vowels and "it is much easier to hear the low vowel [a] than the high vowels, [i, u]" (Ladefoged 1993: 245).

4.2.2. Faithfulness Constraints

Faithfulness constraints are those that require output forms to preserve the properties of lexical forms, as introduced in chapter 2. A language needs faithfulness constraints to distinguish words, since they refer to the comparison of inputs and outputs. Moreover, faithfulness constraints are not pure output constraints in the sense that they refer to the elements in inputs as well as in outputs.

We propose that five faithfulness constraints are playing a crucial role in analyzing the realization of English [r] in the loanwords in Japanese. The five constraints are shown below.

(53) Max-IO (Prince and Smolensky 1993)

Every element of inputs must have a correspondent in outputs (no deletion).

(54) Dep-IO (Prince and Smolensky 1993)

Every element of outputs must have a correspondent in inputs (no insertion).

(55) I-Contig (McCarthy and Prince 1995)

No word-medial deletion.

(56) Ident-IO(consonantal)

An output segment has the identical feature values for [consonantal] as its input correspondent.

(57) Ident-IO[a]

An output segment has the identical feature values for [a] as its input correspondent.

(58) Ident-IO([a], Wd])

A word-final output segment has the identical feature values for [a] as its input correspondent.

4.3.1. [r] in Onset Position

The first type of the data to be analyzed is the examples of the realization of onset [r] in the inputs. In the examples belonging to this type, as shown in Chapter 3, input [r] always corresponds to output [r], and the distinction between the new loanwords and the old loanwords is irrelevant. (The examples in (34) are repeated here as (61) for the sake of convenience.)

(61) (=34)

a. bréak → [bure:ki]

b. ríbbon → [ríboN]

c. trúck → [torákku]

d. cóntract → [kontorákuto]

e. recýcle → [risáikuru]

As mentioned in the previous section, we assume that the three constraints, *Coda-Condition*, **Complex^{Ons}*, *I-Contig*, *Ident-IO(consonantal)*, and *Ident-IO([a], Wd])* are undominated in the constraint ranking. Hereafter, instead of **Complex^{Ons}* and *Ident-IO(consonantal)*, we will use **[$_{\sigma}$ CC* and *Ident-IO(C)* respectively in tableaux, for simplicity. Consider the tableau (62).

(62) 'contract'

Input[19]: [kontrakt]	CODA-COND	*[σ CC	I-CONTIG	IDENT-IO(C)	IDENT-IO ([a], WD])	DEP-IO
a. kon·trakt	*!*	*				
b. kon·tra·ku·to		*!				**
c. kon·ta·ku·to			*!			*
d. ☞kon·to·ra·ku·to						***
e. kon·to:·a·ku·to				*!		***

In the tableau, the candidate (a) *kon·tract*, which is the most faithful to the input, is ruled out, since it violates two of the highest ranked constraints: *Coda-Condition* and **Complex*^{Ons}. The violation of *Coda-Condition* can be avoided if a vowel is inserted after each of the consonants in coda position, which yields the candidate (b) *kon·tra·ku·to*. However, this candidate is also excluded, since it still violates a highest ranked constraint **Complex*^{Ons}. Then, there are two ways to avoid the violation of **Complex*^{Ons}. One of them is to delete the counterpart of the input [r], which yields the candidate (c) *kon·to·a·ku·to*. But this candidate violates another highest ranked constraint *I-Contig* and this is not the optimal output, either. The other way to avoid the violation of **Complex*^{Ons} is to insert a vowel between the consonants in onset position, which yields the candidate (d) *kon·to·ra·ku·to*. The vowel insertion causes the serious violation of *Dep-IO*, but the

[19] In the tableaux below, we will show the phonetic representation at the Perceptual Level as the input, since, in Silverman's model, the pronunciation in the source language is merely a non-linguistic acoustic signal, and is not directly related to the selection of the optimal output candidate.

candidate (d) is the optimal output, since *Dep-IO* is ranked lowest. The candidate (e) *kon·to:·a·ku·to* is ruled out, since its violation of a highest-ranked constraint *Ident-IO(consonantal)* is fatal.

4.3.2. [r] in Coda Position

Next, in this subsection, we will analyze the data on the Japanese realization of English [r] in the coda position of the inputs. As mentioned before, the data are categorized into four groups with regard to the corresponding patterns: Short [a] Type, Long Vowel Type, New Loanwords, and Variants.

4.3.2.1. Short [a] Type

The first group of the data we will analyze is what is called 'short [a]' type where input coda [r] corresponds to a nucleus [a] in Japanese outputs. As shown in chapter 3, this phenomenon occurs both in the old and the new loanwords, and word-medially and word-finally.

In the analysis of the data of this type, the three constraints, *Ident-IO([a], Wd])*, *Ident-IO[a]*, and *Spread (+round)*, play a significant role, and, as mentioned in the previous section, they are ranked as in (63).

(63) (=59) Ident-IO([a], Wd]) >> Spread (+round) >> Ident-IO[a]

Let us start with the case of word-final [r]. Consider the tableau (65) below.

(64) Word-final [r] in coda position (=44)

a. dóor → [dóa] (*[doa:], *[do:])

b. flóor → [furóa] (*[furoa:], *[furo:])

c. píer → [pía] (*[pía:], *[pí:])

d. púre → [p^{y}úa] (*[p^{y}ua:], *[p^{y}u:])

e. cáre → [kéa] (*[kea:], *[ke:])

(65) Word-final [r] in coda position

'door'

Input: [doa]	CODA-COND	*[$_{\sigma}$CC	I-CONTIG	IDENT-IO(C)	IDENT-IO ([a], WD])	DEP-IO	MAX-IO	SPREAD (+ROUND)	IDENT-IO[a]
a. dor	*!			*	*				*
b. do:					*!				*
c. do							*!		
d. do·a:						*!		*	
e. ☞do·a								*	

This tableau, more precisely the candidates (c), (d), and (e), shows the ranking between the three constraints *Dep-IO*, *Max-IO*, and *Spread (+round)*. That is, to obtain the optimal output candidate (e), the constraints *Dep-IO* and *Max-IO* must be ranked higher than *Spread (+round)*.

The candidate (a) *dor* is the most faithful to the pronunciation in English. But it violates three of the highest ranked constraints *Coda-Condition*, *Ident-IO(consonantal)*, *Ident-IO([a], Wd])*, and is not the optimal output form. The candidate (b) *do:* is also ruled

out, since it violates another undominated constraint *Ident-IO([a], Wd])*. Although the candidate (c) *do* violates only one constraint *Max-IO*, it is not the optimal output, since *Max-IO* is ranked higher and its violation is fatal. The candidate (d) *do·a:*, which has a word-final long vowel [a:] as in the case of the 'long vowel' type, is ruled out due to the violation of *Dep-IO*. Finally, the candidate (e) *do·a*, which is the most faithful to the representation at the Perceptual Level, is the optimal candidate, although it violates *Spread (+round)*, since the constraint is ranked lower.

In the tableau (65), the constraint **[a:]* is not shown, although the other constraints introduced in the preceding section are used. This is because this constraint is irrelevant to the selection of the optimal output. For instance, in the tableau (65), the candidate (d), which is the only candidate with a long vowel [a:], is ruled out in any case because of the constraint *Dep-IO*, independent of the ranking of the constraint **[a:]*. We conclude, therefore, that **[a:]* is irrelevant to the selection of the optimal candidate of the examples belonging to this type.

Next, we will analyze the case of word-medial [r]. Consider the tableau (67) below.

(66) Word-medial [r] in coda position (=45)

a. cheerléader → [čiarí:da:]

b. géarshift → [giašífuto]

d. áirbus → [eabasu]

(67) Word-medial [r] in coda position

'gearshift'

Input: [giašift]	CODA-COND	*[σCC	I-CONTIG	IDENT-IO(C)	IDENT-IO ([a], WD])	DEP-IO	MAX-IO	SPREAD (+ROUND)	IDENT-IO[a]
a. gir·šift	*!**			*					*
b. gi:·ši·fu·to						**			*!
c. gi·ši·fu·to			*!			**	*		
d. gi·a:·ši·fu·to						***!			
e. ☞gi·a·ši·fu·to						**			

The candidate (a) *gir·šift*, which is the most faithful to the pronunciation in English, is not the optimal candidate, since its violation of *Coda-Condition* and *Ident-IO(consonantal)* is fatal. In Japanese phonology, a coda segment cannot have a place of articulation by itself, which means that, in this case, none of [r], [f], and [t] can occur in coda position. Therefore, the candidate (a) has three violation marks under *Coda-Condition* in the tableau. The candidate (b) *gi:·ši·fu·to* is excluded due to the violation of the lowest-ranked constraint *Ident-IO[a]*. The violation of *Ident-IO[a]* is avoided if [r] in the input has no correspondent in the output, which yields the candidate (c) *gi·ši·fu·to*. However, the candidate (c) violates a highest-ranked constraint *I-Contig* and is also ruled out. The candidate (d) *gi·a:·ši·fu·to* has a word-medial long vowel [a:] as the correspondent of input coda [r], as in the examples of the 'long vowel' type. However, this is not the optimal candidate, either, because the violation of *Dep-IO* is fatal. Finally, the candidate (e) *gi·a·ši·fu·to* is the optimal output, although it violates *Dep-IO* twice, since the violation is not fatal.

As noted in chapter 3, the word-medial coda [r] has a different property from the word-final coda [r] with regard to the realization of input [r]. In the latter, as shown in (44) (=(64) in this chapter), [r] corresponds to a short vowel [a] when the nucleus of the input syllable of [r] corresponds to a vowel other than [a], namely [i], [e], [o], and [o]. In the former case, however, the second half of a long vowel [o:] is the corresponding segment of input coda [r] if the counterpart of the vowel of the syllable of [r] is [o] in the Japanese outputs, as shown in (68). Since input [r] does not correspond to a short vowel [a] in Japanese output, the examples in (68) are not examples of the 'short [a]' type. This pattern occurs in the other three types of data: Long Vowel Type, Variants, and New Loanwords. But we will analyze it here for convenience. Consider the tableau (69).

(68) (=46)

a. pórk → [po:ku] (*[poaku])

b. córn → [kó:N] (*[koaN])

c. fórm → [fó:mu] (*[foamu])

d. résource → [risó:su] (*[risoasu])

(69) 'pork'

Input: [poak]	CODA-COND	*[$_{\sigma}$CC	I-CONTIG	IDENT-IO(C)	IDENT-IO([a], WD])	DEP-IO	MAX-IO	SPREAD (+ROUND)	IDENT-IO[a]
a. pork	*!*								*
b. po·ru·ku				*!		**			*
c. po·ku			*!			*	*		
d. po·a·ku						*		*!	
e. ☞po:·ku						*			*

In the tableau (69), as in the case of the tableau (65), the candidate ***[a:]*** is not shown, since, in the examples of this type, the vowel preceding [a], which is the correspondent of English [r] at the Perceptual Level, is not [a] and the long vowel [a:] cannot happen at the Perceptual Level.

The candidate (a) ***pork***, which is the most faithful to the pronunciation in English, is excluded due to the violation of the highest ranked constraint *Coda-Condition*. Violation of *Coda-Condition* is avoided if a vowel is inserted after the coda consonants in the input, which yields the candidate (b) ***po·ru·ku***. But it causes the violation of another higher ranked constraint *Ident-IO(consonantal)*, and the candidate (b) is not the optimal candidate, either. The candidate (c) ***po·ku***, which has no correspondent of the input [r], is ruled out, since it violates one of the highest ranked constraints *I-Contig*. The candidate (d) ***po·a·ku*** where the input [r] corresponds to a short vowel [a] as in the case of word-final input [r] shown in (65) cannot be the optimal form, either, since it violates *Spread (+round)*. Finally, the candidate (e) ***po:·ku*** is selected as the optimal candidate, since its violation of *Dep-IO* and *Ident-IO[a]* is not fatal.

4.3.2.2. Long Vowel Type

The second group of the data is 'long vowel' type, which consists of the old loanwords. The corresponding pattern of this type is simple. Input coda [r] corresponds to the second half of a long vowel in the Japanese outputs. The correspondents of the input [r] can occur both word-medially and word-finally, based on the location of the [r] in the inputs.

Let us start with the case of word-final [r] in coda position. Consider the tableau (71).

(70) Word-final [r] in coda position (=35)

a. sír → [sá:]

b. stár → [sutá:]

c. tówer → [táwa:]

d. órganizer → [o:ganáiza:]

(71) Word-final [r] in coda position

'star'

Input: [sta:]	CODA-COND	*[$_{\sigma}$CC	I-CONTIG	IDENT-IO(C)	IDENT-IO ([a], WD)	DEP-IO	MAX-IO	*[a:]	SPREAD (+ROUND)	IDENT-IO[a]
a. star	*!	*		*	*					*
b. su·ta·ru				*!	*	**				*
c. su·ta						*	*!			
d. ☞su·ta:						*		*		

First candidate *star* is the most faithful to the pronunciation in English, but it is not the optimal candidate, since it violates four undominated constraints, *Coda-Condition*, **Complex*^{Ons}, *Ident-IO(consonantal)*, and *Ident-IO([a], Wd])*. The violation of *Coda-Condition* and **Complex*^{Ons} is avoided if a vowel is inserted between the onset consonants and after [r] in coda position, which yields the candidate (b) ***su·ta·ru***. The candidate (b) is also excluded, however, since the candidate still violates *Ident-IO(consonantal)*, and *Ident-IO([a], Wd])*, which are undominated constraints. The

candidate (c) *su·ta* where the input [r] has no apparent correspondent in the output is ruled out due to the violation of *Max-IO*. Finally, the candidate (d) *su·ta:* is selected as the optimal output, because **[a:]* is ranked lower than *Max-IO*.

Next, let us consider the case of word-final [r] in coda position. Consider the tableau (73).

(72) Word-medial [r] in coda position (=36)

a. stárt → [suta:to]

b. nórmal → [no:maru]

c. páttern → [pata:N]

d. cartóon → [ka:tu:N]

(73) Word-medial [r] in coda position

'pattern'

Input: [pata:N]	CODA-COND	*[$_\sigma$CC	I-CONTIG	IDENT-IO(C)	IDENT-IO ([a], WD])	DEP-IO	MAX-IO	*[a:]	SPREAD (+ROUND)	IDENT-IO[a]
a. pa·tarN	*!			*						*
c. pa·taN			*!				*			
b. ☞pa·ta:N								*		
d. pa·ta·ruN				*!		*				*

In the tableau (73), the candidate (a) *pa·tarn*, which is the most faithful to the pronunciation in English, is not the optimal output, since its violation of *Coda-Condition* is fatal. The candidate (b) *pa·tan*, which violates one of the highest ranked constraints *I-*

Contig, is not the optimal candidate either. Although the candidate (c) *pa·ta:n* violates **[a:]*, it is optimal, since **[a:]* is ranked lower. The candidate (d) *pa·ta·run* is excluded due to the violation of a highest-ranked constraint *Ident-IO(consonantal)*.

4.3.2.3. New Loanwords

The third group of examples we will analyze is the case of the new loanwords. As introduced in chapter 3, this group consists only of the new loanwords and they have a peculiar property with regard to the realization of input word-final [r].

First, we will analyze the case of input word-final [r] in coda position. As shown in (37) in chapter 3, which is repeated below as (74) for convenience, word-final [r] of the English inputs has no apparent correspondent in the Japanese outputs. This phenomenon occurs only in the new loanwords, as mentioned above. Consider the tableau (75).

(74) Word-final [r] in coda position (=37)

a. connéctor	→	[konekuta]	(*[konekuta:])
b. wáfer	→	[wéha]	(*[weha:])
c. séquencer	→	[sí:kensa]	(*[si:kensa:])
d. clúster	→	[kurásuta]	(*[kurasuta:])
e. scánner	→	[suk^{y}ána]	(*[suk^{y}ana:])

(75) Word-final [r] in coda position

'cluster'

Input: [krasta:]	CODA-COND	*[σCC	I-CONTIG	IDENT-IO(C)	IDENT-IO ([a], WD])	DEP-IO	*[a:]	MAX-IO	SPREAD (+ROUND)	IDENT-IO[a]
a. kras·tar	**!	*		*	*					*
b. ku·ra·su·ta·ru				*!	*	**				*
c. ku·ra·su·ta:						**	*!			
d. ☞ku·ra·su·ta						**		*		

This tableau, more precisely the candidates (c), and (d), shows the ranking between the three constraints *Dep-IO*, and **[a:]*. That is, to obtain the optimal output candidate (d), the constraints *Dep-IO* must be ranked higher than **[a:]*.

The candidate (a) ***kra·star*** is the most faithful to the pronunciation in English, but it is ruled out due to the violation of four undominated constraints, *Coda-Condition*, **Complex^{Ons}*, *Ident-IO(consonantal)*, and *Ident-IO([a], Wd])*. The violation of *Coda-Condition* and **Complex^{Ons}* is avoided if a vowel is inserted between the onset consonants and after the word-final [r], which yields the candidate (b) ***ku·ra·su·ta·ru***. The candidate (b) is not the optimal candidate, however, since the candidate violates two undominated constraints *Ident-IO(consonantal)*, and *Ident-IO([a], Wd])*. The candidate (c) ***ku·ra·su·ta:*** where the input word-final [r] corresponds to the second half of a long vowel [a:] as in the case of the long vowel type is excluded due to the violation of **[a:]*. The candidate (d) ***ku·ra·su·ta*** is the optimal output form in this case, since *Max-IO* it violates is ranked lower than **[a:]*.

Next, we will analyze the case of word-medial [r] in coda position. In this case, unlike the case of word-final [r] in coda position shown above, input coda [r] corresponds to the second half of a long vowel. Consider the tableau (77).

(76) Word-medial [r] in coda position (=38)

a. ínternet → [intá:netto]

b. interléave → [intá:ri:bu]

c. wízard → [wíza:do]

d. cómmerce → [kóma:su]

e. insérter → [insa:ta]

(77) Word-medial [r] in coda position

'commerce'

Input: [koma:s]	CODA-COND	*[σCC	I-CONTIG	IDENT-IO(C)	IDENT-IO ([a], WD)	DEP-IO	*[a:]	MAX-IO	SPREAD (+ROUND)	IDENT-IO[a]
a. ko·mars	*!*			*						*
b. ko·ma·ru·su				*!		**				*
c. ko·ma·su			*!			*		*		
d. ☞ko·ma:·su						*	*			

The candidate (a) *ko·mars* is the most faithful to the pronunciation in English. This is not the optimal candidate, however, since its coda consonants are not allowed, which causes the violation of *Coda-Condition*, and it violates another highest-ranked constraint *Ident-IO(consonantal)*. In the candidate (b) *ko·ma·ru·su*, vowels are inserted after the coda

consonants to avoid the violation of *Coda-Condition*. This candidate is also excluded, however, because the candidate still violates *Ident-IO(consonantal)*, which is ranked highest. The candidate (c) *ko·ma·su* where the input [r] has no apparent counterpart in the Japanese output is not the optimal output form, either, due to the violation of *I-Contig*. In the case of word-final [r] in coda position, as shown in the tableau (75) above, the candidate where the input [r] has no apparent correspondent in the output is the optimal output form. In the case of word-medial [r] in coda position, however, the candidate without an apparent correspondent of the input [r] cannot be the optimal candidate due to the undominated constraint *I-Contig*. Finally, the candidate (d) *ko·ma:·su* is the optimal output, since the violation of **[a:]* is not fatal.

4.3.2.4. Variants

Finally, we will analyze the examples that have variants with regard to the realization of input [r]. As shown in chapter 3, the phenomenon of 'free variation' occurs in both new loanwords and old loanwords, although it does not mean that all the new loanwords and the old loanwords have variants with regard to the counterpart of input [r].

With regard to input, although it might be possible to assume that each of them has its own input, we suppose that two output variants are derived from a single input. There are two major evidences for this claim. First, the two output variants are idiolectal variants, and both of them have the same meaning. Second, most importantly, the claim that each of variants has its own input suggests that [r] in one of the two input forms is not perceived at the Perceptual Level and corresponds to zero in output. But this is unlikely, since the other sounds in inputs are preserved in outputs. Therefore, we assume

that the two variants in output share a single input and variants are generated because of free-ranked constraints.

Let us start with the case of word-final [r] in coda position. As shown in (78), which is repeated here for convenience, word-final input [r] in coda position has two possible correspondents in the Japanese outputs: the second half of a long vowel [a:] and no apparent counterpart.

(78) Word-final [r] in coda position (=40)

a. élevator → [erebé:ta(:)]

b. compúter → [komp^{y}ú:ta(:)]

c. prínter → [purínta(:)]

d. coódinator → [ko:diné:ta(:)]

e. compréssor → [kompuréssa(:)]

In OT, as introduced in chapter 2, it is assumed that 'free variation' occurs due to two unranked constraints. In the analysis of this work, therefore, we assume that the two constraints *Max-IO* and **[a:]* are freely ranked. Consider the tableau (79).

(79) Word-final [r] in coda position

(*Max-IO* and **[a:]* are freely ranked.)

'printer'

Input: [printa:]	CODA-COND	*[σCC	I-CONTIG	IDENT-IO(C)	IDENT-IO ([a], WD)	DEP-IO	MAX-IO	*[a:]	SPREAD (+ROUND)	IDENT-IO[a]
a. prin·tar	*!	*		*	*					*
b. pu·rin·tar	*!			*	*	*				*
c. pu·rin·ta·ru				*!	*	**				*
d. ☞pu·rin·ta:						*		*		
e. ☞pu·rin·ta						*	*			

The first candidate *prin·tar*, which is the most faithful to the pronunciation in English, is excluded due to the violation of four highest-ranked constraints, *Coda-Condition*, **Complex*^{Ons}, *Ident-IO(consonantal)*, and *Ident-IO([a], Wd])*. Violation of **Complex*^{Ons} is avoided if a vowel is inserted between onset consonants, which yields the candidate (b) *pu·rin·tar*. But, since the candidate still violates three other highest-ranked constraints *Coda-Condition*, *Ident-IO(consonantal)*, and *Ident-IO([a], Wd])*, this is not the optimal output, either. One way to avoid the violation of *Coda-Condition* is to insert a vowel after the word-final [r], which yields the candidate (c) *pu·rin·ta·ru*. However, this is also ruled out, because the candidate violates two undominated constraints, *Ident-IO(consonantal)*, and *Ident-IO([a], Wd])*. In this case, as shown in the tableau, the two candidates, the candidate (d) *pu·rin·ta:* and the candidate (e) *pu·rin·ta*, are selected as the optimal outputs, due to the two freely ranked constraints *Max-IO* and **[a:]*. Consider the tableau (80) and (81).

(80) *Max-IO* >> **[a:]*

Input: printer	CODA-COND	*[σCC	I-CONTIG	IDENT-IO(C)	IDENT-IO([a], WD)]	DEP-IO	MAX-IO	*[a:]	SPREAD (+ROUND)	IDENT-IO[a]
d. ☞pu·rin·ta:						*		*		
e. pu·rin·ta						*	*!			

The tableau (80) shows the case where *Max-IO* is ranked higher than **[a:]*. In this tableau, the candidate (e) violates the higher constraint *Max-IO*, and the candidate (d) is the optimal output. In this case, the violation of *Dep-IO* is irrelevant to the selection of the optimal output, since both of the two candidates violate it once.

(81) **[a:]* >> *Max-IO*

Input: printer	CODA-COND	*[σCC	I-CONTIG	IDENT-IO(C)	IDENT-IO([a], WD)]	DEP-IO	*[a:]	MAX-IO	SPREAD (+ROUND)	IDENT-IO[a]
d. pu·rin·ta:						*	*!			
e. ☞pu·rin·ta						*		*		

The tableau (81), on the other hand, displays the case where **[a:]* is ranked higher than *Max-IO*. In this case, the candidate (e) is selected as the optimal output form, since the candidate (d) violates **[a:]*, which is ranked higher than *Max-IO* that the candidate (e) violates. The violation of *Dep-IO* is irrelevant in this case also.

To conclude, the two candidates are selected as the optimal output forms in the tableau (79), since each of the two subhierarchies of constraints, one in the tableau (80) and the other in the tableau (81), selects an optional output.

Next, we will analyze the case of the word-medial input [r] in coda position. In this case, unlike the case of the word-final [r] in coda position, the input [r] corresponds to the second half of a long vowel and variants are not allowed.

(82) Word-medial [r] in coda position (=41)

a. términator	→	[ta:miné:ta(:)]	(*[tamine:ta(:)])
b. mórphing	→	[mó:ɸiŋgu]	(*[moɸiŋgu])
c. tárget	→	[tá:getto]	(*[tagetto])
d. arcáde	→	[á:ke:do]	(*[ake:do])
e. párking	→	[pá:kiŋgu]	(*[pakiŋgu])

(83) Word-medial [r] in coda position

(*Max-IO* and **[a:]* are freely ranked.)

'parking'

Input: [pa:king]	CODA-COND	*[σCC	I-CONTIG	IDENT-IO(C)	IDENT-IO ([a], WD)	DEP-IO	MAX-IO	*[a:]	SPREAD (+ROUND)	IDENT-IO[a]
a. par·kiŋg	*!			*						*
b. pa·ru·kiŋ·gu				*!		**				*
c. pa·kiŋ·gu			*!			*	*			
d. ☞pa:·kiŋ·gu						*		*		

The first candidate *par·kiŋg*, which is the most faithful to the pronunciation in English, is excluded due to the violation of two highest-ranked constraints *Coda-Condition* and *Ident-IO(consonantal)*. The candidate (b) *pa·ru·kiŋ·gu* also violates the undominated

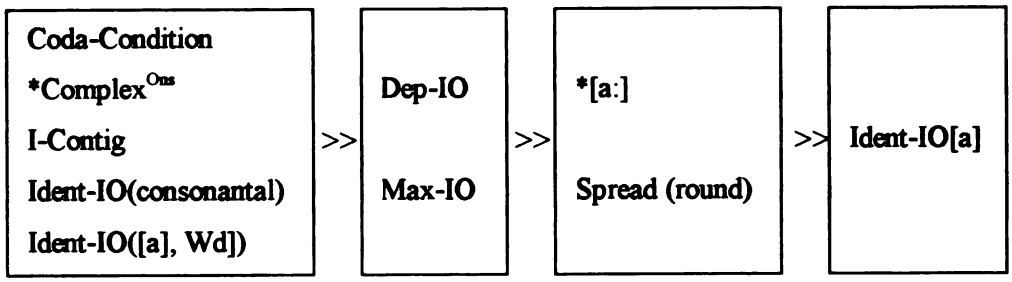
constraint *Ident-IO(consonantal)*. Therefore, this candidate is not the optimal candidate, either. The candidate (c) *pa·kiŋ·gu* where input [r] has no apparent counterpart is ruled out, since it violates one of the highest ranked constraints *I-Contig*. The candidate (c) shows that, although, in the case of word-final [r] in coda position, the candidate where input [r] has no apparent counterpart in the output is one of the optimal outputs as shown in the tableau (79), it is not allowed in the case of word-medial [r] in coda position due to the constraint *I-Contig*. Finally, the candidate (d) *pa:·kiŋ·gu* where the input [r] in coda position corresponds to the second half of a long vowel [a:] in the output is the optimal output form, since, in this case, *Dep-IO* and **[a:]* are irrelevant in the selection of the optimal output.

4.4. Summary

In the preceding section, we obtained three different constraint rankings in terms of the ranking between the two constraints *Max-IO* and **[a:]*, as shown in (84), (85), and (86). Among them, the ranking in (84) applies to the loanwords of the long vowel type, the ranking in (85) applies to the new loanwords, and the ranking in (86) applies to the loanwords with variants. Also we noted in the preceding section that any of the three rankings is consistent with selection of the correct output candidate of loanwords belonging to the '[r] in Onset Position' type and the 'Short [a]' type, since the constraint **[a:]* is irrelevant to the selection of the optimal output candidate of the loanwords belonging to those categories.

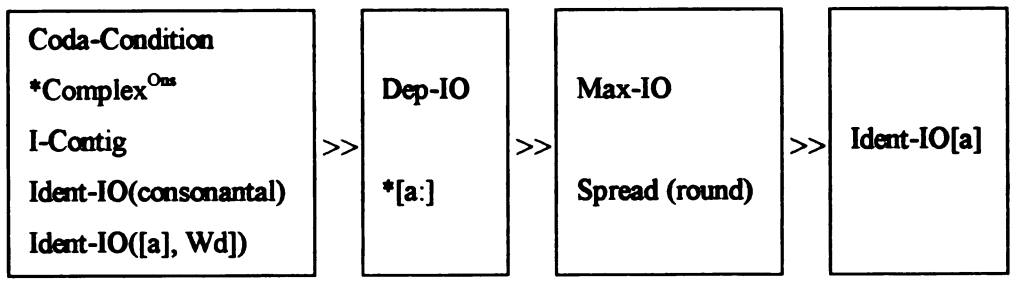
(84) Ranking 1 (*Max-IO* >> **[a:]*) (=71)

(For Long Vowel Type)



(85) Ranking 2 (**[a:]* >> *Max-IO*) (=75)

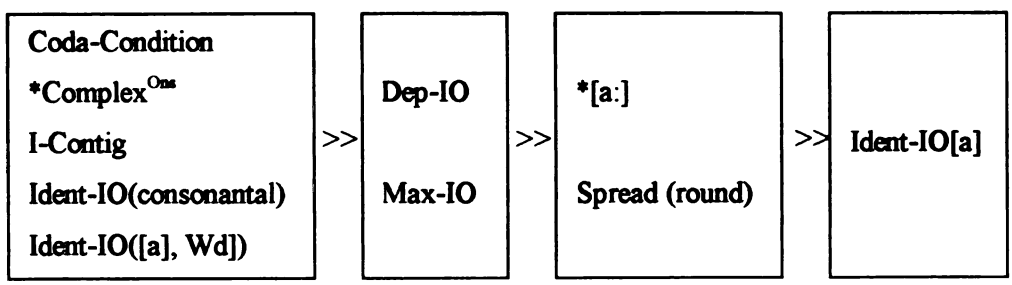
(For New Loanwords)



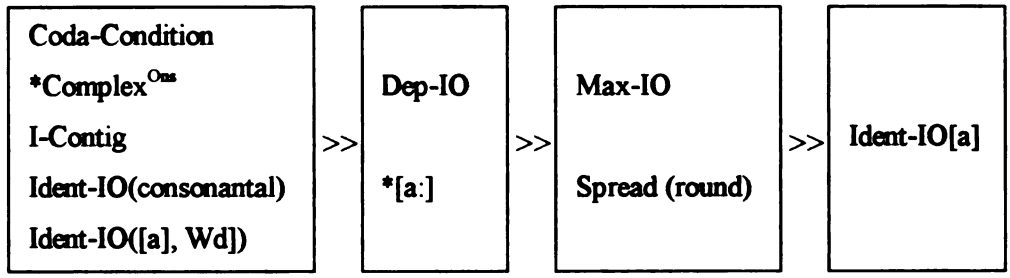
(86) Ranking 3 (*Max-IO* and **[a:]* are freely ranked.) (=79)

(For Variants)

(a) Subhierarchy 1 (*Max-IO* >> **[a:]*) (=80)



(b) Subhierarchy 2 (**[a:] >> Max-IO*) (=81)



The fact that we need the three constraint rankings to explain the realization of [r] in English-based loanwords in Japanese suggests that the category 'loanword' in the Japanese lexicon consists of strata. The notion of 'stratum' in Japanese was first introduced by Itô and Mester (1995), and they argue, as mentioned in chapter 1 of this master's thesis, that the Japanese lexicon consists of the four strata, to each of which slightly different constraint ranking applies. However, the constraint rankings in (84), (85), and (86) show that the category 'loanword', which is one of the four strata shown by Itô and Mester (1995, 1999), and Fukuzawa et al (1998), also consists of strata, or co-phonologies in the sense of Inkelas and Orgun (1995). As shown in the preceding section, moreover, the distinction between the old and the new loanwords is crucial to understand the realization of [r] in English-based loanwords in Japanese, and the following data in (87) support the idea that the constraint ranking has been changing over time.

(87)

English		Japanese	meaning	
a. 'wafer'	→	[weha:]	a thin biscuit	(old loanword)
	→	[weha]	a component of a computer	(new loanword)
b. 'server'	→	[sa:ba:]	a person who puts in play	(old loanword)
	→	[sa:ba]	a computer or a program that renders service to through a network	(new loanword)

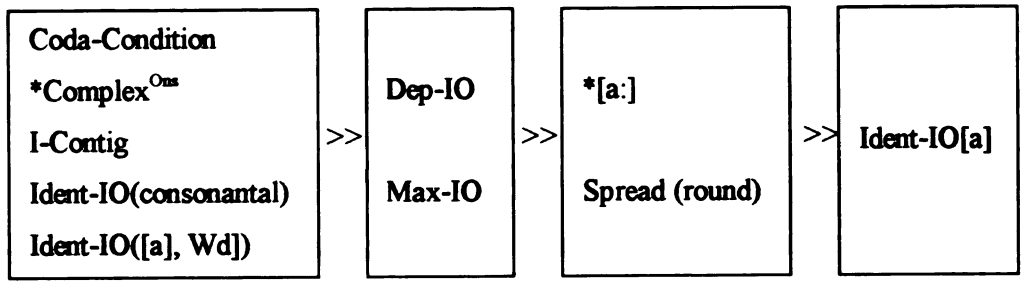
The examples in (87) shows that a single English word corresponds to two outputs in Japanese, depending on the time period it was borrowed, and the first correspondent of each pair does not have the meaning of the second, and vice versa. Therefore we conclude that the constraint ranking has been changing over time, as shown in (88).

(88) a. Old Ranking (=84)

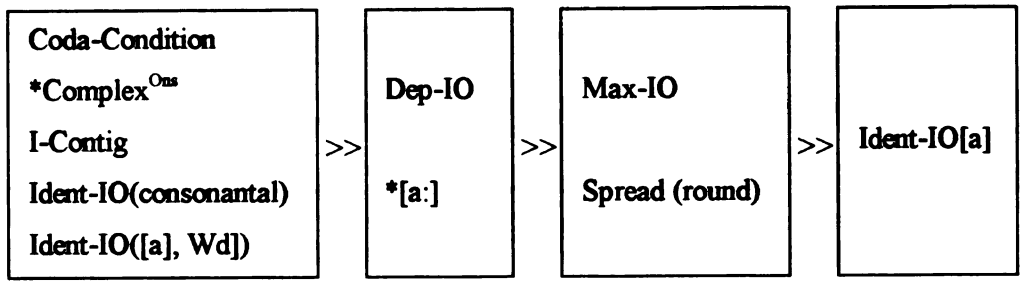
Coda-Condition *Complex^{Ons} I-Contig Ident-IO(consonantal) Ident-IO([a], Wd])	>>	Dep-IO Max-IO	>>	*[a:] Spread (round)	>>	Ident-IO[a]

b. Intermediate Ranking (=86)

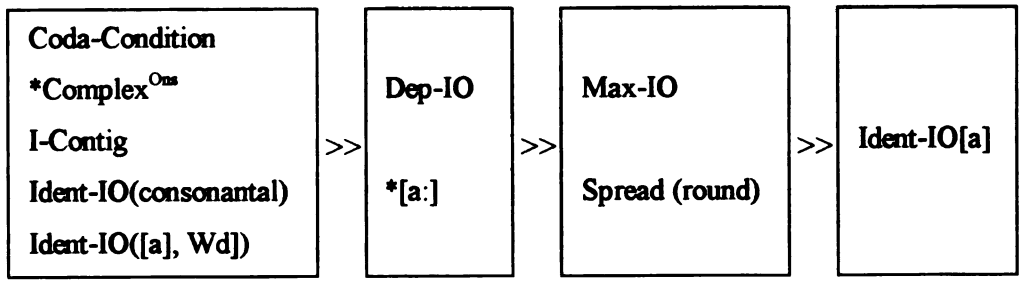
(I) Subhierarchy 1 (*Max-IO* >> **[a:]*)



(II) Subhierarchy 2 (**[a:]* >> *Max-IO*) (=81)



c. New Ranking



5. CONCLUSION

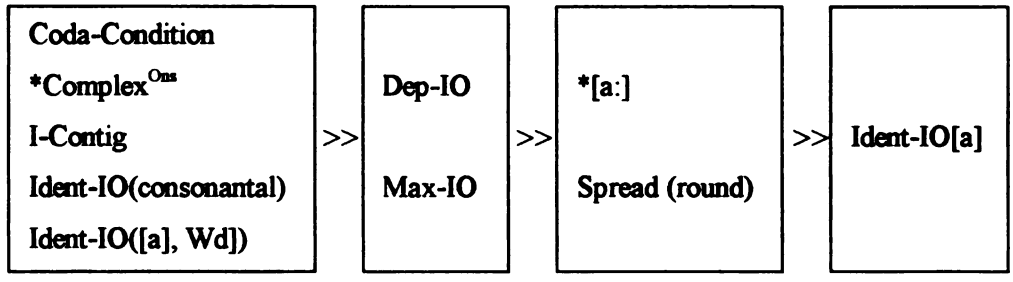
The present study investigates the realization of input [r] in English-based loanwords in Japanese and how this can be analyzed in the framework of OT. The major findings of this study are summarized as follows.

First, English-based loanwords with [r] in the input can be categorized into five groups with regard to the realization of the [r] in the output: English onset [r] which corresponds to [r] in Japanese output, input [r] in coda position which corresponds to a short vowel [a] in Japanese, input [r] in coda position which corresponds to the second half of a long vowel [a:] or [o:], input coda [r] of new loanwords which has no apparent correspondent in output, and input coda [r] which can correspond to either the second half of a long vowel [a:] or [o:], or zero.

Second, as discussed in chapter 4, we need three constraint rankings to account for the four coda-[r] types of English-based loanwords, which are repeated here as (89), (90), and (91).

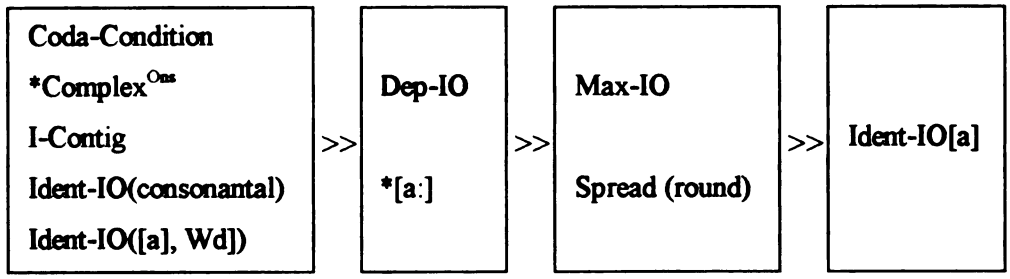
(89) Ranking 1 (*Max-IO* >> **[a:]*) (=71)

(For Long Vowel Type)



(90) Ranking 2 (**[a:] >> Max-IO*) (=75)

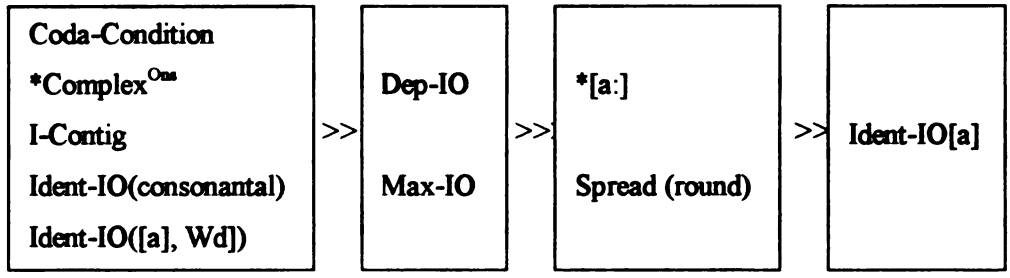
(For New Loanwords)



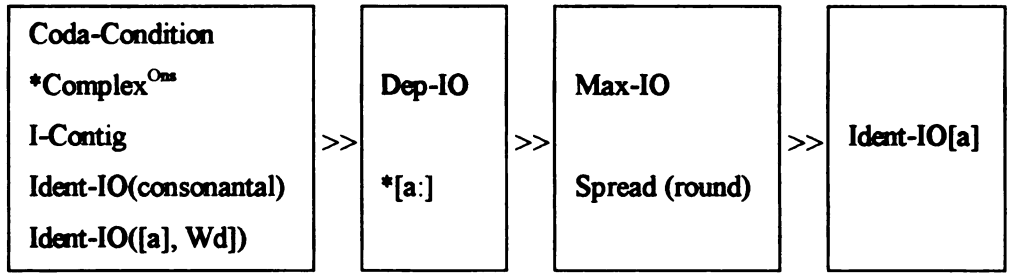
(91) Ranking 3 (*Max-IO* and **[a:]* are freely ranked.) (=79)

(For Variants)

(a) Subhierarchy 1 (*Max-IO >> *[a:]*) (=80)



(b) Subhierarchy 2 (**[a:] >> Max-IO*) (=81)



Although three rankings (89), (90), (91) specifically account for the Long Vowel Type, New Loanwords, and Variants, respectively, each of the rankings can select the correct

output form of loanwords with [r] in onset position and the Short [a] Type as well. Moreover the rankings above indicate that the category 'loanword' of the Japanese lexicon consists of three co-phonologies with regard to the rankings between the two constraints **[a:]* and *Max-IO*. The idea that Japanese loanword phonology consists of co-phonologies supports Inkelas and Orgun (1995) as well as Itô and Mester (1995, 1999).

Third, we have proposed that the constraint ranking has been changing over time, based on the fact that the ranking (89) applies to the old loanwords, the ranking (90) to the new loanwords, and the ranking (91) to some of the old and new loanwords with a heavy penultimate syllable in Japanese outputs. That is, we have discussed that the ranking (89) is the old ranking and the ranking (90) is the new ranking while the ranking (91) is the intermediate ranking.

Fourth, we have shown that we need to distinguish the Perceptual Level from the input, which supports Silverman's (1992) idea. Furthermore, we have discussed that English onset [r] and coda [r] in the input are perceived differently at the Perceptual Level, although, in Silverman's Perceptual Uniformity Hypothesis, a single sound in a source language cannot have more than one acoustic correspondent at the Perceptual Level in the host language.

With regard to the findings of this study, the following researches need to be done in the future.

First, consider the result of the preliminary dictionary research in (92).

(92) The Result of Preliminary Dictionary Research

Category	# of Words (%)
[r] in Onset Position	150 (51.0%)
Short [a] Type	11 (3.7%)
Long Vowel Type	81 (27.6%)
New Loanwords	14 (4.8%)
Variants[20]	38 (12.9%)
Total # of Words	294 (100%)

The data were randomly collected from Horiuchi (1996)[21]. First, the number of loanwords belonging to New Loanword category is smaller than expected, but this might be because this dictionary does not include many computer-related words, which appears to constitute the majority of the category 'New Loanwords'. Second, the category 'Variant' in (92) consists of 29 old loanwords and 9 new loanwords. (See Appendix 2.4.) This partially supports my hypothesis that the ranking (91) is the intermediate ranking and applies to both the old and new loanwords. As mentioned above, however, not all the loanwords with a heavy penultimate syllable in Japanese are categorized in this group. For example, as shown in chapter 3, the latest loanwords with the same structure do not have variation. But, we could not get data supporting this claim. Therefore, a more systematic and statistically significant dictionary research should be done in the future.

[20] Horiuchi (1996) does not show any variations. Therefore, the loanwords shown in this category were judged as 'Variants' based on Akahori (1999), Asano (1999), Inaba (2001), and the author's intuition.

[21] I collected English-based loanwords with [r] in inputs on every ten pages of Horiuchi (1996). The loanwords used as data are shown in Appendix. Horiuchi (1996) is 600-page dictionary, which means the loanwords on 60 pages in total were collected.

Also, with regard to the Variants, we need to answer the question "What characteristics do the loanwords in this category have in common?" Intuitively, two-syllable words tend not to have a variant (e.g. 'father' → [ɸa:za:] (*[ɸa:za]), 'finger' → [ɸiŋga:] (*[ɸiŋga])), but there are exceptions (e.g. 'corner' → [ko:na(:)],'charter' → [ča:ta(:)]). We need further study.

Next, as mentioned above, we have adopted Silverman's (1992) idea that in loanword phonology the input and the Perceptual Level should be separated. We have assumed that Japanese people perceive onset [r] and coda [r] inputs differently, and perceiving coda [r] in inputs as a short vowel [a] at the perceptual level and onset [r] as [r]. The analysis in this study has become straightforward due to this assumption.

However, although we have asserted how English [r] is perceived as the Perceptual Level, we do no opinion how other English input phones are perceived at the Perceptual Level. For example, whereas Japanese has only five vowels, English has many more, which implies complex correspondence patterns of vowels. Also, as briefly mentioned in chapter 1, schwas in English inputs can correspond to the five vowels in Japanese, which suggests that a single phonetic sound in input can have more than one correspondents in output depending on the environments in which it occurs. How to analyze vowel adaptation in terms of Silverman's morel requires further study.

APPENDIX

We will show the word list of randomly selected loanwords for the preliminary dictionary research, the result of which was given in chapter 5.

1. [r] in Onset Position (150 words)

'Abrahum'	[aburahamu]	'brand'	[burando]
'Africanthropus'	[aɸurikantoropusu]	'cambric'	[k^{y}amburikku]
'Afro'	[aɸuro]	'cantering'	[k^{y}antariŋgu]
'urushiol'	[urušio:ru]	'carotene'	[karočiN]
'Africanization'	[aɸurikanaize:šoN]	'carotenoid'	[karotenoido]
'Afrikaans'	[aɸurika:nsu]	'chevron'	[šeburoN]
'Afrikaner'	[aɸurika:na]	'chicory'	[čikori:]
'Russian'	[rošiaN]	'corporation'	[ko:pore:šoN]
'a priori'	[a piriori]	'correct'	[korekuto]
'acerola'	[aserora]	'crab'	[kurabu]
'anthropology'	[ansuroporoǰi:]	'craftman'	[kuraɸutomaN]
'anthurium'	[ansur^{y}u:mu]	'craft'	[kuraɸuto]
'appreciation'	[apurishie:šoN]	'crawl'	[kuro:ru]
'approach'	[apuro:či]	'crony'	[kuro:ni:]
'approval'	[apuru:baru]	'currants'	[karend^{z}u]
'apricot'	[apurikotto]	'currency'	[karenši:]
'auditorium'	[o:ditoriamu]	'current'	[karento]
'authority'	[o:soriti]	'diagram'	[daiyaguramu]
'authorize'	[o:soraid^{z}u]	'direct'	[dairekuto]
'autocracy'	[o:tokuraši:]	'director'	[direkuta:]
'autograph'	[o:toguraɸu]	'earring'	[iyariŋgu]
'brain'	[bure:N]	'editorial'	[editoriaru]
'branch'	[buranči]	'eraser'	[ire:za(:)]

‘filaria’	[ɸiraria]
‘framework’	[ɸure:muwa:ku]
‘frame’	[ɸure:mu]
‘franchise’	[ɸurančaidᶻu]
‘francium’	[ɸuranšiumu]
‘garage’	[gare:ǰi]
‘generalist’	[ǰenerarisuto]
‘generation’	[ǰenere:ɸure:mu]
‘generator’	[ǰenere:ta(:)]
‘gerontocracy’	[ǰerontokuraši:]
‘gerontology’	[ǰerontoroǰi:]
‘gerund’	[ǰerando]
‘glamorous’	[guramarasu]
‘graffiti’	[guraɸiti]
‘grammar’	[gurama:]
‘graphic’	[guraɸikku]
‘graphite’	[guraɸaito]
‘graph’	[guraɸu]
‘grommet’	[guramitto]
‘illustrate’	[irasutore:to]
‘illustration’	[irasutore:šoN]
‘illustrator’	[irasutore:ta:]
‘imperialism’	[imperiaridᶻumu]
‘imperial’	[imperiaru]
‘impression’	[impuresšoN]
‘impressive’	[impuresshibu]
‘improvisation’	[impurobize:šoN]
‘inventory’	[imbentori:]
‘iridium’	[iriǰiumu]
‘irradiation’	[iraǰe:šoN]
‘irrational’	[irašonaru]
‘irregular’	[iregʸura:]
‘isometrics’	[aisometorikkusu]
‘kangaroo’	[kaŋgaru:]
‘kraft’	[kuraɸuto]
‘margarine’	[ma:gariN]
‘marguerite’	[ma:garetto]
‘mercury’	[ma:kʸuri:]
‘mushroom’	[mašuru:mu]
‘obstruction’	[obusutorakušoN]
‘ophthalmograph’	[oɸusarumoguraɸu]
‘pedigree’	[pediguri:]
‘plunger’	[puranǰa(:)]
‘produce’	[purodʸu:su]
‘producer’	[purodʸu:sa(:)]
‘profile’	[puroɸi:ru]
‘propaganda’	[puropaganda]
‘property’	[puropati(:)]
‘proper’	[puropa:]
‘protection’	[purotekušoN]
‘protector’	[purotekuta:]
‘protect’	[purotekuto]
‘protein’	[puroteiN]
‘protestant’	[purotesutanto]
‘protest’	[purotesuto]
‘protocol’	[purotokoru]
‘prototype’	[purototaipu]
‘provider’	[purobaida]
‘radian’	[raǰiaN]
‘radiator’	[raǰie:ta:]

'radical'	[rajikaru]	'sabra'	[sabura]
'radio'	[rajio]	'safari'	[saɸari]
		'saffron'	[saɸuraN]
'radium'	[rajiumu]	'sheriff'	[šeriɸu]
'read'	[ri:do]	'submarine'	[sabumariN]
'reception'	[resepušoN]	'subscribe'	[sabusukuraibu]
'receptor'	[reseputa:]	'subtrack'	[sabutorakku]
'recover'	[rikaba:]	'synchrotron'	[šiŋkurotoroN]
'reef'	[ri:ɸu]	'syrup'	[široppu]
'reel'	[ri:ru]	'tracer'	[tore:sa(:)]
'relation'	[rire:šoN]	'trade'	[tore:do]
'request'	[rikuesuto]	'trader'*	[tore:da(:)]
'rescue'	[resuk^{y}u:]	'trainer'	[tore:na(:)]
'response'	[resuponsu]	'tray'	[tore:]
'restaurant'	[resutoraN]	'tyrannosaurus'	[tiranosaurusu]
'restore'	[resutoa]	'tyrant'	[tairanto]
'rest'	[resuto]	'ultramarine'	[urutoramariN]
'rewind'	[riwaindo]	'ultranationalism'	[urutoranašonarid^{z}umu]
'ring'	[riŋgu]	'ultra'	[urutora]
'rink'	[riŋku]	'underground'	[anda:gurauNdo]
'rinse'	[rinsu]	'veteran'	[beteraN]
'rocket'	[roketto]	'wrestler'	[resura:]

2. [r] in Coda Position

2.1. Short [a] Type (11 words)

'campfire'	[k^{y}ampuɸaia]	'pedicure'	[pedik^{y}ua]
'cashmere'	[kašimia]	'restore'	[resutoa]
'conveyer'	[kombea]	'sapphire'	[saɸaia]
'earring'	[iyariŋgu]	'score'	[sukoa]
'impairment'	[impeamento]	'underwear'	[anda:wea]
'offshore'	[oɸušoa]		

2.2. Long Vowel Type (81 words)

'appetizer'	[apetaiza:]	'import'	[impo:to]
'banker'	[baŋka:]	'incomer'	[iŋkama:]
'bunker'	[baŋka:]	'irregular'	[ireg^{y}ura:]
'canter'	[kanta:]	'letter'	[reta:]
'caster'	[kasuta:]	'liquor'	[rik^{y}u:ru]
'charge'	[ča:ǰi]	'major'	[meja:]
'charm'	[ča:mu]	'margarine'	[ma:gariN]
'chart'	[ča:to]	'marguerite'	[ma:garetto]
'charter'	[ča:ta(:)]	'marker'	[ma:ka(:)]
'church'	[ča:či]	'market'	[ma:ketto]
'corner'	[ko:na(:)]	'mercury'	[ma:k^{y}uri:]
'corporation'	[ko:pore:šoN]	'mixer'	[mikisa:]
'custard'	[kasuta:do]	'morning'	[mo:niŋgu]
'defroster'	[deɸurosuta:]	'north'	[no:su]
'director'	[direkuta:]	'order'	[o:da:]
'editor'	[edita:]	'orthodox'	[o:sodokkusu]
'father'	[ɸa:za:]	'parlor'	[pa:ra(:)]
'filter'	[ɸiruta:]	'pepper'	[peppa:]
'finger'	[ɸiŋga:]	'permanent'	[pa:manento]
'framework'	[ɸure:muwa:ku]	'player'	[pure:ya(:)]
'fur'	[ɸa:]	'popcorn'	[poppuko:N]
'gambler'	[g^{y}ambura:]	'pork'	[po:ku]
'glamour'	[gurama:]	'powder'	[pauda:]
'grammar'	[gurama:]	'proper'	[puropa:]
'hanger'	[haŋga:]	'protector'	[purotekuta:]
'harmony'	[ha:moni:]	'purple'	[pa:puru]
'hooker'	[ɸukka:]	'receptor'	[reseputa:]
'horse'	[ho:su]	'recover'	[rikaba:]
'hunger'	[haŋga:]	'safflower'	[saɸurawa:]
'hurler'	[ha:ra(:)]	'shelter'	[šeruta:]

'sinker'	[šiŋka:]	'star'	[suta:]
'sir'	[sa:]	'start'	[suta:to]
'snowboard'	[suno:bo:do]	'starter'	[suta:ta(:)]
'sort'	[so:to]	'subculture'	[sabukaruča:]
'source'	[so:su]	'underground'	[anda:guraundo]
'spar'	[supa:]	'underwear'	[anda:wea]
'spark'	[supa:ku]	'under'	[anda:]
'spider'	[supaida:]	'vermilion'	[ba:mirioN]
'spiker'	[supaika:]	'visitor'	[bi̯i̯ta:]
'spurt'	[supa:to]	'wrestler'	[resura:]
'starch'	[suta:či]		

2.3. New Loanwords (14 words)

'Afrikaner'	[aɸurika:na]	'mixture'	[mikusuča]
'assembler'	[asembura]	'perfumer'	[pa:ɸ^{y}u:ma(:)]
'divorce'	[dibo:su]	'permission'	[pa:mišoN]
'harvest'	[ha:besuto]	'permutation'	[pa:m^{y}ute:šoN]
'hurler'	[ha:ra(:)]	'portion'	[po:šoN]
'important'	[impo:tanto]	'provider"	[purobaida]
'investor'	[imbesuta]	'voucher'	[bauča]

2.4. Variants (38 words)

(The asterisk indicates the new loanwords.)

'applicator'*	[apurike:ta(:)]	'developer'	[deberoppa(:)]
'calendar'	[karenda(:)]	'educator'	[ed^{y}uke:ta(:)]
'camber'	[k^{y}amba(:)]	'eraser'*	[ire:za(:)]
'charter'	[ča:ta(:)]	'flavor'*	[ɸure:ba(:)]
'clover'	[kuro:ba(:)]	'generator'*	[i̯enere:ta(:)]
'corner'	[ko:na(:)]	'hangover'*	[haŋguo:ba(:)]
'deflator'	[deɸure:ta(:)]	'hurler'	[ha:ra(:)]

'illustrator'	[irasutore:ta(:)]
'invader'	[imbe:da(:)]
'isolator'*	[aisore:ta(:)]
'maker'	[me:ka(:)]
'marker'	[ma:ka(:)]
'meter'	[me:ta(:)]
'motor'	[mo:ta(:)]
'observer'	[obuza:ba(:)]
'parlor'	[pa:ra(:)]
'perfumer'*	[pa:ɸ^{y}u:ma(:)]
'plunger'*	[puranǰa(:)]
'planner'	[puranna(:)]
'planter'	[puranta(:)]
'player'	[pure:ya(:)]
'poker'	[po:ka(:)]
'producer'	[purod^{y}u:sa(:)]
'radiator'	[rajie:ta(:)]
'solar'	[so:ra(:)]
'starter'	[suta:ta(:)]
'submanager'	[sabumane:ja(:)]
'sweater'	[se:ta(:)]
'tracer'	[tore:sa(:)]
'trader'*	[tore:da(:)]
'trainer'	[tore:na(:)]

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Max-IO in (53) is the constraint that ensures that all the elements in inputs are preserved in outputs. In that sense, *Max-IO* is the anti-deletion constraint. *Dep-IO* in (54), on the other hand, is the anti-insertion constraint, since this constraint means that all the elements in outputs must have a correspondent in inputs. *I-Contig* in (55) specifically ensures that all the word-medial segments in inputs are preserved in outputs. That is, *I-Contig*, as well as *Max-IO*, is an anti-deletion constraint. However, the edges of words are out of the sphere of this constraint, in which point *I-Contig* is different from *Max-IO*. Since all the word-medial segments in inputs have corresponding segment in outputs, we assume that *I-Contig* is ranked highest in the hierarchy. The last three constraints, *Ident-IO(consonantal)* in (56), *Ident-IO[a]* in (57), and *Ident-IO([a], Wd])* in (58), are members of a constraint family *Ident-IO*, which was first introduced by Prince and Smolensky (1993). *Ident-IO(consonantal)* in (56) stipulates that an element of inputs and its correspondent in outputs must be identical with regard to the feature [consonantal]. In other words, this constraint assures that the correspondent of a consonant in inputs must be a consonant in outputs and the correspondent of a vowel in inputs must be a vowel in outputs. We assume that this constraint is also undominated in the constraint ranking, since every consonant in inputs corresponds to a consonant in outputs. *Ident-IO[a]* in (57) is conjunction of three constraints: *Ident-IO(-high)*, *Ident-IO(+back)*, and *Ident-IO(-round)*. We use *Ident-IO[a]*, instead of the two distinct *Ident-IO* constraints, only for simplicity. *Ident-IO[a]* means that an input and an output must be identical in terms of features [-high], [+back], and [-round]. As mentioned above, since we assume that coda [r] in inputs is perceived as [a] at the perception level, this constraint is significant for the realization of coda [r]. *Ident-IO([a], Wd])* in (58) is a positional faithfulness constraint of

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(57). The domain of *Ident-IO([a], Wd])* is the word-final segment. The notion of 'positional faithfulness' constraints in OT was first introduced by Beckman (1997). In Beckman (1997), the domains positional faithfulness constraints apply in are initial positions only, e.g. word-initial, and syllabic-initial. But, in this master's thesis, we extend Beckman's idea and assume that positional faithfulness constraints can apply to word-final position. That is, we speculate that word-final position in Japanese is salient enough to maintain the full realization of the most sonorous vowel [a], while word-medial position is not. Pairs of faithfulness constraints such as (57) and (58) must be "universally ranked such that the position-specific constraint is ranked above the general, position-insensitive constraint" (Kager 1999: 409), as given in (59). We assume that *Ident-IO([a], Wd])* is ranked highest, since there is no loanword violating this constraint.

(59) Ident-IO([a], Wd]) >> Ident-IO[a]

Moreover, for word-medial coda [r] to be able to correspond to the second half of a long vowel [o:], we rank *Spread (+round)* in (51) between the two constraints in (59), as shown in (60).

(60) Ident-IO([a], Wd]) >> Spread (+round) >> Ident-IO[a]

4.3. OT Analysis

In this section, we will analyze the data in the framework of OT using the constraints introduced in the previous section.