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STOP PERCEPTION IN SECOND LANGUAGE PHONOLOGY:

PERCEPTION OF ENGLISH AND KOREAN STOPS

BY JAPANESE SPEAKERS

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To my parents

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ABSTRACT

This dissertation sought to identify the perception patterns of English and Korean stops by Japanese speakers who have little knowledge of English or Korean.

Four experiments were conducted. Experiments J-E 1 and J-E 2 investigated how English word-final single stops (e.g. /p/ in *cap*) and word-medial stop clusters (e.g. /pt/ in *chapter*) were perceived by Japanese speakers. Perception of place and of the mora obstruent (/Q/) were examined for both word-medial and word-final stops. Additionally, the effects of coda voicing and vowel tenseness on word-final stops, and the effect of stress patterns on word-medial stop clusters were examined.

Experiments J-K 1 and J-K 2 examined Korean single stops in different word positions and word-medial stop clusters. /Q/ perception is examined for both experiments. Additionally, perception of voicing for single stops, and place identification for word-medial stop clusters were examined.

Results indicate that actual stop perception has both similarities and difference from loanword phonology which allows /Q/ plus voiced coda but avoid /Q/ plus long nuclei. Japanese hearers rarely perceive either long nuclei plus /Q/ or /Q/ plus voiced codas. Also, the ratio of stop closure duration and vowel length was found to be important, although it cannot always predict /Q/ perception. Results of J-E 2 indicate that Japanese speakers frequently perceive /Q/ in word-medial heterorganic stop clusters, and they were quite successful at identifying the places of articulation despite the fact that Japanese does not allow

any underlying heterorganic stop clusters. Stress pattern also influenced /Q/ perception and identification of stops.

The Korean perception experiments showed a different pattern from Korean loanword phonology. Different word positions make different types of stop difficult to distinguish, both in voicing and /Q/ perception. Word-final Korean stops were often perceived as /Q/, despite the "irregularity" of final /Q/ in Japanese.

Korean word-medial stops were often perceived with /Q/, without identified place of articulation.

These four experiments indicate that the different phonetic characteristics and stress patterns create different stop perception patterns.

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CHAPTER 1

INTRODUCTION

Some of the major problems which a second language learner may experience involve misperceiving and mispronouncing foreign sounds which do not exist in the learner's first language. It is commonly observed in second language acquisition that such foreign sounds undergo modifications according to the phonology of the learner's first language. As Japanese has relatively simple forms in terms of phonotactics, syllable structure, and phonemes, foreign words undergo various changes in phonological form according to the linguistic constraints of the Japanese language. For example, *McDonald* is borrowed as /makudonarudo/ and *strike* as /sutoraiku/ and /sutoraiki/: Consonant clusters are broken up with inserted vowels, and missing phonemes such as /l/ are replaced by the Japanese closest equivalent /r/[1].

One of these phonological changes is consonant gemination, which is sometimes interpreted as a moraic obstruent or /Q/ insertion (see Chapter 3.1.1 for /Q/ as a phoneme). Many English words are borrowed with geminates (small 'tsu', ッ) in Japanese. For example, *cut* is borrowed as カット /kaQto/, not as カト /kato/. Needless to say, the original English words of such loanwords do not contain a geminate consonant cluster. Thus, this phenomenon is an insertion of a non-existing sound, rather than modification of a non-Japanese

[1] Japanese liquid is ordinarily the apico-alveolar tap [ɾ] (Vance, 1987).

phoneme. Forms such as カト /kato/ are possible in Japanese, so the gemination, or /Q/ insertion, is not due to a difficulty in producing forms like /kato/. It would be acceptable to borrow *cut* without gemination. As gemination is not motivated by difficulties in production, we could assume that this phenomenon probably occurs at the level of perception rather than at the level of production.

The same phenomenon is found in the ESL situation. Japanese English learners commonly pronounce English words with /Q/, e.g., [rukku atto zatto] for *'Look at that'*.

There have been many studies which have investigated why English loanwords in Japanese (and English spoken by Japanese speakers) undergo gemination, but this question is not completely answered, especially in language acquisition. Additionally, most studies regarding gemination are investigating English loanwords and an ESL situation. It is not clear how stops in other languages are perceived by Japanese speakers.

English is not the only foreign language which may be heard with geminates or the moraic obstruent /Q/. Japanese speakers may perceive /Q/ in the Korean language as well. Many introductory Korean textbooks published in Japan use *kana* orthography[2] to indicate how to read Korean words. Some Korean aspirated stops and tensed stops are written with /Q/ in *kana*. These text books in general describe Korean tensed stops as equivalent to Japanese

[2] See Appendix C for Japanese *kana* orthography.

geminate consonants (i.e. /QC/ clusters). *Kana* cannot tell the exact pronunciations in most of the cases, but Korean plain stops are usually written without ッ /Q/ in *kana* writing. For example, Kim (1987) introduces Korean /kˈa/, the glottalized or tensed velar voiceless stop, to be pronounced as equivalent to Japanese ッカ /Qka/ [kka]. However, in the actual text, /QC/ clusters are not always found with tensed consonants. For example, /kˈa/[3], which is a question marker, is written as カ [ka] in *kana* without /Q/; e.g., [an njəŋ ha sim ni **kˈa**] 'How are you?' as アンニョンハシムニカ [an njon ha si mu ni **ka**]. However, /acəsˈi/ 'middle aged man' is written as アジョッシ [ajʔ**ossi**] with a /Q/ in *kana* orthography. Korean aspirated consonants are also sometimes written with geminates in *kana*, but not always. For example, one of the Korean language handbooks for travelers (ed. by Kai, 1992) published in Japan uses *kana* transcription to indicate the approximate pronunciation. For example, Korean word /mæ**pʰ**joso/[4] 'ticket booth' is written as メッピョソ[me**pp**joso] in *kana*, but /**pʰ**jəntoo**pʰ**jo/ 'one way ticket' is written as ピョンドピョ [**p**jondo**p**jo] in *kana* without gemination. This is interesting because these textbooks never introduce Korean aspirated stops as equivalent to Japanese geminate consonants. Also the same morpheme / pʰjo / 'ticket' is geminated in the first example but not in the

[3] Stops with /ˈ/ indicates Korean tensed consonants here.
[4] Stop + /ʰ/ indicate aspirated consonants here.

second one. As Korean loanwords are not as common as English loanwords, the treatment of Korean aspirated and tensed stops is not consistent, and different books transcribe Korean words differently. Some are probably spelling-based and some could be perception-based. However, it is not certain how Korean stops are perceived by Japanese speakers, especially at the earliest stage of foreign language acquisition.

A principal aim of this dissertation is to establish the pattern of perception of natural English and Korean stop consonants by Japanese speakers. This dissertation will examine how stops in different languages (i.e., English and Korean) are perceived by Japanese speakers who are at the beginning stage of second language acquisition. Examining and understanding perception at the early stage of foreign language is very important in order to find the potential problems for language learners. These findings will be helpful for foreign language teachers to provide more practical pedagogical methods for teaching listening and speaking.

The main focus of this study will be finding out how the Japanese moraic obstruent /Q/ is perceived in English and Korean. Evidence from loanwords suggests that English and Korean stops may be perceived differently by Japanese speakers. For example, Stop + Stop clusters are usually are not borrowed with /Q/ in English loanwords, e.g., *napkin* is borrowed as [napukin] not *[naQpukin] or *[naQkin]. Korean loanwords show a different pattern. Korean word-final coda stops are dropped and stop clusters are perceived with an unidentified first

stop /Q/, e.g., 'kukpap' as [kuQpa], not as *[kukupapu] or *[kukkupappu]. The two languages may have different factors which influence the coda consonant and /Q/ perception. Comparing /Q/ perception in the two languages will show which factors influence stop perception. /Q/ perception in English learning and in loanwords has been well-studied by many scholars; however, it is not clear if the same principles that apply in English are applicable in other foreign languages. The perception of /Q/ in Korean will provide an answer for this question.

Chapter 2 will sketch the phonologies of Japanese, English, and Korean. Chapter 3 will review some studies dealing with /Q/ perception. Chapter 4 will describe my English word-final and word-medial coda stop perception experiments and Chapter 5, my Korean perception experiments which examine three types of Korean stops in different word positions and word-medial coda stop perception. Both chapters will describe the procedures of data collection; background of participants, materials, and method of data collection, and results. Chapter 6 will be a cross-linguistic discussion. English and Korean stop perception patterns will be compared to see how phonetic differences of the two languages influence stop perception patterns by Japanese speakers. Chapter 7 will contain the conclusions of this project, and will discuss any problems in the overall experiments, some pedagogical suggestions for teaching pronunciation and perception, and some further questions.

CHAPTER 2

PHONOLOGY OF JAPANESE, ENGLISH, AND KOREAN

As this study investigates the perception of English and Korean stops by Japanese speakers, some the basic aspects of phonetics and phonology of the three languages will be introduced in this chapter.

2.1 Japanese phonology

In this section, I will introduce some characteristics of Japanese phonology. Because this study deals with /Q/ perception, some stop and vowel features such as segment length contrasts will be emphasized. The features of stops and vowels are important as the distribution of /Q/ is fairly strictly controlled by the vowel length, type of stop (in terms of voicing) and so on.

2.1.1 Japanese stops

Japanese has a much simpler consonant inventory than English. For example, there are no labiodental or interdental sounds. Ishino (1983) claimed that as Japanese speakers learning English often replace English consonants by Japanese consonants, some differences of pronunciation are inevitable. Loanword phonology reflects the same phenomenon. For example, the voiceless interdental fricative is replaced by /s/, resulting in *thank you* borrowed as /sankjuː/. The following consonant chart is based on Okada (1991) and shows the typical consonants produced by an educated Japanese in his mid-twenties, brought up in the Tokyo area:

Table 2.1 Japanese consonants

	LABIAL	ALVEOLAR	POST ALV.	PALATAL	VELAR	UVULA	GLOTTAL
STOP	p b	t d			k g		(Q)[5]
NASAL	m	n				(N)[6]	
LIQUID			r[7]				
FRICATIVE		s z					h
APPROXIMANT				j	w		

Japanese has 6 distinctive stops, phonemically /p, t, k, b, d, g/. Each of them can appear singleton and geminate, but there are some restrictions on their distributions: /p/ in native and Sino-Japanese words can occur only as geminate, e.g., /haQpa/ → [happa] 'leaf', or following /n/ as in /tanpo/ 'mortgage' in word-medial position (Fukui, 1978). Voiced geminate stops are only found in loanwords. More characteristics of geminate consonants will be discussed in Chapter 3.

[5] /Q/ is the first half of a geminate obstruent. It could be treated as a phoneme, but some linguists believe that there is no phoneme /Q/. See Chapter 3 for details.

[6] Some linguists treat syllable final nasal as a phoneme /N/ which differs from /n/. In this view, /N/ is often described as a moraic nasal which forms a mora by itself (see Okada, 1991).

[7] /r/ is included in stop category as /ɖ/in Okada's chart. He describes this sound as slightly affricated initially, and flapped intervocalically.

Labial stops and velar stops are basically identical in place of articulation to their English counterparts, while alveolar stops are somewhat different and described as 'lamino-alveolar' which means that the blade of the tongue is the lower articulator and the alveolar ridge is the upper articulator (Catford, 1977; Vance, 1987).

Voiceless stops are described differently by scholars in terms of aspiration. Some claim that Japanese voiceless stops are unaspirated (e.g., Vance, 1987; Tsujimura, 1996), while others say they are weakly aspirated. Homma (1980) reports that Japanese voiceless stops have positive VOT while voiced stops have negative VOT. The average VOT of Japanese initial /t/ in her study is 25 ms., which falls between the means for unaspirated /t/ and aspirated /t/ in other languages. Han (1992) reported that VOT for Japanese /t/ is 12.0 ms, and 8.1 ms for geminate /tt/. In her study, single stops are found with longer VOT than their geminate counterparts: 7.7 ms for /p/, 6.3 ms for /pp/, 17.9 ms for /k/, and 11.1 ms for /kk/. These values are much smaller than the average VOT of English initial /t/, which is 70 ms, as reported by Lisker and Abramson (1964). Although different studies treat Japanese voiceless stops a little differently in terms of VOT, these studies agree that Japanese voiceless stops are not as strongly aspirated as English ones. Regardless of the degree of aspiration, there is no contrast of aspirated stops vs. unaspirated stops in Japanese. Aspiration is not a distinctive feature of Japanese stops.

2.1.2 Japanese syllable structure and consonant clusters

Japanese has relatively simple syllable structure. Most of the syllables are open, and consonants can be followed by a vowel or the semi-vowel /j/plus a vowel. We find CV or V and CGV. Consonants are not syllabic and do not form underlying consonant clusters, except for geminates. The only closed syllables are word internal geminate consonants and final /N/, which is described by Okada (1991) as a syllabic uvular nasal with a loose tongue contact or a close to half-close nasalized vowel.

The following are some examples which illustrate these various syllable types:

CV	**[ki]**	'tree'
V:	**[iː]**	'good'
CGV	**[kjo**nen]	'last year'
VC	**[ik**ki]	'a riot'
VN	**[un]**	'fortune'
CVN	**[hon]**	'book'

As Japanese allows limited types of consonant clusters, English words are destined to change their syllable structures when they are borrowed into Japanese. When foreign words are borrowed into Japanese, they have to be transcribed in *katakana*, which is a Japanese phonetic script. Once an English word is transcribed in *katakana*, it is a pure Japanese word with Japanese

pronunciation (Kay, 1986). In *katakana* transcription, consonant clusters in English are broken up with vowels, and English words which end in consonants other than /n/ have to end in a vowel (Kay, 1995). The following are some examples:

[kompju:ta:]	'computer'
[ekisutora]	'extra'
[sutoraiku]	'strike'

According to the syllable structure of Japanese, it is impossible to transcribe an English word *strike* as a one-syllable word. *Katakana* transcription is often used as a 'phonetic alphabet' to indicate an approximate pronunciation of English words. This strategy is commonly used by Japanese speakers learning English, especially at the beginning level. However, *katakana* transcription violates the syllable structure of English and causes incorrect pronunciation.

It has been noted that Japanese does not allow any consonant clusters or closed syllables except those with geminate consonants and syllable final moraic nasal. However, the vowel deletion rule, "high vowels are often devoiced and deleted between voiceless sounds, or between a voiceless sound and a pause" may create English-like consonant clusters at the production level. If the vowel devoicing and deletion rule is applied in an ESL situation, Japanese speakers may pronounce target-like English consonant clusters. The vowel devoicing and deletion rule is especially likely to happen in running speech (Major, 1987c).

Major used the following example to show how English consonant clusters produced by Japanese speakers end up as target-like productions:

Vowel insertion	/disk/ → [disuku]
Vowel devoicing	[disuku] → [disu̥ku̥]
Vowel deletion	[disu̥ku̥] → [disk]

Vowel devoicing and deletion will be discussed in the following vowel section.

2.1.3 Japanese vowels

Japanese has 5 vowels /i, e, a, o, u/[8]. Each of them can be short or long, but there is no striking difference in vowel quality between short and long vowels (Vance, 1987). These vowels do not have a noticeable shift in quality (i.e., diphthongization) as they are being produced. In Japanese, a long vowel is a vowel which has a duration roughly equivalent to that of two identical short vowels produced consecutively. A short vowel counts as one timing unit (i.e., one mora) while a long vowel counts as two units (i.e., two moras). A vowel length difference may be subject to free variation in emphasized speech, such as おい[oi] 'hey' and its emphasized form おーい[oːi]. However, in many cases, changing vowel length can change the meaning of words. Each of the five vowels can occur both short and long, and this creates minimal pairs which differ only in vowel length. Some examples are shown below:

[8] The exact phonetic realization of each vowel is ignored here.

short /i/	ojisan	[ojisan]	'middle aged man'
long /i:/	ojiisan	[oji:san]	'old man'
short /o/	kodoku	[kodoku]	'loneliness'
long /o:/	koodoku	[ko:doku]	'subscription'

Long vowels differ from short vowels in terms of their preferred distribution. Short vowels can follow and precede any segments; however, long vowels are disfavored before the moraic obstruent /Q/. Examples of long vowel plus /Q/ are limited to emphasized speech and the outcomes of morphological processes.

emphasized speech

/toQtemo/ → /to:Qtemo/ 'very'

/soQto/ → /so:Qto/ 'quietly'

morphological process[9]

{to:r-}+ {-ta} (past tense) → /to:Qta/ 'passed by'

{ko:r-}+ {-ta} (past tense) → /ko:Qta/ 'frozen'

Avoidance of a long vowel plus /Q/ is reflected in loanword phonology and L2 phonology. More details will be discussed in Chapter 3.

[9] Past tense derivation in Japanese is complex. Geminates result when the allomorph of the negative marker's stem ends in any of /t, r, w/ (Vance, 1987).

Japanese vowels may be devoiced and often deleted in certain phonological environments. Devoicing mainly affects unstressed /i/ and /u/ between voiceless consonants or between a voiceless consonant and a pause. The following are examples:

[kḭkai]	'machine'
[kṵsa]	'grass'
[akḭ]	'autumn'
[imasṵ]	'There is~'

As discussed in the earlier section, devoiced vowels are often deleted, especially in a casual speech.

2.2 English Phonology

In this section, English consonants and vowels will be introduced. A brief phonological and phonetic description of some aspects of English stop-aspiration, syllable structures, cluster assimilation, and vowel length and quality will be given here.

2.2.1 English stops

English phonemic consonants are seen in the following chart, based on Giegerich (1992).

Table 2.2 English Consonants

	LABIAL	LAB.-DENT.	DENT.	ALV.	POST ALV.	PAL.-ALV.	PALATAL	VELAR	GLOTTAL
STOP	p b			t d				k g	
AFFRICATE						č ǰ			
FRICATIVE		f v	θ ð	s z		š ž		h	
NASAL	m			n				ŋ	
LIQUID				l		r			
APPROXIMANT							j	w	

English has 6 distinctive stops, phonemically /p, t, k, b, d, g/, as does Japanese. As discussed in the earlier section on Japanese stops, English labial and velar stops are basically identical in place of articulation to their Japanese counterparts. /t, d/ are apico-alveolar stops in English while they are often described as lamino-alveolar stops in Japanese. One of the characteristics of English is aspiration of voiceless stops. Aspiration of voiceless stops is realized when the voicing of the following segment does not begin immediately with the release of the stop, but after a short delay. Aspiration of voiceless stops is observed in syllable initial position; however, it is strongest in stressed word-initial position. Aspiration is not observed when another consonant such as /s/ precedes stops (Giegerich, 1992). The following words are examples of aspirated vs. unaspirated stops from Giegerich (1992):

	aspirated	unaspirated
/p/	pit [pʰɪt]	spit [spɪt]
/t/	tie [tʰaɪ]	sty [staɪ]
/k/	come [kʰʌm]	scum [skʌm]

English has greater VOT values than Japanese. Lisker and Abramson (1964) report that the average VOT of English initial /t/ is 70 ms in their study.

English stops vary allophonically as released and unreleased. Unreleased stops may occur in two phonological environments; word-medial position before another non-continuant consonant and word-final position:

	word-medial	word-final
/p/	captain [kʰæp˺tən]	cap [kʰæp˺]
/t/	hatpin [hæt˺pɪn]	hat [hæt˺]
/k/	blackboard [blæk˺bɔd]	black [blæk˺]

Word-medial unreleased stops may involve gestural overlap. The second closure begins before the first is released. For example, the /p/ in *captain* is not released, anticipating the secondary closure of the following /t/ (Giegerich, 1992).

2.2.2 English consonant clusters

English has more complex consonant clusters compared to Japanese. English allows different stops within a cluster, e.g. /pt/ in *captain*, while Japanese allows only geminate consonant clusters in lexical forms. English consonant clusters may undergo place assimilation in casual speech. Coronals assimilate in place to following velar and labial consonants. However, in English place assimilation, labials rarely assimilate to a following velar consonants. The stop cluster /dk/ in *red car* /red kaː/ may become [reg kaː], but the /pk/ cluster in *leap quickly* /lip kwɪklɪ/ will not become *[lik kwɪklɪ] (Jun, 1996). Giegerich (1992) reports some examples of English geminate consonants. English may have geminate consonants at morpheme boundary, such as *weight-training* /wet-trenɪŋ/ and *bus-stop* /bʌs-stɒp/. Unlike Japanese geminate consonants, these English geminates can be simplified as [weʔtrenɪŋ] and [bʌstɒp]. Han (1992) mentioned that English geminate stops differ in phonetic manifestation. Words like *Nippon* 'Japan' are pronounced differently by Americans learning Japanese and native speakers of Japanese even though the phonemes are the same. Han claimed that this could be due to the stop closure duration difference in the two languages.

2.2.3 English vowels

One difference between English and Japanese vowels is that English vowels have a tense/lax distinction[10], while there is no such distinction in Japanese. One difference between tense and lax vowels is vowel length. English tense vowels are usually considerably longer than the corresponding lax vowels (Jakobson, Fant, and Halle, 1969). Giegerich (1992) mentioned that regarding tenseness, the vowel length difference may not be the primary feature which distinguishes tense and lax vowels[11]. This is different from Japanese, where the vowel length distinction is a crucial factor, and there is little qualitative difference between long and short vowels. Giegerich reported that speakers of RP (received pronunciation) and GA (general American) would recognize the vowel tenseness distinction in terms of a qualitative difference rather than a quantitative difference. For example, if a speaker produces /i/ in *beat* with the quality of /i/ but with the length of /ɪ/, listeners will still identify the vowel as

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[10] Different scholars have used different criteria to define the tense/ lax feature for vowels. The problems of definition arise mainly because the phonetic distinction between tense and lax vowels is confused with the phonological difference between English tense (Middle English long) and lax (Middle English short) vowels. For example, Giegerich (1992) and Ladefoged (1982) used phonological criteria such as 'lax vowels are the ones which can only occur in closed syllable', noting that, e.g., /bɪt/, /bɛt/ are possible words in English, but not */bɪ/, */bɛ/. Donegan (1978) claims that tenseness is a phonetic feature; intensity of color (palatality or labiality) for a given degree of height. The English vowels create a problem for the phonetic definition, because in the course of history, the old short vowels have not all remained phonetically lax, nor are all the other vowel of modern English phonetically tense. In Donegan's view, the articulatory and acoustic properties with make a vowel palatal or labial are stronger in tense vowels than in their lax counterparts.

[11] Giegerich treats /i, e, u, o, ɔ, ɑ/ as tense vowels and /ɪ, ɛ, ʊ, ʌ, ɒ, a/ as lax vowels. According to Giegerich's definition, tense sounds are produced with a deliberate, accurate, maximally distinct gesture that involves considerable muscular effort.

/i/. However, in general, tense vowels are associated with longer duration than their lax counterparts.

Vowel length is strongly influenced by contextual factors. A vowel may be realized with different durations depending on its phonological environment. For example, according to Giegerich (1992), the length of /i/ in *bee, bead, bean, beat,* decreases from *bee* to *beat*. Because of the influence of the following segment, tense vowels are not necessarily always longer than lax vowels. The /ɪ/ in *bid* may be realized longer than the /i/ in *beat*. Tense vowels are longer than their lax counterparts when the contextual factors are equal (i.e. in minimal pairs like *beat-bit* which differ only in vowel tenseness).

Peterson and Lehiste (1960) measured the duration of syllable nuclei of 118 minimal pairs such as *beat- bead* and *sight- side* and found that the average duration of the vowels before the voiceless consonants was 197 ms while it was 297 ms for vowels before voiced consonants. Thus, the ratio of vowels before voiceless consonants to vowels before voiced consonants is approximately 2 : 3. In medial and final position, voiced consonants are produced with shorter closure intervals than voiceless consonants, and the variation in closure interval is sufficient to signal the voiced/voiceless distinction in minimal pairs such as *rabid* and *rapid* (Lisker, 1957). Kluender et al. (1988) proposed that the vowel length contrast before voiced/voiceless consonants gives a perceptual clue to distinguish the voicing of the following consonant. A longer preceding vowel makes a short closure interval of the following voiced consonant appears even

shorter, whereas a shorter preceding vowel makes a long closure interval seem even longer.

Stress is another factor which may influence vowel length. Stressed vowels are produced longer than their unstressed counterparts. Stressed vowels followed by voiceless consonant, such as /bap/ are almost same length as unstressed vowels followed by voiced consonants, such as /bab/ (Van Summers, 1987). Van Summers investigated the interaction of voicing and stress on vowels length, and found that change in stress does not influence total vowel duration as much for the durationally shorter voiceless utterances as for the longer voiced utterances.

2.3 Korean phonology

In this section, Korean consonants, vowels, and some aspects of Korean phonetics and phonology will be introduced. Some major assimilation rules of Korean consonant clusters will be also introduced here.

2.3.1 Korean stops

Korean has 21 consonants, which are shown in the following chart based on Sohn (1999):

Table 2.3 Korean Consonants

		LABIAL	ALVEO-DENTAL	PALATAL	VELAR	GLOTTAL
STOP	plain	p	t	c	k	
	aspirated	p^h	t^h	c^h	k^h	
	tensed	p'	t'	c'	k'	
NASAL		m	n		ŋ	
LIQUID			l			
FRICATIVE	plain		s			h
	tensed		s'			
APPROXIMANT[12]		w		j		

Korean has only voiceless stop phonemes, with a three-way distinction in laryngeal features and a four-way distinction in place of articulation. There are 12 stop phonemes. Although some linguists exclude palatal stops from the stop category, I will treat palatal obstruents as stops as they also show a 3-way distinction in laryngeal features like other stops. However, I will only consider bilabial, alveolar, and velar stops in this study.

[12] Approximants are not originally in Sohn's chart. He puts them in semivowel category. They are included here in the consonant chart to make inventories of Japanese, Korean, and English as consistent as possible. Kim (1990) treats /w, j/ as glides and put them in the consonant chart.

Korean has plain stops /p, t, k/, aspirated stops /p^h, t^h, k^h/ and tensed stops /p', t', k'/[13]. Places of articulation are divided into bilabial, alveo-dental, and velar, although some linguists may claim /t, t^h, t'/ are alveolar or dental. These phonemes are different from English alveolar /t/ in the way they are produced. The Korean alveo-dental consonants are produced with the top (not the tip) of tongue touching the back of the upper teeth and the gum ridge area and with the tongue tip touching the back of the lower teeth (Sohn, 1999).

The Korean plain stops /p, t, k/ have very weak aspiration. Han and Weitzman (1967) measured three Korean speakers' VOT for these stops, and each of speaker's average falls between 16.8 to 27.0 ms for /p/, 21.0 to 33.0 ms for /t/, and 27.2 to 62.0 ms for /k/. Plain stops are slightly voiced between voiced segments. The following words are some examples which show allophonic variations of plain stops:

/pupu/	[pubu]	'a married couple'
/tanita/	[tanida]	'to visit, go'
/kake/	[kage]	'store'
/kalpi/	[kalbi]	'spare ribs'

[13] Linguists label Korean stops differently. Plain stops are often called lax or weak stops, while tensed stops are called strong. Here I take Ahn (1998)'s labeling.

Aspirated stops /p^h, t^h, k^h/ are never voiced, and are pronounced with strong aspiration. They are similar to English stressed voiceless stops in word-initial position (Sohn, 1999). The degree of aspiration among Korean stops is phonologically significant, so that changing the strength of aspiration changes the meaning of words. Thus, /pal/ 'foot' may sound like /p^{h}al/ 'arm' if the aspiration of the initial stop is too strong. According to Han and Weitzman (1967), the averages of their three Korean informants' VOT for these stops fall between 66.0 to 129.0 ms for /p^h/, 73.0 to 133.0 ms for /t^h/, and 71.0 to 148.0 ms for /k^h/. The following words are some examples of aspirated stops:

/p^{h}jop^{h}i/	[p^{h}jop^{h}i]	'outer skin'
/t^{h}ut^{h}a/	[t^{h}ut^{h}a]	'pitching and batting'
/k^{h}ek^{h}e mukta/	[ke^{h}k^{h}e mukt'a]	'old'

Aspirated stops are all neutralized as plain stops word-finally (this process will be explained in the later section).

Tensed stops /p', t', k'/ are similar to English voiceless stops occurring after /s/, such as in *speak, strong,* and *ski*. Sohn (1999) says that Korean tensed stops are not voiced but produced with the glottis constricted and by building up air pressure behind the closed place of articulation and instantaneously releasing the closure while pushing the air forward without aspiration. VOTs for these stops are the shortest among three kinds of Korean stops. According to Han and

Weitzman (1967), their 3 Korean informants' average VOT falls between 4.8 to 5.3 ms for /p'/, 5.7 to 12.0 ms for /t'/, and 15.7 to 27.1 ms for /k'/. The following words show some examples of tensed stops:

/p'ip'i/	[p'ip'i]	'a very skinny person'
/t'at'ɨs han/	[t'at'ɨt^{h}an]	'warm~'
/k'æk'ɨs hata/	[k'ek'ɨt^{h}ada]	'to be clean'

Tensed stops, as well as aspirated stops, are neutralized as plain stops syllable finally.

2.3.2 Korean syllable structure

The maximum syllable in Korean at the phonetic level is CGVC, and all segments except the nucleus vowel are optional. According to Sohn (1999), Korean syllables exhibit a structural difference between the morphological or lexical level and the phonetic level. The lexical level allows syllable final consonant clusters. However, one of two final consonants will be deleted at the phonetic level unless there is a following morpheme starting with a vowel:

/kaps/	→	[kap]	'price'
/kaps-kwa/	→	[kap. k'wa]	'price and~'

Resyllabification occurs when a coda consonant precedes a morpheme starting with a vowel:

/mas-i/	→	[ma. si]	'taste is~'
/kaps-i/	→	[kap. si]	'price is~'

Korean allows consonant clusters at syllable boundaries. This may create geminate consonants:

/sip-pun/	→	[sipp'un]	'ten minutes'
/mit-ta/	→	[mitt'a]	'to believe'
/kuk-ki/	→	[kukk'i]	'national flag'

A Korean geminate is different from a Japanese geminate in terms of its durational features. As Korean is a syllable-timed language, the duration difference among minimal pairs such as /kuk-ki/ 'national flag' and /kuk-i/ 'the soup is~' is much smaller than the Japanese geminate vs. singleton minimal pairs, e.g. /kokki/ 'national flag' vs. /koki/ 'aspiration'. Sato (1998) found that the durational ratio between Korean geminate vs. singleton minimal pairs was very close to 1 : 1, while Japanese geminate vs. singleton minimal pairs had 1.3 : 1 to 1.39 : 1. Because of the ratio, one might claim that Korean "geminates" are not phonetically geminate at all.

2.3.3 Phonological processes in Korean

The three types of Korean stops described above are phonemes. However, they may be derived by phonological rules. Here, I will introduce

syllable-final neutralization, /h/- aspiration, tensification, pre-tense/aspirate reduction, and consonant cluster assimilation.

Syllable final obstruents are all merged as plain stops when they are followed by a consonant, a word boundary, or a compound boundary. At these positions, consonants are unreleased and realized as [p˺, t˺, k˺] (Sohn, 1999):

/ap^h/	[ap˺]	'front'
/mit^h/	[mit˺]	'bottom'
/nac/	[nat˺]	'daytime'
/os/	[ot˺]	'cloths'
/puək^h/	[puək˺]	'kitchen'

Not only alveo-dental stops /t, t^h, t'/, but also /s, s', c, c^h, c'/ are all merged as [t˺].

These coda consonants are realized as their phonemic forms when followed by a vowel; for example, the postposition /e/ 'to, at':

/ap^{h}e/	[ap^{h}e]	'to the front'
/mit^{h}e/	[mit^{h}e]	'to the bottom'
/nace/	[nace]	'at daytime'
/ose/	[ose]	'to the cloths'
/puək^{h}e/	[puək^{h}e]	'to the kitchen'

The second phonological rule is called /h/- aspiration (Sohn, 1999). In addition to the underlying aspirated stops, there are aspirated stops derived from plain stops preceded or followed by /h/:

/coh-ta/	[co.t^{h}a]	'to like'
/c^{h}uk-ha/	[c^{h}u.k^{h}a]	'celebration'

In the first example above, the initial /t/ in the second syllable gets aspirated and the preceding /h/ is deleted. In the second example, /k/ in the coda position of the first syllable gets aspirated and the initial /h/ in the second syllable gets deleted. Notice resyllabification occurs in this example after the deletion of /h/.

Another phonological rule is tensification. So far, we have seen underlying tensed stops as phonemes; however, there are tensed stops which are derived from plain stops. When plain stops are preceded by obstruents except /h/, the plain stops are tensified. This is called tensification or post-obstruent tensing (Anh, 1998):

/hakpi/	[hakp$^{\prime}$i]	'tuition'
/macta/	[matt$^{\prime}$a]	'to be right'
/akki/	[akk$^{\prime}$i]	'musical instrument'

Addition to the above tensification, there is an optional rule called pre-tense/aspirated reduction (Sohn, 1999). Plain stops and /s/ may be deleted before a homorganic tensed or aspirated consonant. Thus, [matt'a] and [akk'i] above can be realized as [mat'a] and [ak'i].

The last rule introduced here is a place assimilation rule (Jun, 1996). This is an optional rule which depends on the style and the rate of speech. /pk/ and /tk/ clusters optionally become [kk] :

[-continuant] → [- anterior, - coronal] / _ [-anterior, - coronal]

/mitko/	[mikk'o]	'believe and~'
/nupko/	[nukk'o]	'lie and~'

The plain stop /t/ also assimilates to the following bilabial (Sohn, 1999):

[- continuant, + anterior] → [- coronal, + anterior]/ _ [- coronal, + anterior]

/k'oc^h pat^h/ [kot˺pat˺] → [kop˺p'at˺] 'flower garden'

In other words, /t/ assimilates to its following stops (i.e. decoronalization), but /p/ assimilates only to the following /k/, not to /t/.

Stop clusters which have /k/ as the first member do not undergo place assimilation, and also the reverse assimilation (e.g., /pk/→ *[pp]) does not occur

in Korean. /t/ does not trigger place assimilation of the preceding consonant, /pap-to/ → [papt'o] but not *[patt'o] 'rice also~'. The reason why coronal consonants do not cause assimilation to the preceding consonant may be due to the fact that the agility of the tongue tip obviates early preparation for the coronal articulation (Kim-Renaud, 1974). Jun (1995, forthcoming) explains this assimilation pattern by using the universal salience ranking for unreleased stops; dorsal > labial > coronal. According to Jun, coronal has the least salient place perceptual cue because of its short and rapid articulatory gesture. Speakers make efforts to maintain the place cue for perceptually salient sounds, while they are reluctant to do so for perceptually less salient sounds. This is why Korean /t/ may assimilate to the following /p/ and /k/, but the opposite does not occur.

2.3.4 Korean vowels

Sohn (1999) reported that modern Korean has ten vowel phonemes. Some of them might be merged in certain dialects. For the older generation, a vowel length distinction is significant in differentiating meaning. Each vowel has a short and long contrast, for the older generation and for some dialects. Long vowels are about twice as long as their short counterparts, and there is no vowel quality difference between short and long vowels. Long vowels maintain the same monophthongal quality as short vowels. However, in general, the vowel length difference is not significant in modern Korean. Vowel length differences

are not reflected in the *hangul* writing system either. Here are some examples of Korean words in which short vs. long vowels contrast:

short		long	
/mal/	'horse'	/ma:l/	'language'
/nun/	'eye'	/nu:n/	'snow'

Unlike Japanese long vowels, Korean long vowels can occur only in phrase initial syllables. Thus, the vowel in /nu:n/ 'snow' is shortened when /hijn/ 'white' is attached to it, as [hin nun] 'white snow'.

2.4 Summary

Some aspects of the phonetics and phonology of Japanese, English, and Korean were introduced in this chapter. The three languages exhibit different sound systems and have different degrees of voicing and aspiration of stop consonants. The difference in syllable structures is one of the primary differences among these three languages. Japanese has much simpler syllable structure than the two other languages, exhibiting limited types of closed syllables. Vowel length plays an important role in Japanese, but not in English and Korean. English speakers consider the qualitative aspect of vowels as a distinctive feature while Japanese speakers take the quantitative aspect as the primary feature of English vowels. Modern Korean has neither a tenseness nor a length distinction in vowels.

CHAPTER 3

LITERATURE REVIEW

Researchers in the field of second language acquisition and phonology have been attempting to discover the factors which trigger perception of the moraic obstruent /Q/ in L2 and loanword phonology. This chapter will review the characteristics of the mora obstruent /Q/, and various studies of /Q/ perception in foreign language acquisition.

3.1 The Japanese moraic obstruent /Q/

As this research deals with the occurrence of /Q/ (i.e. moraic obstruent) in L2 perception, I will describe some characteristics of /Q/ and /QC/ clusters (i.e. geminate consonants).

3.1.1 Status of moraic obstruent: Phoneme /Q/ vs. long consonant

There have been several views of the Japanese moraic obstruent, which is transcribed as っ or ッ in *kana* orthography[14]. One view treats the moraic obstruent as a phoneme /Q/, and another treats it as the first half of a geminate consonant cluster. Vance (1987) treats the first part of geminate consonant clusters as variants of the phoneme /Q/. One of the reasons comes from Japanese orthography. Regardless of its phonetic realization, the moraic obstruent is always transcribed identically as っ or ッ, which are reduced size

[14] Japanese has two types of *kana* orthography; *hiragana* and *katakana* (see Appendix C). Generally speaking, *katakana* is used for foreign words, and *hiragana* is used in combination with Chinese characters, in native words. A precise explanation of the usage of *katakana* will not be given here.

versions of the *kana* letters つ, ツ pronounced as [tsu]. The existence of morphemes ending with a moraic obstruent may also support this view. For example, the Sino-Japanese prefix 発 /haQ/ 'origination' is written as はっ in *hiragana*, regardless of which variant appears for the moraic obstruent /Q/ (Vance, 1987):

はっか	/haQka/	[hakka]	'ignition'
はってん	/haQten/	[hatten]	'development'
はっぽう	/haQpou/	[happo:]	'fire a gun'

The examples above show that all variants of /Q/, [p, t, k] are spelled identically in *kana* writing as っ.

Another example of word-final /Q/ is found in Japanese. きゃっきゃっという [kjakkjattojuu] 'say eek-eek' shows the existence of word-final /Q/ as a phoneme. The 'eek eek' part is spelled as きゃっきゃっ /kjaQkjaQ/. It is never *きゃきゃ /kjakja/, without final /Q/. This example involves reduplication of きゃっ /kjaQ/ (where final /Q/ is realized as a glottal stop) 'eek', and the final /Q/ is reduplicated as a part of the first syllable [kjaʔ]. Also, the glottal stop is spelled as っ, which is used for geminate consonant clusters in word-medial position. This fact shows that the word-final っ /Q/,

like other phonemes, can be a part of morpheme, and supports the claim that word-final [ʔ] is an allophonic variant of /Q/.

Another analysis of moraic obstruents treats them as long consonants[15] which are in complementary distribution with short consonants. In this view, long consonants must precede homorganic voiceless consonants, as /C_iC_i/, whereas short consonants precede vowels, as /CV/. Bloch (1950) takes this view and gives two reasons for rejecting grouping the first halves of geminates as allophones of a phoneme /Q/. The first reason is that the distribution of /Q/ is limited to V_C environment. The second reason is that adopting /Q/ will make the Japanese phonemic inventory more complex and less general. In other words, treating the moraic obstruent as a phoneme /Q/ allows Japanese phonology to have an extra phoneme which has quite different distribution from other consonants.

Some studies claim that the word-final glottal stop is not a realization of /Q/ but merely a strong glottis closure at the end of utterance. Kubota (1993) says that the small っ in *kana* simply indicates the strong glottis closure and it does not indicate a glottal stop phoneme. Kubota claims that the word-final vowels are followed by 'glottis closure' with or without the small っ in orthography. Thus the pronunciation for あ /a/ 'oh!' could be either [a] and [aʔ], and this example shows that the *kana* っ does not indicate there is a phoneme

[15] By 'long (consonant)', Bloch (1950) seems to mean 'moraic'.

/Q/. However, there are some instances which Kubota's claim cannot explain, such as きゃっきゃっという /kjaQkjaQtoiu/ instance described above.

Although it is difficult to determine which view of the moraic obstruent is better, I will take the view of Vance, and treat the first members of Japanese geminate consonant clusters as variants of /Q/, a phoneme with a varying place of articulation. I will use /Q/ to refer to a mora obstruent throughout this dissertation. This treatment is not uncontroversial, as noted above. However, it seems that Japanese moraic obstruent does not have the exactly the same phonetic characteristics as pure geminate consonants, since /Q/ occurs word-finally, where there is no following segment to assimilate.

3.1.2 Characteristics of /Q/

In the following sections, some phonetic and durational characteristics of /Q/ will be introduced.

3.1.2.1 Phonetic characteristics of /Q/

/Q/ is sometimes referred to as a 'tense' sound because of its impression of tension[16]. It is said that /QC/ clusters, in other words geminate consonant clusters, have stronger closure than their singleton counterparts, with the articulators exerting more pressure on each other (Sakuma, 1963).

/Q/ also influences the phonetic features of the immediately following stops, so that they are phonetically different from word-initial or intervocalic

[16] The characteristic 'tense' does not have a clear definition, and it is used to express different features in different studies (Vance, 1987). It seems that 'tense' here refers to tension of larynx described in Min (1987).

stops. Stops following /Q/ are produced with less aspiration and with greater tension of the larynx than their singleton counterparts (Min, 1987).

As /Q/does not have a consistent place of articulation, the actual phonetic realization of this phoneme may not be crucial. It is an unlikely pronunciation, but if one intentionally pronounces /keQkon/ 'marriage' as [ketkon] instead of [kekkon] (the standard phonetic realization of /Q/), a Japanese speaker may still hear the form as an acceptable variation of /keQkon/. Since Japanese does not allow underlying heterogeneous consonant clusters, Japanese speakers do not have to identify the place of articulation of the first member of consonant cluster so they may not notice this difference. This may explain why Japanese speakers have difficulty distinguishing Korean minimal pairs such as /ikta/ 'to be ripe' and /itta/ 'there is~'. Both words may be heard as /iQta/ by Japanese speakers.

3.1.2.2 Durational characteristics of /Q/

Although /Q/ has some qualitative characteristics, it may be more often described by its durational feature. This is why /QC/ clusters are often regarded as 'long consonants', as mentioned in Bloch (1950).

Takada (1985) reported that /QC/ clusters are about one mora length longer[17] than their singleton counterparts /C/. However, the phonetic durations of /QC/ clusters vary in different studies. Sakuma (1963) reports the duration ratio between single /k/ in /iki/ 'breath' and /-Qk/ in /iQki/ 'at once' is 1 : 1.7.

Sunaoshi (1995) reports that the same ratio in her study was approximately 1 : 3. Han (1992) reports the ratio was 1 : 2.8 in her study.

Sakai (1998) mentioned that /Q/ is basically considered to be one-mora-length, though it becomes shorter in rapid speech and becomes long in emphasized speech[18]. It has been found that /Q/ is shortened and does not have one-mora duration in fast speech (Kamimura, 1993). Also some dialects in Japan exhibit very small durational difference between a word with and without /Q/. Such dialects are called 'syllabeme dialects' and are syllable-timed. For example, minimal pairs such as /kata/ 'shoulder' and /kaQta/ 'won' exhibit very slight length difference in a dialect in Aomori prefecture, the most northern prefecture in Honshu (main) island (Takada, 1985). In such dialects, both /kata/ and /kaQta/ have almost the same duration as both of them are two syllable long, and qualitative features of /Q/ would be more important than the durational feature.

Interestingly, long consonantal duration is not the only 'durational feature' necessary for /Q/perception. /Q/ can be perceived if there is a long silence between two vowels. Fukui (1978) showed interesting results in his study. Perception of /Q/ might occur without qualitative phonetic characteristics of /Q/ such as larynx tension but solely by a long silence: Even a longer pause

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[17] Mora is not a measurement unit. It simply means that Japanese speakers treat /Q/ as long as (C)V or one *kana* letter.

[18] Sakai (1998) says that there are two ways to emphasize a speech with /Q/. One is to lengthen a silence /zuQQQto/ 'continuously', and the other is to make the preceding vowel long /zu:Qto/. Speakers choose one of them for emphasis depending on the individual preference and purpose of the discourse.

(silence) could cause perception of /Q/, but also a qualitative phonetic feature by itself may cause perception of /Q/ as well. Fukui edited natural utterances such as /hata/ 'flag' and inserted a pause between the two syllables. He found that when the closure duration of /t/ in /hata/ was doubled, most of his participants heard the word as [hatta] 'pasted'. On the other hand, when he shortened the stop closure of /haQta/ 'pasted' to the equal the closure duration of /hata/, the token was still heard as [hatta]. As a word with very short /Q/ is perceived with /Q/, it seems that /Q/ is perceived not only by duration but also by phonetic quality.

As it has been noted above, /Q/ does not always maintain one mora duration. Differences in different studies might be due to speech style (rapid or slow etc.) and research design differences, and also some dialectal features. Despite such differences, many studies agree that Japanese /QC/ clusters, (i.e. geminate consonants) are significantly longer than single consonants in most Japanese dialects, and these durational differences are perceived by native speakers of Japanese.

3.1.3 /Q/ and its phonetic realizations in different environment

/Q/ has some restrictions on where it appears, and its phonetic realization differs in different environments. This section introduces the distribution of /Q/ and its phonetic realizations.

/Q/ occurs immediately before the voiceless stops /p, t, k /, the affricate /tʃ/, and the fricative /s/. This is the basic distribution of /Q/ and other instances are exceptional. /Q/ totally assimilates to the following segment, and a word such as /keQkon/ 'marriage' is phonetically realized as [kekkon]. It does not have a consistent phonetic form and is often described as a 'choked sound' (Hirozane 1992) or 'glottalized sound'.

Some loanwords and irregular speech may have voiced geminates (see the following section for details), and some consonants which are never geminated in standard Japanese may be realized as geminates in loanwords, e.g., /baQha/ [bahha] 'Bach', and /aQraː/ [aʔraː][19] 'Allah'. The pronunciation of 'Allah' indicates that the /Q/ does not have to be realized as the first part of a geminate consonant. In this example, it is realized as a stop sound.

/Q/ does not occur before a voiced consonant in the basic forms of native Japanese words, although it may occur in emphasized speech such as /sugoi/ 'amazing' as [suggoi]. Although voiced geminates are basically inadmissible in Japanese, recent borrowings such as /beQdo/ [beddo] 'bed' and /baQgu/ [baggu] 'bag' contain voiced geminates. However, it is difficult to maintain voicing in such consonant clusters, and /QC $_{[+voice]}$ / is not part of the standard distribution of /Q/ in Japanese. Loanwords with voiced geminates vary in pronunciation:

[19] 'Allah' has variations in its borrowed form. The most common pronunciation of this loanword is /araː/. The pronunciation /aQraː/ may be a spelling-based pronunciation.

/beQdo/ may be [beddo] but is more commonly [betto] (Ohso 1973; Vance 1987). The orthographic distinction between バッグ /baQgu/ 'bag' and バック /baQku/ 'back' is generally not reflected in pronunciation, and both words are pronounced as バック [bakku]. This tendency of devoicing of voiced geminates is noteworthy, as Japanese speakers do not have difficulty with voiced geminates in emphasized speech, e.g., /sugoi/ 'amazing' as [suggoi] and /kudaranai/ 'absurd' as [kuddaranai]. Thus Japanese speakers can pronounce voiced geminates for emphasis without difficulty. The reason why voiced geminates are frequently devoiced in unemphasized speech is that speakers probably avoid using the massive articulatory energy needed to produce voiced geminates (Vance 1987). Homma (1981) claimed that voiced geminates are not fully voiced phonetically; she found that stops in voiced geminate clusters have positive VOT, which is seldom observed with voiced single stops.

/Q/ may occur in emphasized speech in word-final position as well (Kawakami 1977, Vance 1987). /Q/ is realized as [ʔ] in such emphasized speech. Examples are あ /a/ 'oh!' as あっ [aʔ] and ね /ne/ 'right?' as ねっ [neʔ]. In these examples, there is no following consonant to which /Q/ can assimilate, and it is pronounced as [ʔ]. Vance (1987) mentions that Japanese short vowels in sentence-final position or before a pause are always followed by a rapid closing of the glottis. This glottal closure is perceivable in emphasized speech, as described earlier. However, speakers are not aware of such closure in normal

speech. The abrupt offset makes the vowel realized as short so that a word like /ko/→ [koʔ] 'child' is more easily distinguished from /koː/→ [koː] 'this way'. When the word /koː/ is read in isolation, the long vowel fades away more gradually.

The moraic obstruent /Q/ does not occur word-initially in standard Japanese. However, it is often found in emphasized speech and comics. The following examples are /Q/ in sentence initial position taken from a comic book by Aoyama (1994):

/Qtaku/	'indeed!'
/QteiunikimaQteru/	'(He) will surely say~'

These examples are reduced forms of /maQtaku/ 'indeed' and /toiunikimaQteiru/ '(He) will surely say~', and occur in casual speech.

/Q/ rarely occurs before or after other non-syllabic moraic segments. According to Kindaichi (1988), there is a tendency in Japanese to avoid having more than two non-syllabic moraic segments[20] together. It is very difficult to find a word with 3 non-syllabic moraic segments together such as /uiːNQko/ 'a person from Vienna' (V̯NQ sequence). Even sequences of 2 non-syllabic moraic segments are disfavored, as noted above. Geminate consonants do not follow long vowels except in emphasized speech, such as /soQto/ 'quietly' as [soːtto],

and multiple morphemic words, such as /to:tta/ 'passed by', which consists of /to:t-/ the stem of /to:ru/ 'pass by' and /-ta/ the past tense morpheme. As the occurrence of 2 or more non-syllabic moraic segments is limited to such cases, it can be said that Japanese avoids 'long vowel plus geminate' combinations. This tendency is reflected in loanword phonology, which also avoids long vowel plus geminate. English words which are borrowed with long vowels do not take following /Q/. There are no loanwords such as */to:Qku / 'talk' or */ko:Qto/ 'coat', but /to:ku/ and /ko:to/.

3.2 Review of literature on stop perception

Many studies have investigated how foreign sounds are borrowed in another language, and how foreign sounds are perceived and produced in second language acquisition (SLA) situations. Here, the main focus of this dissertation, the perception of /Q/ by Japanese speakers, will be introduced. Many studies have examined the occurrence of /Q/ in loanwords, and in first and second language phonology.

3.2.1 Explanations for /Q/ in loanwords

Many studies have been conducted to consider why /Q/ occurs in Japanese-English loanwords and interphonology. The following sections will summarize studies of /Q/occurrence in Japanese-English interphonology and English loanwords.

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[20] Non-syllabic moraic segments in Japanese are; syllable final nasal /N/, the second half part of

3.2.1.1 /Q/ occurrence: Vowel tenseness as an explanation

English loanwords are quite well-established in Japanese, and there are certain rules which English words undergo when they are borrowed into Japanese. Sunaoshi (1995) gives some general rules for the occurrence of /Q/ in /CVC/ English loanwords (e.g., *dog, cat,*) borrowed into Japanese. There is a strong association of English tense vowels with Japanese long vowels, and English lax vowels with Japanese short vowels. When the original English word contains a lax vowel followed by a voiceless stop coda, the word is borrowed with a /Q/[21]. If the original English vowels are tense vowels[22], they are perceived as long and the following coda stops will not be perceived with a /Q/. If the original English vowels are diphthongs, they will be perceived as diphthongs or as long vowels and the following stops are not perceived as geminates. Presumably /Q/ is not used in loanwords which have tense vowels because Japanese phonology avoids long vowel + /Q/. It seems that most loanwords follow Sunaoshi's rules; however, /Q/ occurrence in loanwords is complicated and cannot be explained by the above rules alone.

3.2.1.2 /Q/ occurrence: Mora and syllable as an explanation

Kindaichi (1988) argues that the reason Japanese speakers hear /Q/ in English is that Japanese speakers apply mora timing to English words. Although

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long vowels (indicated as :), and geminate consonant /Q/ (Kindaichi, 1988).

[21] Low vowels behave like lax vowels in this context, e.g. /kæt/ borrowed as /kjaQto/ (Sunaoshi, 1995).

[22] Some tense vowels /e, o/ are diphthongs in most dialects and even /i, u/ are diphthongs in many dialects. Even in such cases, loanwords are borrowed with a long vowel, e.g., /mo:ta:/ 'motor'.

the English word /dɔg/ is one unit (i.e. 1 syllable) for English speakers, Japanese speakers apply mora timing and perceive the word as 3 units (i.e. 3 moras) word /doQgu/. This would indicate that Japanese speakers hear this word as longer than /dogu/, which would have 2 moras. It is possible to assume that inserting /Q/ makes the word longer, and it satisfies the perception of Japanese speakers. However, Kindaichi does not explain why *dog* is perceived as 3 moras rather than 2 moras or why it is perceived as containing a moraic obstruent rather than containing a long vowel /do:gu/. As vowels are generally lengthened before voiced consonants in English, it would be reasonable to borrow *dog* as /do:gu/ rather than /doQgu/, if the purpose of inserting a moraic element is to impose Japanese mora timing on English words.

Ohye (1967) claimed that /Q/ appears in loanwords when moras have 'weak linkage'. For example, *hat* is borrowed as /haQto/ because the form with out /Q/, for example /hato/ has weak linkage between /ha/ and /to/, and the whole word sounds different from the original English word *hat*. His idea is that /Q/ can link two moras as one unit word. What he meant by 'linkage' is probably syllable juncture. The English word *hat* is a monosyllabic word, in other words, it is one unit. On the other hand, the form /hato/ consists of two independent syllables. This means that there is nothing which can make two syllables as one unit. However, Ohye claims that inserting /Q/ may make two syllable closer to each other. This is because when /Q/ is inserted, the phonetic

form will be [hatto]. The geminate [tt] is shared by both syllables: The coda [t] is the first half of geminate and the second [t] is the second half of geminate.

/Q/ perception may be influenced by syllable types. Arai and Kawagoe (1996) found some correlation between word-initial or final consonant types and occurrence of /Q/ in their experiments, using nonsense English words. The occurrence of /Q/ in word-final position shows different patterns depending on the type of final segments. /Q/ is perceived most frequently when there is a single word-final stop (e.g. /tek/), second when the coda is a stop + /s/ (e.g. /peps/), and the least when the coda is a stop + stop cluster (e.g. /kept/). Word-initial segments did not seem to influence the occurrence of /Q/ in word-final position. In word-medial position, an open syllable such as in /kepan/ and a Stop + $C_{[+son]}$ configuration such as in /keplin/ showed an almost equal percentage of /Q/ perception (26% and 29%), but a C + $C_{[-son]}$ configuration such as in /keptin/ showed only 5% /Q/ perception. Word-medial open syllable words ending with a nasal such as the above example /kepən/ showed a high frequency of /Q/ perception as [keppən]. Additionally, these words showed a lower frequency of /Q/ perception when the onset was a consonant cluster such as /skepən/. This word is rarely perceived with word-medial geminate. #C type words ending with a nasal had higher frequency of /Q/ perception. However,

why such patterns cause a /Q/ perception differences is not clear in Arai and Kawagoe's study.

3.2.1.3 /Q/ occurrence: Spelling as an explanation

It seems that orthography often influences the occurrence of /Q/ in loanwords. Ohso (1973) suggested that spelling with double consonants could influence the occurrence of geminates in loanwords. For example, *batter* was borrowed as /baQta:/ [batta:], *cotton* as /koQton/ [kotton]. Arai and Kawagoe (1996) also found a certain degree of influence of spelling on perception of /Q/ in nonsense words. However, the influence of spelling is not always reflected in /Q/ perception. In fact there are loanwords such as *butter* which is borrowed as [bata:] not as [batta:]. Additionally, many English words with final consonant are not spelled with double consonants, CC#, but borrowed with /Q/, e.g., *dog* /doQgu/, *skip* /sukiQpu/.

3.2.1.4 /Q/ occurrence: Stress as an explanation

Accentuation patterns are often considered to be a part of /Q/ perception in loanword phonology. Ohso (1973) states that an English short vowel and the following consonant in a stressed syllable are considerably lengthened and this lengthening of the consonant might cause /Q/ perception by Japanese speakers. Final consonants are especially lengthened when they are released, thus Ohso assumes that Japanese speakers borrowed released forms of English words into Japanese. She further claims that if unreleased forms of English words are

borrowed, the final consonants may be deleted. Some examples are *white shirt* as *wai shatsu* (the coda /t/ of *white* is deleted) and *auto bike* as *ooto bai* (the coda /k/ of *bike* is deleted).

Kawagoe (1995) also claimed that accent pattern can be important in /Q/ perception. The condition for word-medial /Q/perception is that a potentially geminatable segment (i.e. a voiceless obstruent) occurs immediately after a stressed vowel. Furthermore, there is usually one syllable after the stressed vowel, and this syllable should not have a condition favored for consonant gemination. In her discussion, she uses 3 words *chapter*, *heater*, and *Jupiter*, which are borrowed without a /Q/ as /tʃaputa:/, /hi:ta:/, /ʄ̃upita:/ comparing with *shutter* which is borrowed with a /Q/as /ʃaQta:/. Each of these words has final /ta:/, but the first three examples have extra segments between the stressed vowel and /ta:/. Those extra segments are/p/ in *chapter*, the second part of a long vowel in *heater*, and /pi/ in *Jupiter*. The reason for /Q/ insertion after a stressed vowel is to maintain a strong-weak rhythmic pattern among moras. /Q/ is inserted when there are two moras which are perceptually salient and have strong rhythm (i.e. the stressed mora and the nucleus mora of the following syllable) next to each other. For example, *chapter* is analyzed as following[23]:

tʃa	p	ta	:
|	|	|	|
S	W	S	W

Kawagoe claims that a mora with a stressed vowel has strong rhythm. Non-syllabic moras have weak rhythm. In the above example, SWSW rhythm is maintained thus there is no 'rhythmic clash'. Therefore /Q/ insertion does not occur. However, when there is a rhythmic clash (i.e. moras with strong rhythm are next to each other), /Q/ is inserted to maintain SWSW rhythm. The following example is *shutter*:

ʃa	ta	:	/Q/ insertion	ʃa	Q	ta	:
|	|	|	→	|	|	|	|
S	S	W		S	W	S	W

The mora /ʃa/ is stressed, and the following mora is also has a strong rhythm. Thus /Q/ is inserted to maintain a bimoraic beat.

3.2.1.5 /Q/ occurrence: Durational features as an explanation

/Q/ occurrence in loanword phonology and L2 phonology is often explained by the durational features, such as consonant to vowel length ratio.

Fukui (1978) shows the effect of the duration of the voiceless consonant closure as cues to the /QCV/ and /CV/[24] distinction in Japanese. The longer the consonant closures, the more participants perceived a mora obstruent /Q/.

Some studies examine /Q/ perception in terms of ratio of consonant and vowel. Hirozane (1992) examines why Japanese speakers hear some English words as containing /Q/ by looking at the perception of 6 Japanese speakers.

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[23] This is the form before applying /Q/ insertion, and called Level Q (LQ) in Kawagoe.
[24] Fukui uses terms 'choked' (i.e. glottalized) and 'non-choked' to indicate /QCV/ and /CV/.

His participants listened to a nonsense syllable /ɛk/ with different durations of the vowel and the consonant (vowel lengths are 131, 156, and 178 msec. and closure durations were 98, 119, and 136 msec.[25]), and decided if they have heard [eku] or [ekku]. For each stimulus the percentage of [ekku] responses is calculated. The results show that whatever the duration of the consonant closure or the preceding vowel duration, there were some participants who perceived the form [ekku], in other words, with a /Q/. As results indicate that consonant/vowel ratio cannot always predict /Q/ perception, Hirozane assumes that there may be some qualitative features of the vowel that cause the perception of /Q/. However, he does not provide any experiments which show the influence of vowel qualities.

In another study, Hirata (1990) examined the effect of the duration of the preceding vowel. For a Japanese word to be perceived as containing a /Q/, the duration of the consonant closure must increase in accordance with the increase in the duration of the preceding vowel. Hirata assumes that the perception by Japanese speakers of English sounds with /Q/ depends on duration features.

Sunaoshi (1995) also conducted experiments to provide an explanation in terms of vowel vs. consonant duration ratio. She hypothesized that gemination occurs to maintain the Ratios of the consonants' Duration to the preceding Vowels (RDV) of the original English word. Thus, RDV of English word *knit* /nɪt/, which is borrowed as /niQto/into Japanese, must have an RDV which is

[25] The differences in vowel durations and consonant durations are not noticeable difference by

closer to Japanese word きっと /kiQto/ 'probably' than Japanese singletons such as いと /ito/ 'thread'. However, this hypothesis is not supported by her findings. In her experiment, the RDV of English VC $_{[-voice]}$ is 1.29 while that of Japanese words with geminates is 2.53. Rather the RDV of English VC $_{[-voice]}$ is closer to the RDV of Japanese words with a single stop, which is 0.85. She concludes that the most confusing RDV (i.e. 50% perceived as singleton and 50% as geminate) in Japanese is probably right around the RDV of English VC $_{[-voice]}$ (i.e. 1.29), and this causes Japanese speakers to perceive English VC $_{[-voice]}$ words as containing /Q/. The question here is that it is not clear why Japanese speakers choose the form with a /Q/ over a singleton when RDV is at the most confusing value. The RDV of Japanese words with singletons is 0.85, rather closer to the most confusing RDV (which is assumed to be around 1.29 by Sunaoshi). A possible explanation for this question is that Japanese speakers perceive a shortened /Q/, which is possible and even occurs in some dialects in Japan, rather than a lengthened singleton stop, which does not occur in Japanese.

Min (1987) also claims consonant duration as an important factor for /Q/ perception for Japanese speakers. He compared the perception of Japanese /Q/ by Korean speakers and native speakers of Japanese. He prepared Japanese words /iQka/ 'one's whole family' and /iQta/ 'went', with different closure duration between the vowel and the syllable-initial stop. The stimuli are created by cutting the duration from the longest form, so that phonetic characteristics of

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the human ear.

the syllable-initial consonants are identical in all stimuli. He found that Korean speakers did not rely on the duration of /Q/ to determine if the word contained /Q/ or not. On the other hand, native speakers of Japanese relied on duration of /Q/ for their judgements. This indicates that Korean speakers use qualitative characteristics of /Q/(which is similar to Korean tensed stops) to judge if the word is /iQta/ or /ita/. Korean speakers produce Japanese /Q/ shorter than its target-like form, and since Japanese speakers relay on duration, there are often confusions between words such as /ita/and /iQta/ when Japanese speakers listen to Korean speakers' Japanese.

3.2.1.6 /Q/ occurrence: Qualitative features as the explanation

Some studies of /Q/ perception examine qualitative features. Shin (1986) reported an example which may contradict Min (1987) who claimed that the durational feature is the primary cue for native speakers of Japanese to perceive a /Q/. Shin reported that Japanese /(C)VC $_{[-voice]}$ V/ words such as /kite/ 'come!' are pronounced as [kit'e] by Korean speakers using Korean tensed stop. This is because Korean tensed stops have the greatest glottis tension among Korean stops. This often causes Japanese speakers to hear the word /kite/ 'come!' as /kiQte/ 'stamp', especially when the vowel before the voiceless stop is a closed (i.e. high) vowel. Thus, Japanese speakers hear /Q/ in Korean speakers' utterances even if the duration of Korean /t'a/ is shorter than /Qta/. This may

suggest that Japanese speakers also use some phonetic cues besides the duration feature to identify Japanese /Q/.

3.3 /Q/ in Korean loanwords

As this dissertation examines Japanese /Q/ perception in Korean words, some factors of Korean loanwords in Japanese are introduced here.

The occurrence of /Q/ in Korean loanwords in Japanese is not consistent. Compared to English loanwords, Korean loanwords are remarkably few in the Japanese language, and they are limited to certain types of words such as food names. Some loanwords are well-established, such as *bibinba* /bibinba/ for Korean /pipimpap/ 'rice with vegetable and meat toppings', *kuppa* /kuQpa/ for Korean word /kukpap/ 'rice soup', and *yukkejan* /juQkeǰan/for Korean word /jukkæǰaŋ/ 'spicy beef soup'. However, these loanwords may show some variation, for example, *pibinpappu* for Korean word /pipimpap/. It may be that the more recent loan *pibinpappu* is more spelling-based, and earlier loan *bibinba* is more perception-based. Examples from well-established forms such as *bibinba* and *kuppa* indicate that Korean final stops may not be perceived by Japanese speakers at all. However, there are examples like トッ *toQ* /toQ/ or トック *tokku* /toQku/ for the Korean word /tʼək/ 'rice cake' (notice /toQ/ has a form which is not permissible in standard Japanese) and ヤクパプ *yakupapu* /jakupapu/ for the

Korean word /jakpap/ 'seasoned rice'[26]. These forms show that Korean coda obstruents may be realized as /Q/, /QCV/, or /CV/ in Japanese, and it seems that loanword phonology in Korean words does not exhibit a consistent pattern compared to English loanwords. However, /Q/ in Korean loanwords usually corresponds to syllables closed with obstruents or word-medial tensed stops in the original Korean words.

3.4 Summary

Perception of /Q/ in foreign words and loanwords by Japanese speakers can be influenced by multiple factors. /Q/ in English loanwords occurs mostly with voiceless obstruents preceded by a lax vowel. Factors which may cause perception of /Q/ are accentuation pattern, rhythmic pattern (foot structure), syllable type, consonant-to-vowel duration ratio, consonant quality, and spelling. Among these explanations, the spelling-based explanation is very weakly supported, as many loanwords are borrowed with /Q/ but do not contain double consonants in the spellings. Stress pattern is important if a stress lengthens the consonant duration and such lengthened consonants may cause /Q/ perception. Stress also influences the foot structure. To maintain an alternating rhythm in the foot structure, /Q/ may be inserted. The durational ratio between the consonant and the preceding vowel is expected to have a strong influence on /Q/ occurrence in L2 phonology. When the duration of consonant closure is considerably longer than the preceding vowel, /Q/ is likely

[26] None of these words are well-established loanwords in Japanese. These examples are taken from Jun (1984).

to be perceived. However, there are some cases where /Q/ is perceived despite a smaller ratio between the consonant and vowel, so the evidence is not very clear. This leads us to consider some qualitative feature such as a glottis feature or tenseness of the consonant, which also may influence /Q/ perception. Some of these factors seem to cause /Q/ perception in both loanword phonology and L2 phonology, but some of the factors may be applicable only for loanword phonology and others, only for L2 phonology.

There is not as systematic a pattern in /Q/ occurrence in Korean loanwords, as compared to English loanwords. In general, Korean word-medial tense stops are borrowed with /Q/. Korean coda stops exhibit inconsistent patterns in terms of /Q/: They are often completely deleted, but are sometimes borrowed with a /Q/.

CHAPTER 4

EXPERIMENTS: JAPANESE PERCEPTION OF ENGLISH STOPS

This chapter will investigate how English coda consonants are perceived by Japanese speakers. The condition for /Q/ perception will be the main focus of the experiments.

4.1 English stop perception: Questions and Hypotheses

There are two experiments in this section. Experiment J-E 1 will test vowel length perception in different phonological environments, and examine if the findings in my earlier study (Yasuta, 2001) reflect the general tendency of vowel length perception by Japanese speakers at the early stage of L2 acquisition. Experiment J-E 2 will test how /Q/ is perceived in English word-medial stop clusters. Followings are research questions in this chapter:

Question 4.1: Does vowel tenseness determine the perception of word-final English stops with /Q/ by Japanese speakers?

Hypothesis4.1: Vowel tenseness will decrease the perception of /Q/, because Japanese speakers will perceive English tense vowels as long vowels.

The tense/ lax distinction is often described in terms of features such as duration, tongue height and the degree of muscular effort. Among these, duration is related to the tense/ lax distinction, as tense vowels are usually considerably longer than corresponding lax vowels (Jakobson, Fant, and Halle, 1969).

Tense vowels may be associated with long vowels by Japanese speakers because tense vowels are phonetically longer than their lax counterparts. Sunaoshi (1995) points out a strong association of English tense vowels with Japanese long vowels, and English lax vowels with Japanese short vowels. If the original English vowels are tense, they are perceived as long and the following coda stops will not be perceived with a /Q/.

However, some questions remain. Phonological context strongly influences vowel length in English. It is uncertain which will be more often perceived as long; tense vowels before voiceless stops or lax vowels before voiced stops.

It is also possible that both are equally perceived as long. In my former study (Yasuta, 2001), the results showed that more than 70% of lax vowels before voiced stops are perceived long while about 40% of tense vowels before voiceless stops are perceived long. Thus, voicing of the consonant and consequent vowel length may be a bigger influence on the preceding vowel length than tenseness.

Question 4.2: Does vowel length influence the perception of /Q/ word-finally?

Hypothesis 4.2: Perception of /Q/ will be influenced by vowel length.

In Japanese, /Q/ normally appears after a short vowel, as the first part of a geminate consonant cluster, e.g., /kiQte/ 'stamp' is okay, but */ki:Qte/ is not. As Japanese does not favor the combination of a long vowel plus /Q/ within a syllable, it is predicted that vowels perceived as short (i.e. one mora long) will be more frequently heard with /Q/. Conversely, /V:QC/ will be rarely observed, as Japanese does not allow this pattern within a single morpheme in normal

speech. This means that vowel length may influence /Q/ perception: When vowels are perceived long, /Q/ will not be perceived often, but when vowels are perceived short, /Q/ will be perceived more often.

Question 4.3: Does the voicing of the following stop influence the perception of word-final /Q/?

Hypothesis 4.3: /Q/ will be perceived far more often with a voiceless coda than with a voiced coda.

/Q/ may be heard more frequently when the coda stop is voiceless. This is because /Q/ in Japanese mostly occurs in this environment. Voiced stops preceded by /Q/ may be realized, as they occur in loanword phonology. However, as they do not occur in standard Japanese phonology, they will not be found as much as with voiceless coda stops. As evidence, voiced stops with /Q/ were not frequently observed in Yasuta (2001). Experiment J-E 1 will retest the question and see if the same results will be obtained again.

Question 4.4: How do Japanese speakers perceive English consonant clusters? This question will be divided into 3 small questions:

Question 4.4.1: Do Japanese speakers hear English heterorganic stop clusters as geminates? Or do they hear these clusters with vowel insertion, or both?

Hypothesis 4.4.1: English stop clusters will be perceived as geminate stop clusters by Japanese speakers.

It seems likely that Japanese speakers will hear English voiceless stop clusters, as in *chapter*, with a /Q/, as [tʃaQtaː]. This is because Japanese speakers may not be able to identify the heterorganic place of articulation of the first stops

in consonant clusters due to L1 interference. The only possible stop cluster in Japanese is geminate. Thus Japanese speakers may perceive /Q/ as the first member of stop clusters without specifying the place of articulation. It is also possible that Japanese speakers hear stop clusters with vowel epenthesis, as [tʃaputa:] as suggested by Kawagoe (1995), based on loanword phonology.

Another possibility is that the Japanese speakers perceive the English consonant cluster correctly, as /tʃapta:/, but choose [tʃaputa:] as the underlying form, and assume that devoicing and deletion have applied to the underlying vowel /u/. Some studies (see Major, 1987; Yasuta, 1996) report that Japanese speakers use vowel insertion to break up consonant clusters at the production level. It is possible that Japanese speakers reconstructed the stop clusters with non-existing vowels (deleted vowels due to a vowel deletion rule[27]) at the perception level as well, but not with a /Q/. However these earlier studies are based on production, with word-initial and final consonant clusters, and they do not tell how word-medial clusters will be perceived.

Question 4.4.2: Is the place of articulation of the first stop in consonant clusters perceived accurately?

Hypothesis 4.4.2: Japanese speakers will not be able to identify the first stop in consonant clusters.

Place of articulation identification of first member of a stop cluster is not crucial in Japanese phonology. This is because Japanese phonology allows only

geminate stop clusters; thus whatever stop appears in the first stop position, a stop cluster may be heard as a geminate. As Kawakami (1977) pointed out, even if [kekkon] 'marriage' is intentionally pronounced as [ketkon], it will be still perceived as a possible variation of /keQkon/. This is because Japanese speakers do not need to pay attention to the place of articulation of the first member of stop clusters. If this is true, the participants may not be able to identify the /p/ in *chapter*, but simply perceive it as a realization of /Q/, assuming the underlying form /tʃaQta:/.

Question 4.4.3: Does stress pattern influence the perception of the first stop (i.e. C_1) of consonant clusters?

Hypothesis 4.4.3: A two-stress pattern will increase the perception of C_1 in stop clusters.

Test words in Experiment J-E 2 will be either single words with word-medial consonant clusters (e.g., *chapter*), or combinations of two words which create consonant clusters with the final consonant of the first word and the initial consonant of the second word (e.g., *zip tie*). The former type has one stress, and latter type has 2 stresses.

The identification rate of C_1 will be also influenced by a stress, because stressed syllable may have a longer vowel-to-stop transition. In a word like [tʃǽptər̆], the first syllable is shortened by the second, unaccented syllable. In a word like [sǽp kʰǽn], the first syllable is longer because there is no unstressed

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[27] Japanese high vowels /i, u/ may be devoiced and deleted between voiceless segments or word-finally.

syllable which take away time from it. Therefore perhaps two-stressed English words (with longer first syllable) will have more instances of /Q/ insertion.

4.2 Experiment J-E 1: Vowel and /Q/ perception

Experiment J-E 1 is based on my earlier project (see Yasuta, 2001[28]). Experiment J-E 1 repeated that study, using modified material and methodology. Experiment J-E 1 investigates how Japanese speakers perceive /Q/ in monosyllabic English words which differ in vowel tenseness and in voicing of the syllable-final stops. This experiment tested questions 1-3 in section 4.1.

4.2.1 Participants

The participants were all the same for both Experiments J-E 1 and 2. Participants are 20 Japanese first year junior high school students (equivalent to 7th graders in the USA) in Fukushima Prefecture, Japan. Out of 20 students, 14 students were male and 6 students were female. They were 13-14 years old, and had been studying English at junior high school for approximately 8 months when the experiment was carried out. According to a brief survey of background information, none of them had lived in foreign countries or received special training in listening to or speaking foreign languages. Six of them were learning English at prep schools; however, attending such grammar-oriented schools will not influence the experiments here. This is because such prep schools do not provide much speaking or listening practice. No student had studied any other foreign language besides English.

[28] From now on, I will refer this study as Yasuta 2001 for convenience.

4.2.2 Materials

Twelve English monosyllables (see Appendix A) were used as stimuli. They consist of 6 minimal pairs which differ in the tenseness of the vowel; e.g., /tip/ vs. /tɪp/. Four disyllabic words were added as distracters. Most of the test words were English-like nonsense words, although some real words were included. Each test word has the form; a stop consonant as onset, vowel, coda consonant /p/ or /b/. Each final stop was preceded by either a lax vowel /ɪ, ʊ, ɛ/, or a tense vowel /i, u, o/. Each test word and distracter was put in a word list 3 times in a random order, creating a word list of 48 words. Two such word lists were prepared for a male speaker's recording and a female speaker's recording. Both lists consisted of identical test words, but they were put in different orders.

Word list J-E 1 male (see Appendix B) was read by a male native speaker of American English, and Word list J-E 1 female (see Appendix B) by a female native speaker of American English, and tape-recorded in a sound-attenuated recording studio. All words were read with final stop release. The recorded speech was edited using SoundEdit 16 version 2.0.1. After the recording session, each word was copied and pasted twice following the number read in Japanese. There was a 0.75 second pause between the first and second copy, and a 4 second pause was inserted after the second copy to give participants time for working on the task. Edited recordings were burnt on Memorex CD-R 650MB, in a CD player format.

The vowel length and final stop closure length of all tokens were measured using PCquirer. Vowel length was measured from the point where formants started, and to the point of the vowel where the formants clearly faded in the spectrogram. The wave form of each token was also used to determine the precise starting and ending point of vowels. Stop closure was measured from the ending of the preceding vowel to the point where the release of the stop started, in other words, at the beginning of the spike in the spectrogram.

4.2.3 Procedures

The participants listened to the recorded stimuli in a computer laboratory at Fukushima 3rd Junior High School in Fukushima prefecture, Japan. The CD was played using a Macintosh iBook and Subwoofer speaker system (three speakers including two full range satellite speakers). Participants listened to the recorded tokens and transcribed them using *katakana* syllables[29]. This method allows us to see if the vowel was perceived as long or short, if the stop was perceived as voiced or voiceless, and if the coda consonant was perceived as a single consonant or geminate or nothing. A short practice session was conducted before the real experiment. Any questions regarding the experiment were answered before the experiment, and no participant claimed any difficulties in task or tempo during the practice session. Experiment J-E 2, which required a multiple choice task, was conducted before Experiment J-E 1, which required a transcription task. This is because multiple choice seemed less demanding and

easier than *kana* transcription, and it was hoped that giving the easier task first would decrease participants' stress and difficulties during the experiments.

4.2.4 Results and discussion

The results of Experiment J-E 1 will answer the questions 4.1 to 4.3 stated earlier. Questions and hypotheses are repeated here: Question 4.1: Does vowel tenseness determine the perception of word-final English stops with /Q/ by Japanese speakers? *Hypothesis4.1: Vowel tenseness will decrease the perception of /Q/, because Japanese speakers will perceive English tense vowels as long vowels;* Question 4.2: Does vowel length influence the perception of /Q/ word-finally? *Hypothesis 4.2: Perception of /Q/ will be influenced by vowel length;* Question 4.3: Does the voicing of the following stop influence the perception of word-final /Q/? *Hypothesis 4.3: /Q/ will be perceived far more often with a voiceless coda than with a voiced coda.*

In this experiment, there were 1440 tokens. Some unanalyzable tokens were excluded from the data. Among the all collected data, 1326 tokens[30] (691 tense vowel tokens and 635 lax vowel tokens) were considered to be valid and used for analysis.

The following tables show the influence of vowel tenseness and final consonant voicing on vowel length and /Q/ perception in English monosyllabic words. /Q/ was perceived most frequently in the lax vowel + voiceless stop

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[29] Experiment J-E 1 did not use multiple choice, because the number of possible choices became 8 for each token. As too many choices will cause difficulty in the task, only this experiment used *kana* transcription.

[30] Excluded words are those which are written completely differently from the original forms and those which were left blank (not answered).

condition. /Q/ was perceived more frequently with voiceless than with voiced stops.

Table 4.1 Vowel tenseness, consonant voicing and /Q/ perception in English words (TNS = tense, LAX = lax, ( ) = %))

	/Q/ perceived	no /Q/ perceived	total
TNS/ voiceless	26 (7.6)	317 (92.4)	**343 (100)**
TNS/ voiced	2 (0.6)	346 (99.4)	**348 (100)**
total for TNS	**28 (4.1)**	**663 (95.9)**	**691 (100)**
LAX/ voiceless	140 (46.1)	164 (53.9)	**304 (100)**
LAX/ voiced	19 (5.7)	312 (94.3)	**331 (100)**
total for LAX	**159 (25.0)**	**476 (75.0)**	**635 (100)**
total	**187 (14.1)**	**1139 (85.9)**	**1326 (100)**

In Table 4.2, /Q/ is almost never perceived with long vowel. When the vowel is perceived short, /Q/ is perceived more often with lax vowels than tense vowels. /Q/ is perceived more often with lax vowel in general, but voicing of the coda consonant influenced the results:

Table 4.2 The influence of tenseness, perceived vowel length, and final consonant voicing on /Q/ perception (TNS = tense, LAX = lax)

	/Q/ perceived	no /Q/ perceived	total
TNS perceived long /_ voiceless	0 (0.0)	275 (100)	**275 (100)**
TNS perceived long /_ voiced	0 (0.0)	317 (100)	**317 (100)**
TNS perceived short/_voiceless	26 (38.2)	42 (61.8)	**68 (100)**
TNS perceived short/_voiced	2 (6.5)	29 (93.5)	**31 (100)**
total for TNS	**28 (4.1)**	**663 (91.6)**	**691 (100)**
LAX perceived long/_voiceless	1 (0.9)	106 (99.1)	**107 (100)**
LAX perceived long /_ voiced	0 (0.0)	267 (100)	**267 (100)**
LAX perceived short/_voiceless	139 (70.6)	58 (29.4)	**197 (100)**
LAX perceived short/_voiced	19 (29.7)	45 (70.3)	**64 (100)**
total for LAX	**159 (25.0)**	**476 (75.0)**	**635 (100)**
total	**187 (14.1)**	**1139 (85.9)**	**1326 (100)**

4.2.4.1 Vowel tenseness and perception of /Q/

The results shown in Table 4.1 indicate that the 28 (4.1%) tense tokens and 159 (25.0%) lax tokens were perceived with /Q/. Thus, only187 (14.1%) of all

tokens were perceived with /Q/. In Yasuta 2001[31], the percentage of total perceived /Q/ was 30.9%. Results of J-E 1 and Yasuta 2001 are shown in the following table for comparison of the two studies with the results of Kawagoe and Arai (1996):

Table 4.3 Percentage and number (n=) of /Q/ perception in Yasuta 2001, J-E 1, and Kawagoe & Arai 1996 (number of /Q/ tokens/ total number of each token type)

	tense V /voiced C	tense V /voiceless C	lax V /voiced C	lax V /voiceless C
Yasuta, 2001	2.0	50.0	10.8	60.8
J-E 1 results	0.6	7.6	5.7	46.1
Kawagoe & Arai, 1996[32]	-----	-----	35.5	90

Yasuta 2001 and J-E 1 show the same pattern of /Q/ perception: Tokens which contain lax vowels before voiceless stops are the most frequently heard with /Q/. In second place are tokens with tense vowels before voiceless stops, in third place, tokens with lax vowels before voiced stops, and last, tokens with tense vowels before voiced stops. However, the percentages are quite different in Yasuta 2001 and J-E 1. Kawagoe and Arai (1996) also shows different degrees of /Q/ perception, with a much higher percentage of /Q/ for both voiceless and voiced codas. The common finding of these three studies is that /Q/ was heard more often with voiceless stops.

[31] The original study (Yasuta, 2001) included test words which were not used in J-E 1. The results here are based on only the tokens used in J-E 1 as well. The overall results of Yasuta (2001) shows slightly higher occurrence of geminate consonants, which was 36.8%.
[32] Kawagoe and Arai examined lax vowels only.

The results in Yasuta 2001 show clear differences across token types, but J-E 1 shows smaller differences among tokens except lax vowels preceding voiceless stops. The results of J-E 1 are also shown in the following graph:

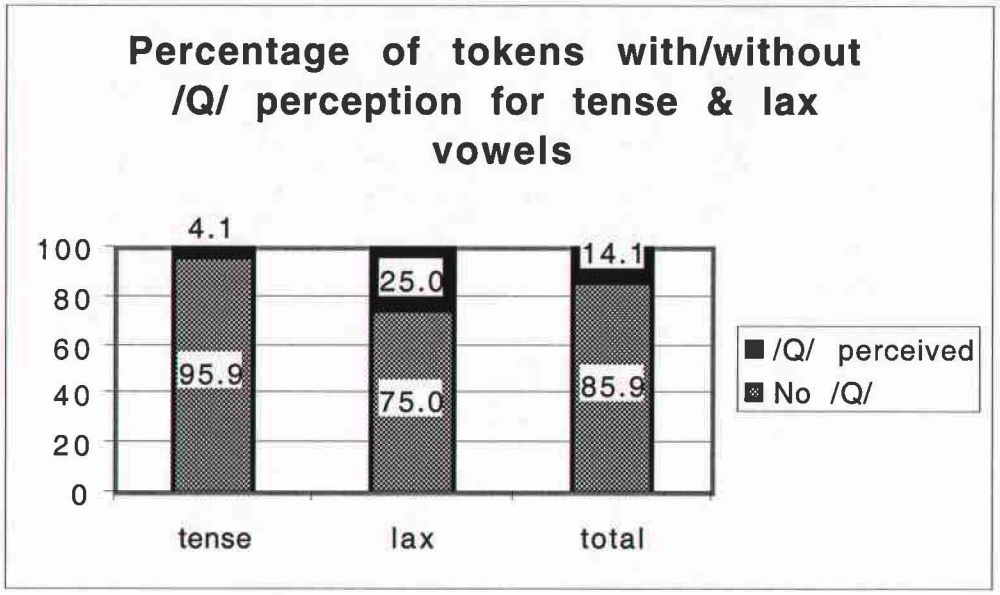


Figure 4.1 Relationship of vowel tenseness and perception of /Q/ (number of /Q/ tokens / total of each tenseness)

A Chi-square test was conducted to see the correlation between tenseness and /Q/ perception. It was found that the P-value was <.0001, which is a significant level. The data shows that most of the tense vowel tokens were perceived without /Q/. On the other hand, lax vowels are more likely to be heard with /Q/. However, only 25% of lax tokens were perceived with /Q/, while 75% were perceived without /Q/. Although the Chi-square test showed a high correlation between tenseness and /Q/ perception, and indicates that lax tokens are significantly more likely to be heard with /Q/, it seems that the difference tenseness makes is not as clear as in loanword phonology. Scholars such as

Lovins (1973) and Sunaoshi (1995) have claimed a strong association of English tense vowels with Japanese long vowels, and English lax vowels with Japanese short vowels in loanword phonology. The condition for /Q/ insertion requires a voiceless stop preceded by a lax vowel in loanword phonology. However, this seems to be more like a convention of second language phonology which is only partly supported by perception data. If /Q/ insertion were observed in accordance with Lovins' and Sunaoshi's predictions, 50% of the lax tokens (i.e., all the lax tokens with voiceless coda) would have been perceived with /Q/. The results in J-E 1 indicate that there is a significant association of vowel tenseness and /Q/ perception, but it is not as clear as in loanword phonology.

4.2.4.2 Perceived vowel length

As there is no absolute association between tenseness by itself and vowel length, it is necessary to examine how vowel lengths are actually perceived by L2 learners. Table 4.4 shows that 592 out of 691 tense vowel tokens, and 374 out of 635 lax tokens were perceived as long vowels:

Table 4.4 The influence of vowel tenseness and consonant voicing on vowel length perception in English words (TNS = tense, LAX = lax, ( ) = %)

	perceived long	perceived short	total
TNS/ voiceless	275 (80.2)	68 (19.8)	**343 (100)**
TNS/ voiced	317 (91.1)	31 (8.9)	**348 (100)**
total for TNS	**592 (85.7)**	**99 (14.3)**	**691 (100)**
LAX/ voiceless	107 (35.2)	197 (64.8)	**304 (100)**
LAX/ voiced	267 (80.7)	64 (19.3)	**331 (100)**
total for LAX	**374 (58.9)**	**261 (41.1)**	**635 (100)**
total	**966 (72.9)**	**360 (27.1)**	**1326 (100)**

Figure 4.2 shows the results shown in the above Table 4.4 in terms of percentage:

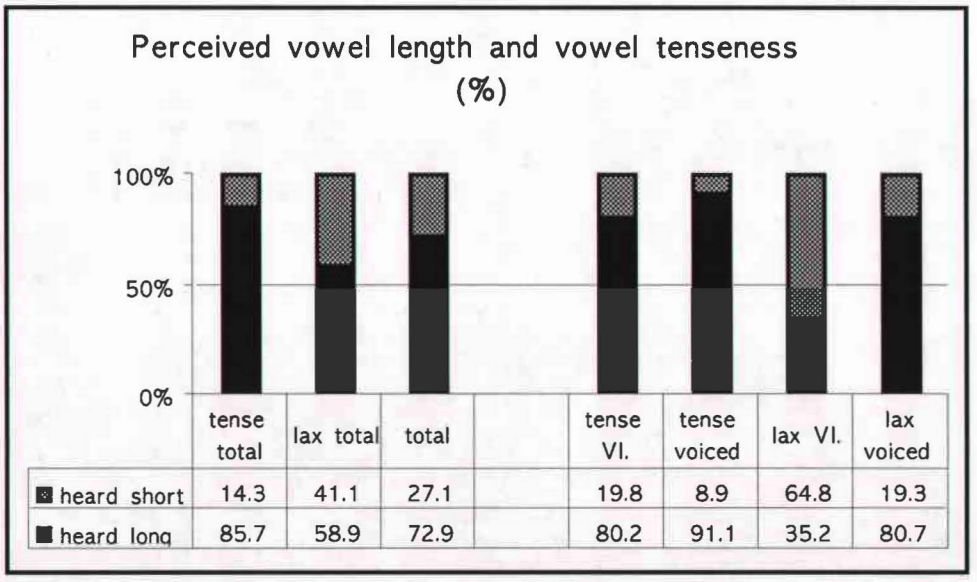


Figure 4.2 Percentage of vowels heard as long/short before voiced/voiceless (Vl.) final consonants

Figure 4.2 clearly shows that all tokens except lax vowel voiceless tokens were likely to be perceived as long vowels. The results show that the total of tense tokens are recognized as long vowels 26.8% more often than lax vowel tokens (Chi-square $p < .0001$). However, the results do not suggest a clear association between tenseness itself and perceived vowel length. Figure 4.2 shows that tense vowels are mostly heard as long vowels regardless of the voicing of the following consonants; however, for lax vowels, the perceived vowel length is strongly influenced by the voicing of the following stop. The percentage of lax tokens with voiced final consonants perceived as long is almost identical to the percentage of tense tokens with voiceless final consonants (tense vowel/ voiceless C = 80.2%, lax/voiced C = 80.7%). These results are a little different from Yasuta 2001 in which tense vowels before voiceless consonants are far less often perceived as long vowels. The overall results of Yasuta 2001 and Experiment J-E 1 are compared in the following Table 4.5:

Table 4.5 Percentage (%) of vowels perceived as long vowels (number of tokens heard as long / total number of each token type)

	tense vowel / voiced C	tense vowel / voiceless C	lax / voiced C	lax / voiceless C
Yasuta, 2001	88.2	25.5	74.5	13.7
total	**56.4**		**44.1**	
J-E 1 results	91.1	80.2	80.7	35.2
total	**85.7**		**58.9**	

The differences between the two studies are especially prominent with vowels before voiceless consonants. In the 2001 study, perceived vowel lengths were more influenced by the voicing of coda consonants. Regardless of tenseness,

vowels before voiced stops were far more often perceived as long vowels. J-E 1 also shows a similar pattern for voiced tokens. However, tense vowels before voiceless stops were usually perceived as long in J-E 1. This is probably due to the actual vowel length in two studies. In J-E 1, the tense vowels may have been long enough to be perceived as long vowels regardless of the voicing of the coda stops. The following tables show the actual vowel lengths in J-E 1 and Yasuta 2001:

Table 4.6 Test words and their average vowel and closure duration (ms) in J-E 1

token types	test words	Average duration of vowel	Average duration of stop closure	C/V Ratio (C duration / V duration)
lax_vl	tɪp	104	103	0.99
	dʊp	139	108	0.78
	gɛp	141	117	0.83
Average		**128**	**109**	**0.85**
lax_vd	tɪb	164	101	0.62
	dʊb	221	87	0.40
	gɛb	224	105	0.47
Average		**203**	**98**	**0.48**
Tns_vl	tip	118	113	0.96
	dup	153	121	0.79
	gop	142	101	0.71
Average		**138**	**112**	**0.81**
Tns_vd	tɪb	240	74	0.31
	dub	257	86	0.33
	gob	287	81	0.28
Average		**261**	**80**	**0.31**

Table 4.7 J-E 1 test words and their average vowel and closure duration (ms) in Yasuta 2001

token types	test words	Average duration of vowel	Average duration of stop closure	C/V Ratio (C duration / V duration)
lax_vl	tɪp	96	161	1.68
	dʊp	98	199	2.03
	gɛp	130	243	1.87
Average		**108**	**201**	**1.86**
lax_vd	tɪb	261	128	0.49
	dʊb	208	117	0.56
	gɛb	263	119	0.45
Average		**244**	**121**	**0.50**
Tns_vl	tip	101	177	1.75
	dup	122	199	1.63
	gop	137	173	1.26
Average		**120**	**183**	**1.55**
Tns_vd	tɪb	272	92	0.34
	dub	319	104	0.33
	gob	329	115	0.35
Average		**307**	**104**	**0.34**

Table 4.8 Average vowel lengths in Yasuta 2001 and J-E 1 (ms)

	tense vowel / voiced C	tense vowel / voiceless C	lax / voiced C	lax / voiceless C
Yasuta, 2001	307	120	244	108
Average	**214**		**176**	
J-E 1 results	261	138	203	128
Average	**200**		**166**	

These tables show that the vowels of the voiceless tokens in J-E 1 are about 20 ms longer than those of Yasuta 2001. On the other hand, the vowels of the voiced tokens are shorter in J-E 1 than Yasuta 2001. However, Table 4.5 shows

that the percentage of perceived long vowels is slightly higher in J-E 1 for vowels before voiced stops. It seems to be the case that vowels beyond a certain length tend to be heard long. Fujisaki and Sugito (1977) reported that Japanese vowels are heard as long vowels when they are longer than 156 ms in their vowel length perception experiment. In J-E 1, the average lax vowel before a voiced stop was 201 ms long, which was a 'long vowel' for most of Japanese speakers. Although the short/ long boundary may vary in different studies with different settings, the vowels perceived as long in J-E 1 and Yasuta 2001 are much longer than the boundary value in Fujisaki and Sugito.

For voiceless tokens in J-E 1 and Yasuta 2001, about 20 ms vowel length difference caused a great difference in the perception of long vowels. In J-E 1, the boundary between short and long vowel seemed to be somewhere between 128 ms (average length of lax/voiceless vowels) and 138 ms (average length of tense/voiceless vowels). However, not all tokens longer than 138 ms were perceived long. There exist some other factors which may influence perceived vowel length. C/V Ratio, the ratio between the duration of the vowel and the following stop closure, may be a perceptual cue for long vs. short vowel perception. However, Table 4.6 shows that tense/voiceless tokens (C/V Ratio 0.81) and lax/voiced tokens (C/V Ratio 0.48) were almost equally perceived as long, even though they have quite different C/V Ratio values. This indicates that the C/V Ratio is not a cue for vowel length perception. Thus, perception of English vowel length is not always determined by the actual vowel length or the ratio between segments.

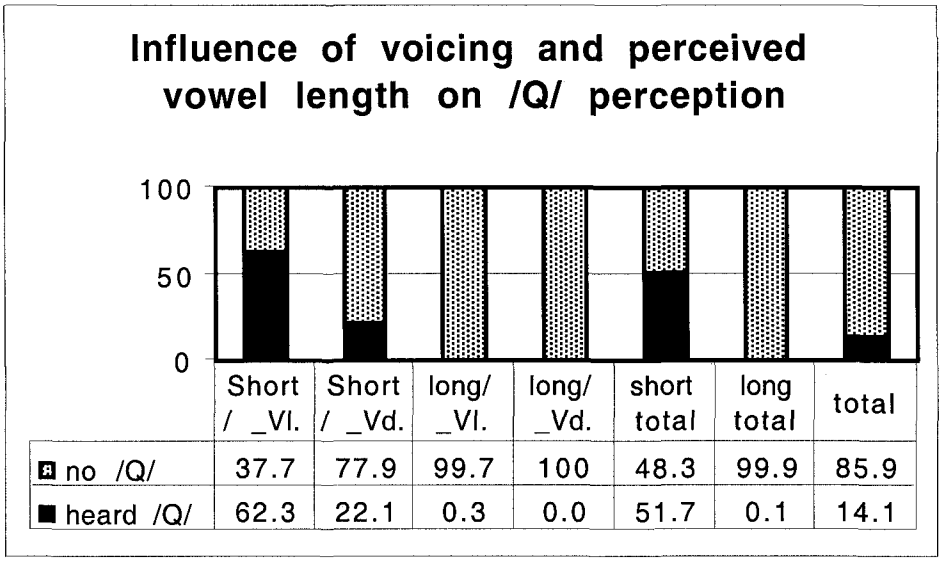
In both J-E 1 and Yasuta 2001, the results did not show a strong association of vowel tenseness and perceived vowel length. Thus, actual vowel perception does not follow the same pattern as loanword phonology, which shows a strong relationship between tenseness and vowel length.

The results from perception studies (like J-E 1 and Yasuta 2001) suggest that native speakers of English may have different degree of vowel length, depending on speakers or speech style, and such individual differences could be crucial in terms of how Japanese speakers perceive vowel length. Some native speakers of English may pronounce vowels longer than other speakers, but such difference in the degree of lengthening is not very crucial for English speakers. This is because for native speakers of English, vowel length is not the primary characteristic in differentiating vowels. Giegerich (1992) reported (as noted in chapter 3) that native speakers of English may recognize the vowel tenseness distinction in terms of a qualitative difference rather than a quantitative difference. However, a vowel length difference may be perceived crucially by native speakers of Japanese. English speakers may recognize tenseness of the vowels even when tense vowels are produced with the length of lax vowels or vice versa. On the other hand, Japanese does not have a vowel quality difference between short and long vowels. For Japanese speakers in this study, the correlation between tenseness and perceived vowel length is not as strong as that observed in loanword phonology. It is true that J-E 1 showed that most tense vowels are heard as long, but it is not the case that most lax vowels are perceived as short (i.e., vowel length is influenced by the voicing of coda stops). Results

could differ depending on speakers and speech style. In fact, Yasuta 2001 showed a stronger influence of the voicing of coda consonants to determine vowel length. Thus, the formulas "tense vowels equal long vowels" and "lax vowels equal short vowels" are not reliable for Japanese speakers in English learning. Additionally, formulas such as "vowels before voiced stops equal long vowels" and "vowels before voiceless stops equal short vowels" are not always true for Japanese speakers. Thus, if Japanese speakers are taught to distinguish tense/ lax vowels in terms of perceived vowel length, just as in loanword phonology, it may cause some confusion.

4.2.4.3 Perceived vowel length and /Q/

Now perceived vowel length and the occurrence of the moraic obstruent /Q/will be examined. Figure 4.3 shows the relationship between perceived vowel length and the occurrence of /Q/:



	Short / _Vl.	Short / _Vd.	long/ _Vl.	long/ _Vd.	short total	long total	total
no /Q/	37.7	77.9	99.7	100	48.3	99.9	85.9
heard /Q/	62.3	22.1	0.3	0.0	51.7	0.1	14.1

Figure 4.3 Percentage of tokens heard with /Q/ for different vowel length and final consonants (Vl. = voiceless stops, Vd. = voiced stops)

Figure 4.3 shows a strong disfavoring of long vowel plus /Q/ at the perception level. Vowels heard as long are almost 100% perceived without /Q/. A Chi-square test showed that perceived vowel length and /Q/ perception have correlation at P-value < .0001. It was hypothesized that long vowel plus /Q/ will be rare, but it was even rarer than expected. Although long vowel plus /Q/ is not found in normal speech within the same morpheme in Japanese, the combination does occur. However, the results in J-E 1 indicate that such cases are not observed in L2 phonology.

For short vowels, the results are not as clear as for long vowels. /Q/ was mostly heard with voiceless tokens which contain vowels perceived short: 62.3% of such tokens were perceived with /Q/. So, it cannot be said that /Q/ is always perceived when a vowel is perceived short.

4.2.4.4 /Q/ perception and voicing of coda stops

Now the relationship between /Q/ perception and the voicing of coda stops will be examined. Table 4.1 shows that there were 187 tokens heard with /Q/out of 1326 tokens. Most of these had lax vowels and voiceless finals: 140 lax tokens with voiceless final consonant, 26 tense tokens with voiceless final consonant, 19 lax tokens with voiced final consonant, and 2 tense tokens with final voiceless were heard with /Q/. Figure 4.4 shows these results in percentages:

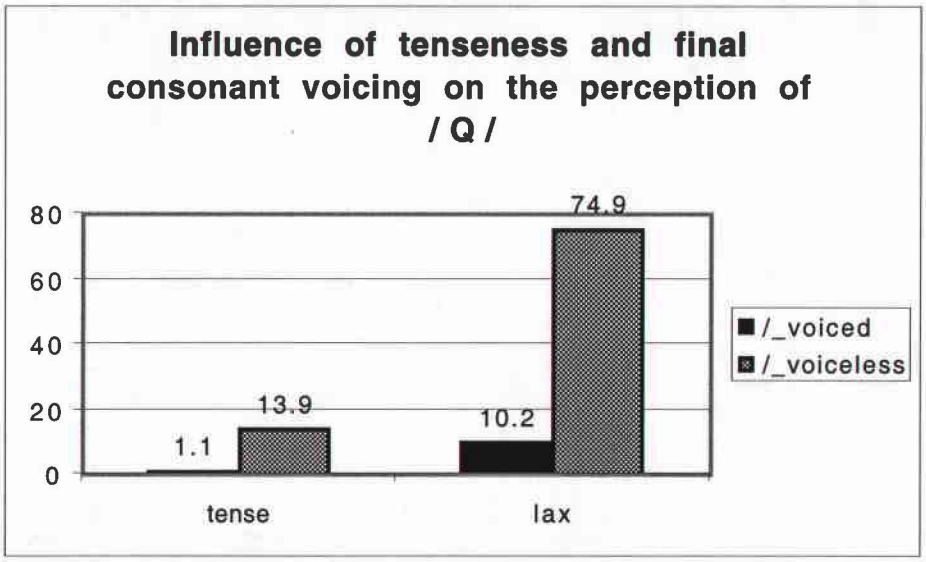


Figure 4.4 Percentage (%) of /Q/tokens for each environment out of 187 tokens perceived with /Q/ (100% = 187 tokens)

The results show a strong disfavoring of /Q/ perception before a voiced stop. A Chi-square test showed correlation between voicing of the coda consonant and /Q/ perception at P-value < .0001. Only 2 tense + voiced tokens and 19 lax + voiced tokens were perceived with /Q/, which is 11.2% of the total number of tokens heard with /Q/, 187.

The most likely explanation is that vowels before voiced consonants were lengthened and created an unfavorable environment for /Q/ to be perceived. Kindaichi (1988) reported that there is a tendency in Japanese that extra-heavy syllables (i.e., syllables having more than two non-syllabic moraic segments[33] together) are dis-preferred. A /Q/ does not follow a long vowel except in emphasized speech. This tendency is reflected in loanword phonology which

[33] Non-syllabic moraic segments in Japanese are; syllable final nasal /N/, the second half part of long vowels (indicated as :), and geminate consonant /Q/ (Kindaichi, 1988).

does not exhibit such a pattern. English words which are borrowed with long vowels do not take a following /Q/. There are no loanwords such as */to:Qku / 'talk' or */ko:Qto/ 'coat', but /to:ku/ and /ko:to/.

However, vowel length may not be the only explanation for less /Q/ perception with voiced stops. According to Table 4.2, 95 tokens were perceived with a short vowel followed by a voiced stop. 21 of them were perceived with /Q/, but 74 of them were perceived without /Q/. Thus, even when vowels are perceived short, voiced coda stops are not usually perceived with /Q/. This suggests that perception of /Q/ is strongly influenced not only by vowel duration, but also by the qualitative features of voiced stops.

The avoidance of /Q/ with voiced stops cannot be attributed to the non-occurrence of combinations like /geQbu/ in native Japanese words. Loanwords permit such forms, thus rare occurrence of /Q/ plus voiced stop in J-E 1 is not due to orthographic restriction. Additionally, the younger generation is more influenced by the language usage in comic books and loanwords, which use non-standard syllable structures and orthography.

As noted in Chapter 3, disfavor of /Q/ plus voiced stops could be explained in terms of articulatory difficulty. Disfavor of voiced geminates is supported by the fact that /Q/ + voiced stop in English loanwords are often devoiced at the production level. /beQdo/ 'bed' has variation in its phonetic forms; [beddo] and more commonly [betto] (Ohso, 1973; Vance, 1987). Vance (1987) claimed that voiced geminates are disfavored and devoicing of voiced

geminates occur because Japanese speakers avoid using the high degree of articulatory energy needed to produce voiced geminates. The interesting point is that Experiment J-E 1 suggests that the disfavoring of /Q/ plus voiced consonant occurs at the perception level as well.

It appears that voicing is less influential than vowel length on the perception of /Q/. The results in J-E 1 show that the occurrence of long vowel plus /Q/ is 0.1% (1 token) out of 1326, while 1.6% (21 tokens) out of 1326 were perceived as /Q/ plus voiced consonant. These results correspond to both of the conditions that disfavor /Q/ in Japanese phonology (Kindaichi, 1988). Loanword phonology exhibits a strong tendency to avoid a long vowel plus /Q/ combination, but not /Q/ plus a voiced obstruents. Although it may cause some articulatory difficulties, there are quite many loanwords with /Q/ plus voiced obstruents, such as /baQgu/ 'bag' and /doQgu/ 'dog'. On the other hand, there is probably no English loanword with a long vowel followed by a /Q/; long vowel plus /Q/ is more disfavored than voiced geminate. However, both phonological environments strongly disfavor /Q/ perception. These results indicate that the common usage of /Q/ plus voiced stops in loanword phonology is probably based on spelling rather than actual perception. First of all, if the word such as *dog* is borrowed into Japanese via perception, the nucleus vowel will be heard long due to the vowel lengthening before a voiced stop, such as [do:gu]. As evidence, 80.7% of lax vowels before voiced consonants were heard long in Experiment J-E 1. In [do:gu], both disfavored conditions (i.e., long

vowel and voiced coda) for /Q/ are created, and they will prevent the occurrence of /Q/. And since voiced geminates are avoided in L2 phonology, /Q/ will not usually be perceived even if the vowel is perceived short. Thus the actual loanword /doQgu/ cannot be derived from the perceived form [do:gu]. Loanword phonology employs the association of lax vowel and short vowel regardless of the actual length of the vowel. Then /Q/ is inserted, probably to create a closed syllable. One-syllable words with a lax vowel ending with a stop are almost always borrowed with /Q/. Some possible explanations for this are discussed by Ohye (1967), Kawagoe (1995) and in other studies (see Chapter 3).

4.2.4.5. C/V Ratio and /Q/ occurrence

Comparison of Yasuta 2001 and J-E 1 show some differences in the degree of /Q/ perception. The two studies show quite big differences in /Q/ perception for voiceless stop tokens. But as seen in Table 4.8, there are only slight differences in the actual vowel lengths for voiceless stop tokens. Therefore the vowel length by itself may not be the cause for the differences in the two studies in /Q/ perception. Then what could be the cause for the difference between the two studies? The reason could be the difference in C/V Ratio, or what Sunaoshi (1995) calls **R**atios of the consonants' **D**uration to the preceding **V**owels (RDV). C/V Ratio is stop closure duration divided by vowel length, and C/V Ratio in J-E 1 and Yasuta 2001 are shown in Table 4.6 and 4.7. C/V Ratio is especially important for /Q/ perception in Japanese (Fujisaki and Sugito, 1977), but its relationship with /Q/ in Japanese loanword phonology is not direct.

Although some other factors influence /Q/ perception, Arai and Kawagoe (1996) found that C/V Ratio has some influence on /Q/ perception in English words with CVC $_{[-voice]}$ syllable structure. In their study, the percentage of /Q/ perception for monosyllabic English words was 90%, and the C/V Ratio was 1.60. In Sunaoshi (1995), the C/V Ratio of lax vowel with voiceless tokens is approximately 1.3 while the C/V Ratio of lax vowel with voiced stop is 0.6. In Yasuta 2001, the C/V Ratio for lax vowel + voiceless stop is 1.86. All these studies show much greater C/V Ratio than that of J-E 1, where it is 0.85 for lax/voiceless tokens. This could be one reason why /Q/ in voiceless tokens is perceived less often than in these other studies. The following table shows the C/V Ratio and /Q/ perception of these studies:

Table 4.9 C/V Ratio and percentage (%) of /Q/ perception of lax/ voiceless tokens in Yasuta 2001, J-E 1, and Kawagoe & Arai 1996

	C/V Ratio	Perceived /Q/ (%)
Yasuta, 2001	1.86	60.8
J-E 1 results	0.85	46
Kawagoe & Arai, 1996	1.6	90

Although C/V Ratio cannot explain everything regarding /Q/ perception in English, the C/V Ratio in J-E 1 is far smaller than other two studies. The C/V Ratio in J-E 1 is rather similar to the C/V Ratio of a Japanese word with a singleton stop, and this could be too small to be perceived with /Q/. In

Sunaoshi (1995)[34], the C/V Ratio of Japanese words with single stop, such as /gipu/ was 0.85, and that of geminates such as /gippu/ is 2.53. A geminate has a C/V Ratio 3 times that of a single stop in Japanese in this particular study. As the C/V Ratio required for /Q/ perception is greater in Japanese, it is probable that the C/V Ratio for English CVC syllable to be heard without /Q/ should be lower than 0.85 (which is the C/V Ratio for Japanese singleton /gipu/ type words). In any case, the C/V Ratios of voiceless stop tokens in J-E 1 are quite small, and this could be one of the reasons for the lower occurrence of /Q/.

However, as Arai and Kawagoe (1996) pointed out, C/V Ratio is not the only cause for /Q/ perception in English words. In Yasuta 2001, the C/V Ratio is greater than Arai and Kawagoe, but the percentage of /Q/ is 30% lower. Both studies have the same average vowel length for lax tokens, 108 ms, but Yasuta 2001 has longer consonant closure than Arai and Kawagoe. However, the results are significantly different in opposite ways. Yasuta 2001 has the greater C/V Ratio but the percentage of perceived /Q/ is far lower than Arai and Kawagoe. It is possible that there is a difference in measurement points of consonant closure durations in these studies. However, as Arai and Kawagoe pointed out, it is also possible that /Q/perception in English words is not only due to the C/V Ratio. From results of these studies, it is possible that C/V Ratio cannot be too small (i.e., small as that of singleton stop) if /Q/ is to be perceived, but a larger C/V Ratio does not guarantee higher degree of /Q / perception. Thus it could be said that the findings in J-E 1 and Yasuta 2001, and Arai and Kawagoe

[34] Sunaoshi examined only lax vowel tokens in her study.

(1996, 1998) support the claim that C/V Ratio partially influences the perception of /Q/ in CVC English words, but does not always correctly predict the degree of /Q/ perception. This fact is pointed out by Kawagoe and Arai (1998). They reported that different combinations of segments seem to influence the degrees of /Q/ perception, even with the same C/V Ratio. Thus, some other factors besides the ratio between vowels and consonants may play an important role in /Q/ perception.

4.2.4.6 Token differences (vowel quality)

Certain tokens in the J-E 1 study were more likely to be perceived with /Q/. In the data, /gɛp/ was significantly more perceived with /Q/ than any other words. Table 4.10 shows the number and percentage of perceived /Q/ for each token:

Table 4.10 Number and percentage of perceived /Q/ for each token

	token	# of perceived /Q/	%
lax /voiceless	/dʊp/	30	16.0
	/gɛp/	77	41.2
	/tɪp/	33	17.6
subtotal		140	74.9
lax / voiced	/dʊb/	1	0.5
	/gɛb/	14	7.5
	/tɪb/	4	2.1
subtotal		19	10.2
tense / voiceless	/dup/	6	3.2
	/gop/	11	5.9
	/tip/	9	4.8
subtotal		26	13.9
tense / voiced	/dub/	1	0.5
	/gob/	1	0.5
	/tib/	0	0
subtotal		2	1.1
total		187	100

Table 4.10 shows that /ɛ/ tokens are heard with /Q/ significantly more often than tokens with other vowels. The sum of /gɛp/ and /gɛb/ reaches almost 50% of the tokens heard with /Q/. It is possible that vowels which are similar to

Japanese vowels in terms of quality and quantity create a Japanese-like phonological environment for /Q/ to be perceived. When English vowels are transcribed using the Japanese vowel system, English /ɛ/ could be the most well-substituted vowel to Japanese equivalent, which is /e/. /ɛ/ is always realized as Japanese /e/ in loanword phonology (Hirozane, 1992). Patterns of perceived vowel types in Experiment J-E 1 are shown in the following tables:

Table 4.11 Categorization of perceived vowels for tense vowel tokens (bold letter = number of tokens, ( ) = percentage)

tense Vs	token	heard /i/	heard /e/	heard /u/	heard /o/	heard /a/	total
/i/	tip	**103** (88.8)	**12** (10.3)	**1** (0.9)	**0** (0.0)	**0** (0.0)	116
	tib	**115** (99.1)	**1** (0.9)	**0** (0.0)	**0** (0.0)	**0** (0.0)	116
total		**218** (94)	**13** (5.6)	**1** (0.4)	**0** (0.0)	**0** (0.0)	232
/u/	dup	**5** (4.4)	**4** (3.5)	**101** (88.6)	**4** (3.5)	**0** (0.0)	114
	dub	**0** (0.0)	**0** (0.0)	**110** (94.8)	**5** (4.3)	**1** (0.9)	116
total		**5** (2.2)	**4** (1.7)	**211** (91.7)	**9** (3.9)	**1** (0.4)	230
/o/	gop	**0** (0.0)	**2** (1.8)	**13** (11.5)	**98** (86.7)	**0** (0.0)	113
	gob	**0** (0.0)	**4** (3.4)	**6** (5.2)	**104** (89.7)	**2** (1.7)	116
total		**0** (0.0)	**6** (2.6)	**19** (8.3)	**202** (88.2)	**2** (0.9)	229

Table 4.12 Categorization of perceived vowels for lax vowel tokens (bold letter = number of tokens, ( ) = percentage)

lax Vs	token	heard /i/	heard /e/	heard /u/	heard /o/	heard /a/[35]	total
/ɪ/	tɪp	**40** (39.6)	**58** (57.4)	**2** (2.0)	**1** (1.0)	**0** (0.0)	101
	tɪb	**77** (69.4)	**31** (27.9)	**3** (2.7)	**0** (0.0)	**0** (0.0)	111
total		**117** (55.2)	**89** (42.0)	**5** (2.4)	**1** (0.5)	**0** (0.0)	212
/ʊ/	dʊp	**0** (0.0)	**1** (0.9)	**47** (43.9)	**59** (55.1)	**0** (0.0)	107
	dʊb	**0** (0.0)	**3** (2.6)	**53** (46.1)	**59** (51.3)	**0** (0.0)	115
total		**0** (0.0)	**4** (1.8)	**100** (45.0)	**118** (53.2)	**0** (0.0)	222
/ɛ/	gɛp	**0** (0.0)	**71** (74.0)	**1** (1.0)	**0** (0.0)	**24** (25.0)	96
	gɛb	**0** (0.0)	**87** (82.9)	**1** (1.0)	**0** (0.0)	**17** (16.2)	105
total		**0** (0.0)	**158** (78.6)	**2** (1.0)	**0** (0.0)	**41** (20.4)	201

In Experiment J-E 1, /ɛ/ was mostly categorized as Japanese /e/ (158 out of 201). /ɪ/ tokens and /ʊ/ tokens showed some variations in categorization: /ɪ/ tokens were mostly perceived as Japanese /i/ and /e/, and /ʊ/ tokens are nearly equally categorized as Japanese /u/ and /o/. However, about 80% of /ɛ/ tokens were categorized as Japanese /e/. These results are consistent with the idea that English /ɪ/ has a quality somewhere between Japanese /i/ and /e/; similarly English /ʊ/ has a quality between Japanese /u/ and /o/.

[35] For /ɛ/ tokens, 'heard /a/' was mostly preceded by a glide as /ja/, e.g., /gɛp/→ [gjapu].

Like /ɛ/, each of the tense vowels was also clearly associated with one of the Japanese vowels in terms of vowel quality: English /i/ was mostly perceived as the equivalent of Japanese /i/, English /u/ as Japanese /u/, and /o/ as Japanese /o/. However, English tense vowels were actually perceived as long vowels /iː, uː, oː/, which are approximately two times longer than Japanese single vowels. This means that English tense vowels were perceived as equivalent to Japanese long vowels, which created a disfavored phonological condition for /Q/ perception.

/ɛ/ has the most similar characteristics to its Japanese equivalent, and it was perceived short. These characteristics of /ɛ/ might have created the most similar phonological environment for /Q/. English lax vowels other than /ɛ/may have distracted participants' attention due to the ambiguity of vowel quality. If participants had be engaged in determining the vowel, they might not have paid as much attention to the consonant.

4.2.4.7 The use of small vowels

An additional question arose in Experiment J-E 1: Is vowel length the only feature of English vowels which could be recognized by Japanese speakers? There was a phenomenon which may indicate that some Japanese speakers may hear the difference between tense and lax vowels in terms of vowel quality. In Experiment J-E 1, 15 participants out of 20 used an uncommon *kana* usage; the

use of small *kana* letters for vowels such as ゲ<u>ェ</u>プ /geepu/[36] for /gɛp/. There were 115 tokens which contain such small vowels in the collected data[37] (about 9% of the responses).

The usage of small *kana* for vowels is not a standard usage of the *kana* writing, but it is often used for transcribing certain loanwords. The small vowels are not identical to the preceding vowels, and they are used to maintain certain phonetic features of the preceding consonants. Small vowels are used to indicate vowel quality and are not counted as 1 mora. For example, the English word 'party' /parti/ is originally borrowed into Japanese as パーテー/pa:te:/, changing the English original final vowel /i/ to /e/ to maintain the preceding consonant /t/. This is because Japanese phonology lacks [ti], and /t/ followed by /i/ is changed into [tʃ]. If the original final vowel /i/ is maintained, 'party' will be realized as [pa:tʃi:]. Later loanword phonology has adopted [ti] into Japanese, but there was no standard *kana* writing to indicate this syllable. Therefore a vowel in the small *kana* テ<u>ィ</u> was newly invented for /ti/ on the pattern of *kana* チ<u>ャ</u> [tʃa], in order to maintain the quality of both /t/ and the following vowel /i/. Thus パーテー /pa:te:/ became パーティー /pa:ti:/. Thus ティ /ti/ is different from テイ /tei/, which has two full vowels. The small vowel in ティ /ti/ is used to

[36] A small font for the second /e/ is used here; however, Roma-ji writing (alphabetical transcription of Japanese) does not have such an invention.
[37] Some tokens which were excluded for /Q/ perception analysis were added here to observe more detailed patterns of small vowel occurrence.

maintain the consonant quality of /t/ and the vowel /i/, so it is not counted as a mora. On the other hand, regular sized *kana* テイ /tei/ contains two full vowels, which means two moras.

In Experiment J-E 1, small vowels which are identical to the preceding vowels are observed, e.g., テェプ /teepu/. This use of a small vowel is not observed in loanword phonology: Small vowels must not be identical to the preceding vowel, because they are to indicate vowel quality without affecting consonant quality. Table 4.13 shows three types of such small vowels which were found in the data. These three types represent all instances of such small vowels that occurred in Experiment J-E 1. As seen in Table 4.13 below, small vowels can be lengthened or followed by a /Q/. However, there are no instances which has both vowel lengthening and following /Q/, such as *テェーップ /tee:Qpu/.

Table 4.13 The examples of small vowel in *kana* writing for monosyllabic tokens (e.g. /tɛp/) and the number and percentage of each type (total 115 tokens with small vowel transcription)

type of the usage of small vowels	*kana* writing examples	pronunciation represented	number/ percentage
small vowel	テェプ	[teepu]	33 (28.7%)
lengthened small vowel	テェープ	[tee:pu]	52 (45.2%)
small vowel + /Q/	テェップ	[teeQpu]	30 (26.1%)
total			115 (100%)

Most of the small vowels (88.7%) were used for lax vowels, as shown in Table 4.14 and Figure 4.5:

Table 4.14 Number and percentage of small vowels for tense/lax vowels occurrence in different coda environment

	voiceless stop	voiced stop	total number/ percentage
tense vowel	8 (7.0%)	5 (4.3%)	13 (11.3%)
lax vowel	58 (50.4%)	44 (38.3%)	102 (88.7%)
total	66 (57.4%)	49 (42.6%)	115 (100%)

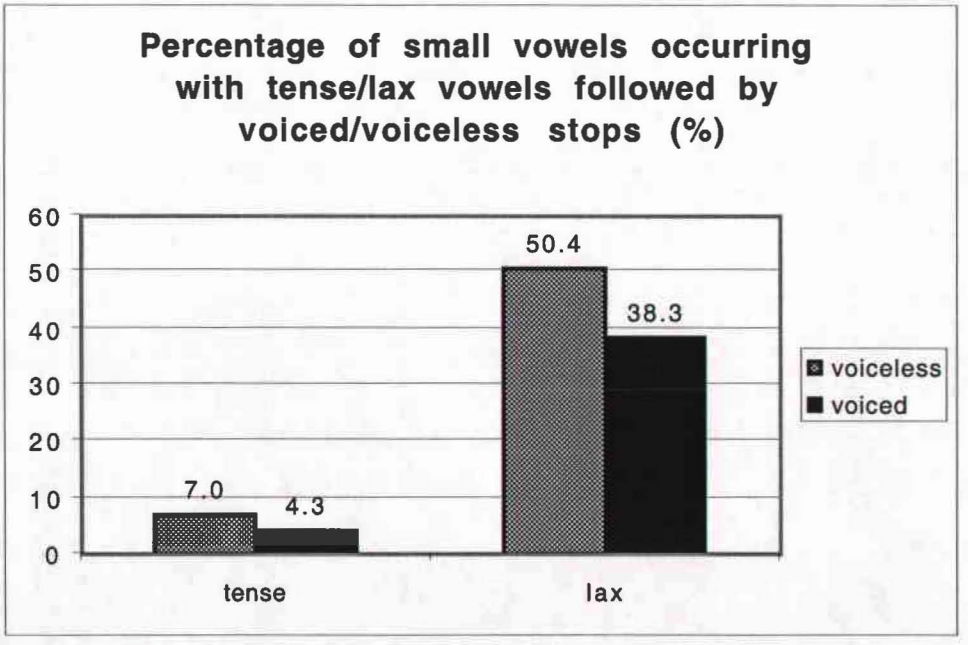


Figure 4.5 The percentage of small vowels' occurrence for tense vowels followed by voiceless/voiced stops and lax vowels followed by voiceless/voiced stops

What is the use of small vowels which are identical to the preceding vowels? Are they used for indicating qualitative or quantitative features? One of the

assumptions is that participants perceived the difference between tense and lax vowels in terms of vowel quality. Table 4.14 shows that 88.7% of small vowels occurred with lax vowel tokens. There is no way to write the English tense/ lax distinction using Japanese *kana* writing system. Thus, if the participants in J-E 1 perceived the differences in English vowel tenseness in terms of quality, they need to invent a new way to express a tenseness distinction. Small vowels may be an attempt to express a difference in vowel quality using Japanese *kana* writing.

One might suppose that a vowel followed by an identical small vowel might be associated with a vowel length which may be a little longer than a full vowel (i.e., one mora) but shorter than two moras. However, this is probably not the case here. The first reason is that half a mora is not a permissible mora count. It is unlikely that participants were sensitive to such small vowel length, and used small vowels to indicate half a mora. Additionally, the second example in Table 4.13 テェープ /teeːpu/ indicates that small vowels can be lengthened. If small vowels were associated with length, they could not be further lengthened, since Japanese has only 2 vowel lengths. Additionally Table 4.14 and Figure 4.5 indicate that lax vowels before both voiceless and voiced stops are often perceived with small vowel. If a small vowel indicated extra length, it should be observed more often with tense vowels or with lax vowels before voiced stops, which were usually perceived as long vowels. Accordingly, lax vowels before voiceless stops would not be associated with small vowels. Another piece of evidence which disassociates small vowels with quantitative feature is the fact

that small vowels can be followed by /Q/ (26.1% of small vowels have a following /Q/). If small vowels are associated with longer duration, /Q/ would not follow these vowels, as /Q/ is generally disfavored in long vowel contexts in Japanese.

This evidence suggests that small vowels are associated with lax vowel quality, and that some Japanese speakers notice the tenseness distinction in English vowels in terms of a qualitative feature.

4.2.5 Summary

Experiment J-E 1 investigated the relationship between /Q/ perception, vowel length and the voicing of the coda stops. The results showed that /Q/ perception in monosyllabic words was much lower than expected based on loanword phonology, which strongly favors /Q/ in monosyllabic words with lax vowels. It was found that /Q/ perception is strongly influenced by perceived vowel length. /Q/ was not perceived when the vowels were perceived long or when the coda stop was perceived voiced. This is largely because the vowels were lengthened and were perceived long in this phonological environment.

Some voiced coda stop tokens, especially lax tokens, were perceived with a short vowel and /Q/. This indicate that voiced coda consonants do not disfavor /Q/ perception as strongly as a long vowel does. These results accord with loanword phonology, which never allows a long vowel plus /Q/, but does show some voiced geminate stop clusters. However, both long vowels and voiced stops strongly disfavor /Q/ perception, and the most favored condition for the perception of /Q/ was found to be a short nucleus plus a voiceless coda.

This suggests that loanword phonology, which allows voiced geminates to represent English voiced codas, is based more on English spelling or written representation.

The results showed that tenseness is also an important factor for /Q/ perception in J-E 1. This is because tenseness may influence vowel length. In J-E 1, tense vowels were mostly perceived long regardless of the voicing of the coda consonant. Lax vowel + voiced stop tokens were also usually heard with long vowels. Yasuta 2001 showed different results: Vowels before voiced coda stops were perceived as long regardless of their tenseness, but tense vowels before voiceless stops were more frequently perceived as short (19.8% in J-E 1 vs. 75.5% in Yasuta 2001). The difference between the two studies may indicate that the association between vowel tenseness and length (i.e., tense = long, lax = short), which is strongly held in loanword phonology, is not relevant in L2 phonology. Native speakers of English may produce vowels with different lengths, depending on speech style and individual, because vowel length is not the most crucial factor of the tenseness distinction. From the two studies, it may be safe to say that vowels are perceived long before voiced coda stops regardless of the tenseness of the vowel, but with voiceless stops, tense vowels may be heard long or short depending on the speech style and the individual differences of native speakers who read the test words.

J-E 1 and Yasuta 2001 showed a big difference in /Q/ perception. This is probably because the stimulus C/V Ratios (stop closure divided by the vowel length) in J-E 1 were much smaller than in Yasuta 2001. However, Yasuta 2001

has a percentage of perceived /Q/ far lower than Arai and Kawagoe (1996). From the results of these studies, it can be said that C/V Ratio cannot always predict the degree of /Q/ perception. The fact may be that C/V Ratio cannot be too small (i.e., small as that of singleton stop) if /Q/ is to be perceived, but a larger C/V Ratio does not guarantee a higher degree of /Q / perception.

4.3 Experiment J-E 2: Consonant cluster perception

This experiment examines questions 4.4.1-4.4.3 in section 4.1. Three questions are asked to answer how Japanese speakers perceive English consonant clusters: Question 4.4.1: Do Japanese speakers hear English heterorganic stop clusters as geminates? Or do they hear these clusters with vowel insertion, or both?; Question 4.4.2: Is the place of articulation of the first stop in consonant clusters perceived accurately?; Question 4.4.3: Does stress pattern influence the perception of the first stop (i.e. C_1) of consonant clusters? The hypotheses for these questions are as follows: *Hypothesis 4.4.1: English stop clusters will be perceived as geminate stop clusters by Japanese speakers; Hypothesis 4.4.2: Japanese speakers will not be able to identify the first stop in consonant clusters; Hypothesis 4.4.3: A two-stress pattern will increase the perception of* C_1 *in stop clusters.*

The basic methodology and the participants in J-E 2 were the same as Experiment J-E 1 described in 4.2.1 to 4.2.2. Six words which contain /pt/ clusters and 6 words which contain /pk/ clusters were used as test words. These test words were categorized into 2 types in terms of accent pattern and word structure. The first type consists of a single word which has a single accent and a

word-medial stop cluster, such as *optima*. The stress is on the first syllable, and there is no stop aspiration. The second type consists of two monosyllabic words which have 'compound' stress like English *cattail*. The primary accent is on the first syllable and the secondary stress on the second syllable. The coda consonant of the first syllable was not released, and the onset of the second syllable was aspirated. As it is difficult to find this type of compound, made-up words were created using actual English words, e.g., *zip tie, sap can*. All tokens were unfamiliar words for the test participants (junior high school level)[38]. Each test word was put in two word lists 3 times in a random order with 4 distracters (also 3 x each), creating two word lists of 48 words. The actual test word are in Appendix A.

These word lists were read by two native speakers of English who also read the word lists for Experiment J-E 1. A short warm-up session was given before the experiment. Each test word was presented after the serial number pronounced in Japanese, and repeated after a 0.75 second interval. The second reading was a copy of the first reading, so they were identical utterances. There was a 3 second pause after the second reading so that the participants could choose the answer from the given choices. The participants chose the best matching *kana* transcription among 4 choices, which had $C_0V\underline{C_1VC_2V}$, $C_0V\underline{C_2V}$, $C_0V\underline{QC_1VC_2V}$, and $C_0V\underline{QC_2}$ structures. These choices will tell us whether the

[38] Some of the words such as *can* and *ten* are learned at junior high school level. However, the created word 'sap can' and 'nap ten' are read as one word, and considered to be unfamiliar words.

participants perceived both members of the stop clusters and whether they perceived a /Q/. Table 4.15 shows an example of answer choices.

Table 4.15 An example (*chapter*) of answer choices for Experiment J-E 2

token	answer choices	example	*kana* writing	C_1	C_2	/Q/
chapter	$C_0VC_1VC_2V$	/tʃaputa:/	チャプター	√	√	
	C_0VC_2V	/tʃata:/	チャター		√	
	$C_0VQC_1VC_2V$	/tʃaQputa:/	チャップター	√	√	√
	C_0VQC_2	/tʃaQta:/	チャッター		√	√

The $C_0VC_1VC_2V$ type is the form such as チャプター /tʃaputa:/ which does not have a /Q/, but both stops (i.e. /p/ and /t/) are perceived. The C_0VC_2V type is the form such as チャター /tʃata:/ in which only the second stop (i.e. /t/) is perceived, without a /Q/. The $C_0VQC_1VC_2V$ form is such as チャップター /tʃaQputa:/ in which both stops (i.e. /p/ and /t/) are perceived and the first stop is perceived with a /Q/. The C_0VQC_2 is a form such as チャッター /tʃaQta:/ in which the second stop (i.e. /t/) is perceived with a /Q/. These 4 choices were arranged in a different order for each token. See Appendix B for the actual word lists used for Experiment J-E 2 (word lists differed only in their order).

4.3.1 Results

The findings of Experiment J-E 2 bear on the questions stated earlier: How do Japanese speakers perceive English consonant clusters? Do they hear these consonant clusters as geminates? Or do they hear these clusters with vowel insertion or both? Is place of articulation perceived accurately? Does stress influence the perception of syllable-final stops?

In this experiment, there were 720 one-accented tokens (360 for both /pt/ and /pk/ tokens) and 720 two-accented tokens (360 for both /pt/ and /pk/ tokens). Table 4.16 shows that the clusters were perceived as clusters, not as a single stop:

Table 4.16 Results of J-E 2. Chosen numbers and (%) for one-stressed and two-stressed tokens

	C_0V $\underline{QC_1VC_2V}$	$C_0V\underline{QC_2V}$	C_0V $\underline{C_1VC_2V}$	$C_0V\underline{C_2V}$	
example *chapter*	/tʃaQputa:/	/tʃaQta:/	/tʃaputa:/	/tʃata:/	total
one-stressed /pt/	110 (30.6)	107 (29.7)	137 (38.1)	6 (1.7)	360
one-stressed /pk/	132 (36.7)	134 (37.2)	92 (25.6)	2 (0.6)	360
subtotal	**242** (33.6)	**241** (33.5)	**229** (31.8)	**8** (1.1)	**720**
example *nap ten*	/naQputen/	/naQten/	/naputen/	/naten/	total
two-stressed /pt/	207 (57.5)	87 (24.2)	63 (17.5)	3 (0.8)	360
two-stressed /pk/	165 (45.8)	107 (29.7)	78 (21.7)	10 (2.8)	360
subtotal	**372** (51.7)	**194** (26.9)	**141** (19.6)	**13** (1.8)	**720**
total	**614** (42.6)	**435** (30.2)	**370** (25.7)	**21** (1.5)	**1440**

Figure 4.6 shows the results for one-stressed words. For one-stressed words, responses were divided fairly evenly among $C_0V\underline{C_1VC_2V}$, $C_0V\underline{QC_2V}$, and $C_0V\underline{QC_1VC_2V}$. There are almost no instance of $C_0V\underline{C_2V}$, which is a complete deletion of C_1:

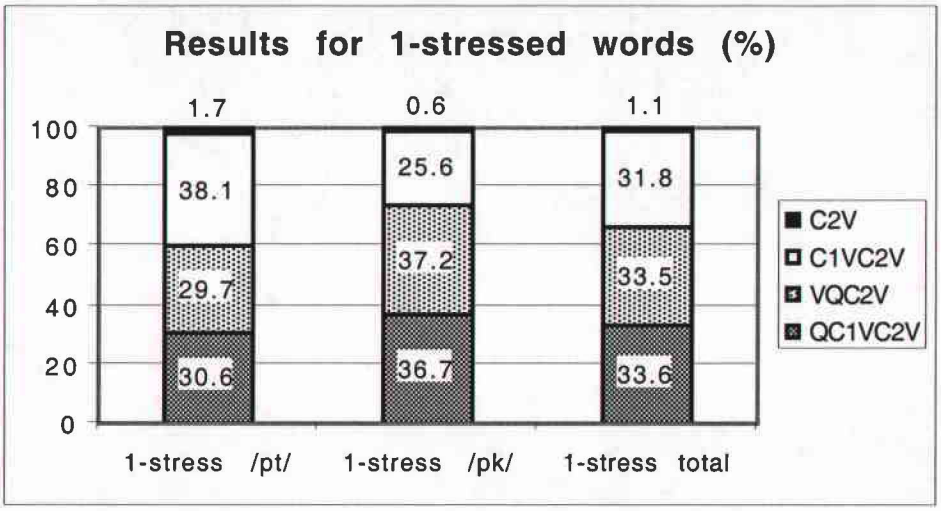


Figure 4.6 Results of 1-stressed words based on Table 4.16 (C_2V = $C_0V\underline{C_2V}$, C_1VC_2V = $C_0V\underline{C_1VC_2V}$, VQC_2V = $C_0V\underline{QC_2V}$, and QC_1VC_2V = $C_0V\underline{QC_1VC_2V}$)

Figure 4.7 shows the results for two-stressed words. Again, $C_0V\underline{C_2V}$ form was rarely observed; however, more $C_0V\underline{QC_1VC_2V}$ responses than Figure 4.6 were observed:

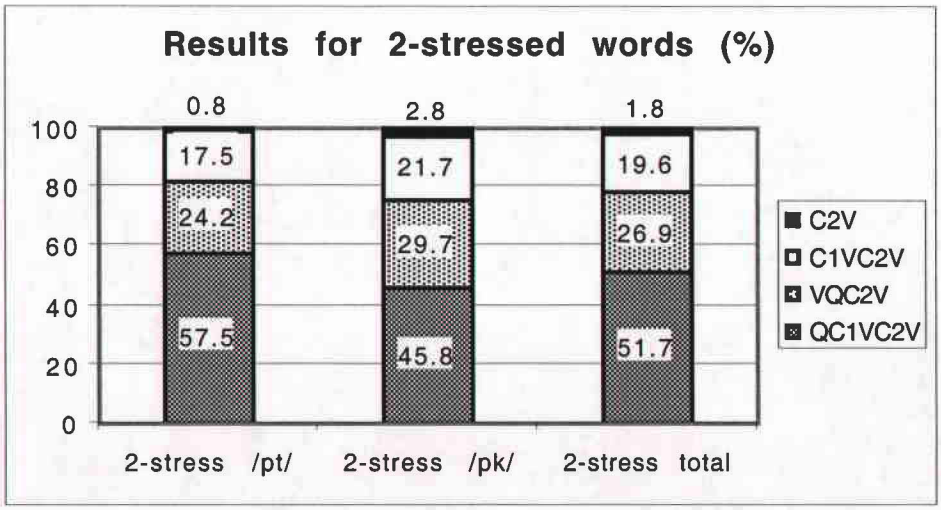


Figure 4.7 Results of 2-stressed words based on Table 4.16 (C_2V = $C_0V\underline{C_2V}$, C_1VC_2V = $C_0V\underline{C_1VC_2V}$, VQC_2V = $C_0V\underline{QC_2V}$, and QC_1VC_2V = $C_0V\underline{QC_1VC_2V}$)

Table 4.17 Tokens heard with and without /Q/

	/Q/ perceived	No /Q/ perceived	total
one-stressed /pt/	217	143	360
one-stressed /pk/	266	94	360
subtotal	483	237	720
two-stressed /pt/	294	66	360
two-stressed /pk/	272	88	360
subtotal	566	154	720
total	1049	391	1440

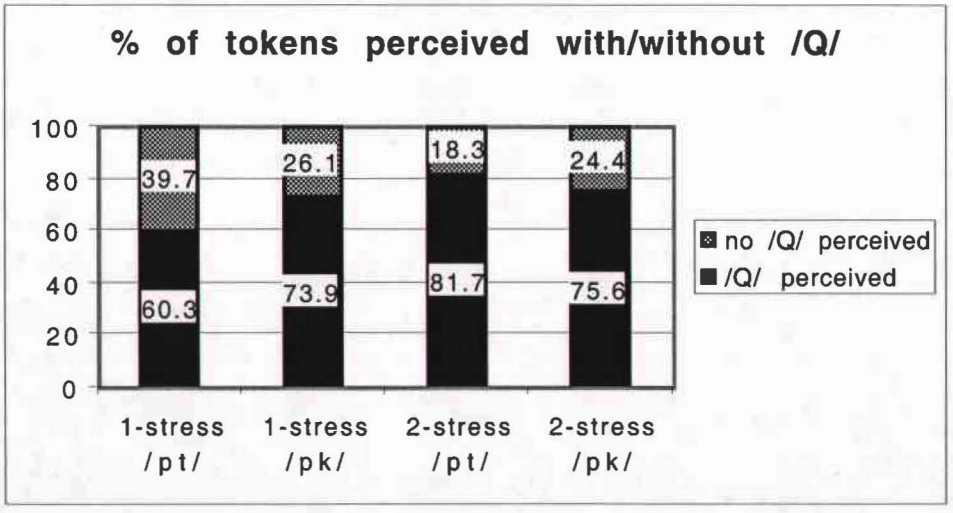


Figure 4.8 Percentage of tokens perceived with/without /Q/

4.3.2 /Q/ perception: Discussion

The results shown in Table 4.16, Figures 4.6 and 4.7 indicate that almost all tokens were perceived with two segments in the consonant clusters. Only

1.5% of the tokens were perceived as $C_0V\underline{C_2V}$, without any segment in the C_1 position, such as [tʃata:] for *chapter*. The results show that 68.3% of tokens were heard with both identified stops in consonant clusters, either as [tʃaQ**p**uta:] or [tʃa**p**uta:]. Additionally, 30.2% of the tokens were heard with /Q/ but without C_1, such as [tʃaQta:]. Thus the participants almost always perceived two stops, either as QC_2 or C_1C_2, at word-medial position.

/Q/ was perceived significantly more than in Experiment J-E 1, in which /Q/ was perceived only 15.7% of all tokens. In Experiment J-E 2, 72.8% of all tokens were perceived with /Q/. This result is noteworthy, because monosyllabic words ending with stops are more likely to occur with /Q/ in loanword phonology, e.g., /pɪg/ → /piQgu/. Especially, a lax vowel plus voiceless stop coda is the most favored condition for /Q/ insertion (Sunaoshi, 1995). Arai and Kawagoe (1996) report that the CVC type tokens were 90% perceived with /Q/. On the other hand, Kawagoe (1995) reported that word-medial stop clusters are borrowed as $C_0V\underline{C_1VC_2V}$ form, without /Q/, such as /tʃaputa:/ for *chapter* not as /tʃaQputa:/. According to these studies, we would expect that Experiment J-E 1 would show a far higher rate of /Q/ perception than in J-E 2. However, the results of J-E 1 and 2 did not support this expectation.

Kawagoe (1995) claimed that /Q/ occurs in loanwords when there is a rhythmic clash between strong moras word-medially. In her study, the strength

of moras in words such as *chapter* is SWSW, assuming that word-medial coda consonant /p/ and the second segment of the final vowel[39] are weak moras.

tʃa	pu	ta	:
S	W	S	W

Chapter does not undergo /Q/ insertion because the moraic rhythm does not have any clash. /Q/ is inserted in a word such as *hitter* because it has a SSW moraic rhythm[40].

hi	ta	:		hi	Q	ta	:
S	S	W	→	S	W	S	W

In Experiment J-E 2, all tokens except *optima* exhibit an underlying SWS(W) pattern[41]:

e.g.,

one-stressed word: *septum*

sɛ	p	tə	m
S	W	S	W

two-stressed word: *dip key*

dɪ	p	ki	:
S	W	S	W

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[39] Kawagoe treats /-ər / of *chapter* as long a vowel, [aː]. The same treatment applies for *hitter*. Some other examples are *butter, pitcher, computer*, etc.

[40] Kawagoe treats the second segment of long vowel [ː] and coda consonant in the word-medial position of the original English word as weak mora. Strong moras are accented mora and syllabic mora.

[41] In my experiment, 2-stressed words are combination of two words but I treated them as single compound words with two accents. The final stop of the first word is not released. However, it is probably the fact that these two words are analyzed separately in loanword phonology.

As there is no SS clash in these words, Kawagoe's idea predicts that these test words will not undergo /Q/ insertion in loanword phonology. For *optima*, the rhythm is;

ɑ	p	tɪ	ma
S	W	S	S

/t/ in the third mora will not be geminated because the preceding /p/ has a weak rhythm. The fourth mora /ma/ also does not undergo /Q/ insertion because nasal sounds do not occur with /Q/ in Japanese. Thus the rhythm clash here does not trigger /Q/ insertion.

The results of Experiment J-E 2 show that L2 phonology does not coincide with the loanword phonology described by Kawagoe. This is probably because Kawagoe's loanword analysis was based on the English pronunciation as transcribed, but not the actual perception of the English words. Perhaps L2 learners at the early stage of acquisition do not apply the systematic rhythm structure which is observed in loanword phonology.

A second possible reason for the big difference in /Q/ perception in Experiment J-E 1 and 2 is the task style. Arai and Kawagoe (1996, 1998) used *kana* transcription and multiple choice for their studies and found that *kana* transcription showed a far lower rate of /Q/ perception. Arai and Kawagoe investigated how nonsense English words such as *keptin* are perceived. In their 1996 study, their participants used *kana* transcription to answer how they heard the test words. The stop cluster in *keptin* (/p/ followed by a stop and a vowel)

was perceived with /Q/ only 3% of the time in the *kana* transcription task. On the other hand, the 1998 study showed much higher frequency of /Q/ perception. In this study, they used multiple choice between only two types of *kana* transcription, such as ケプン /kepun/ vs. ケップン /keQpun/. /Q/ perception increased to 55% in this study. Kawagoe and Arai (1998) explained that the great difference between these two studies was due to a phonological restriction in loanword phonology which was described by Sakai (1994). Sakai claimed that word-medial double epenthesis is disfavored in loanword phonology. Double epenthesis means inserting two segments in sequence, and it is allowed word-finally but not medially, according to Sakai:

e.g.,

	English	borrowed form	wrong form
Word-finally:	*basket*	ba.su.ket.**TO**	*basuket**O**
Word-medially:	*napkin*	nap.**U**.kin	*nap**PU**kin

Thus, words like /kɛptɪn/ usually do not have /Q/ insertion, because of the restriction on word-medial double epenthesis. To make /kɛptɪn/-type words acceptable in Japanese syllable structure, a vowel insertion between /p/ and /t/ is necessary; /kɛp**u**tɪn/. The restriction on word-medial double epenthesis prevents the form */kep**pu**tin/. However, there are some questions about this approach. This rule seems not to be applied to words of the type /keplin/, which have stop plus sonorant consonant clusters (Arai and Kawagoe, 1998). Such

words would be borrowed as /keQpurin/ in loanword phonology, e.g., [tʃæplɪn] '(Charlie) Chaplin' is borrowed as /tʃaQpurin/. Additionally, what Sakai calls 'double epenthesis' may not be double epenthesis at all. In the above example *basket*, it is claimed that final **TO** is inserted (two segments together) as in [basuket**TO**]. However, the underlying form of loanword /basuke**Q**t**O**/ (not */basuket**QO**/) shows that the inserted segments are not in sequence, but one /Q/ and a final vowel to make an open syllable. Thus, the prohibition of double epenthesis as an explanation is questionable.

The most plausible explanation is that word-medial consonant clusters were perceived with /Q/ because the participants perceived English consonant clusters as equivalent to a Japanese /Q/ cluster, which is the only underlying consonant cluster in Japanese. The participants who chose the answers with $C_0V\underline{QC_2}$ form, e.g. /oQtima/, were influenced by the L1 syllable structure, which allows only a geminate as a consonant cluster, and thus failed to perceive the place cues of the /p/ in /pt/ and /pk/ clusters.

There were participants who might have perceived two stops, and chose an open syllable as the underlying form. More than 25% of the tokens were perceived as $C_0V\underline{C_1VC_2V}$, e.g., /tʃaputa:/, without /Q/ but with both stops identified. In Japanese, high vowels may be devoiced and deleted between voiceless consonants. The participants who perceived the word this way probably assumed vowel devoicing and deletion had applied, and they restored the vowel at the perception level. As the participants could perceive both stops,

they did not perceive the heterogeneous consonant clusters as geminate clusters. Instead, the participants appear to have perceived the English tokens as they are, but recognized such forms as results of vowel deletion between two voiceless stops. For example, the test word *chapter* might have undergone the following rules:

English input: /tʃæptər/	*Japanese UR*:	/tʃaputaː/
	Vowel devoicing:	[tʃapu̥taː]
	Vowel deletion:	[tʃaptaː]
	Japanese phonetic form:	[tʃaptaː]

Thus, the participants who chose $C_0V\underline{C_1VC_2V}$ recognized the original English consonant clusters as heterogeneous consonant clusters, not as geminates. There are no underlying heterogeneous consonant clusters in Japanese, but they exist after applying the vowel insertion and deletion rules.

The participants who chose $C_0V\underline{QC_1VC_2V}$, e.g., /tʃaQputaː/, perceived both stop articulations in the consonant cluster, and the closed initial syllable. Thus, they inserted a /Q/, which represents the closed initial syllable of the original English word. Insertion of both /Q/and a vowel is the only way to show the place of articulation of both stops and the closed syllable, using the Japanese writing system. Thus, this form maintains both the first stop's quality and the closed syllable.

Table 4.16 shows the overall results and indicates that almost 100% of tokens were perceived containing consonant clusters, either as geminates or heterogeneous clusters. Ohso (1973) claimed that if unreleased forms of English words are borrowed, the final consonants might not be perceived and might be deleted. Some examples are 'white shirt' as *wai shatsu* (deletion of /t/ in *white*) and 'auto bike' as *ooto bai* (deletion of /k/ in *bike*). However, this claim is not supported by Experiment J-E 2, because a very high percentage of tokens were perceived with coda consonants even though the coda consonants were unreleased. Additionally, codas in Experiment J-E 2 were not released, but they were more frequently perceived with /Q/than the released coda stops in Experiment J-E 1. The results of J-E 1 do not support Ohso's claim because word-medial unreleased clusters are quite often perceived with /Q/, and perhaps surprisingly, the place of articulation of the first consonant was frequently identified as well. Thus, it may be that the release of a coda consonant is not the most important factor in /Q/ perception.

4.3.3 Stress pattern and /Q/ perception

It seems that the stress pattern has some influence on the perception of /Q/. Ohso (1973) associated the perception of /Q/ with stress. She claimed that an English short vowel and the following consonant in a stressed syllable are considerably lengthened and this lengthening of the consonant might cause /Q/ perception in word-final position. She further claimed that the lengthening of the coda consonant is more prominent when the coda consonant is released.

Thus the word *tip* becomes [tɪpː]. As Japanese /Q/ is often treated as a long consonant, borrowing [tɪpː] as /tiQpu/ results in a production very much like the original English word after applying devoicing and deletion of the epenthesized final /u/, [tippu̥]~[tipː]. However, Ohso claimed that this rule is only applicable in word-final position, and the tokens in Experiment J-E 2 contain word-medial consonant clusters, where there was no coda release. The results showed that 67.1% of one-accented words and 78.6% of two-accented words were heard with /Q/. A Chi-square test tells that P-value is <.0001, which is significant. Thus, there was significant difference in /Q/ perception based on the number of stresses. When the word has two stresses, /Q/ is more likely to be heard.

4.3.4 Stop place identification

Now the question of whether both stops in consonant clusters were perceived or not will be examined. The results are shown in Table 4.18 and Figure 4.9.

The results show that both one-stressed and two-stressed stop clusters were often perceived with 2 identified stops. As seen in Table 4.18, 471 tokens (65.4%) of one-stressed tokens and 513 tokens (71.3%) of two-stressed tokens were perceived with correctly identified C_1 and C_2. The Chi-square shows a significant (P-value = 0.0173); however, the percentage does not show a big difference between one-stressed words and two-stressed words. The percentage of C_1 identification (i.e. two stops identified) range between 62.2-75.0%. Thus,

Experiment J-E 2 tells us that Japanese speakers can often identify both stops in English stop clusters regardless the number of stresses.

Table 4.18 Place identification pattern (with/without C_1). 'Both Cs identified' means that C1 and C2 are correctly identified, and 'One C identified' means that only C2 is identified

	Both Cs identified	One C identified
one-stressed /pt/	247 (68.6)	113 (31.4)
one-stressed /pk/	224 (62.2)	136 (37.8)
subtotal	471 (65.4)	249 (34.6)
two-stressed /pt/	270 (75.0)	90 (25.0)
two-stressed /pk/	243 (67.5)	117 (32.5)
subtotal	513 (71.3)	207 (28.7)
total	984 (68.3)	456 (31.7)

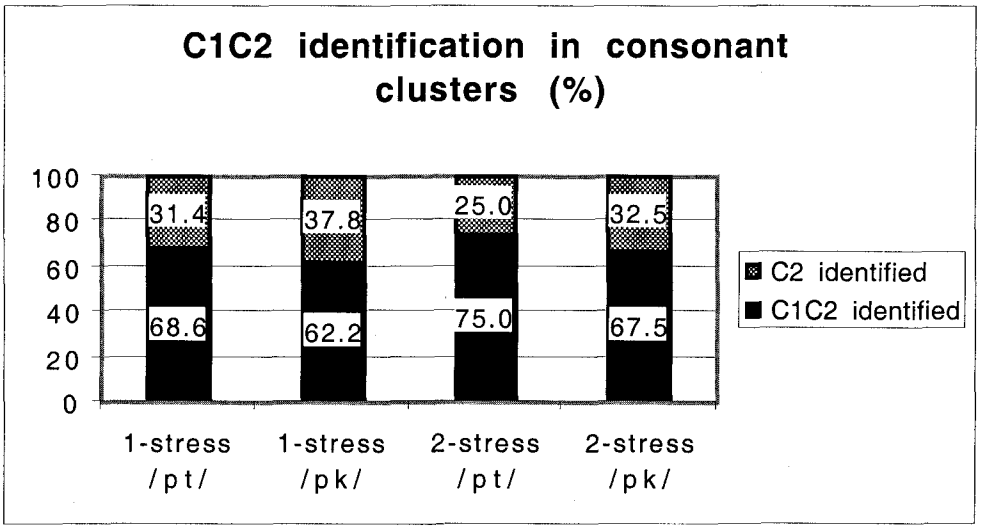

Figure 4.9 Percentage of tokens with/without C_1 identification

It was hypothesized that Japanese speakers may not be able to identify the first stop in consonant clusters, because Japanese phonology does not allow heterorganic stop clusters. Thus, whatever stop appears in the first stop position, a stop cluster may be heard as a geminate stop cluster. As Kawakami (1977) pointed out, Japanese speakers do not need to pay attention to the place of articulation of the first member of stop clusters. Thus it was expected that the C_1 identification rate in heterorganic stop cluster should be low.

Another question was whether C_2 influences the identification of the first stop in consonant clusters. A Chi-square test shows the P-value .1096 which is a non-significant level for /pt/ and /pk/. This means that /p/ was equally identified regardless of the place of articulation of the second stop.

Accent also influences the identification of stops in stop clusters. Table 4.18 and Figure 4.9 show that 65.4% of single-accented words and 71.3% of

compound-accented words were perceived with 2 stops identified. The Chi-square P-value is .0173, which is a significant value. Thus C_1 is more likely to be identified in medial consonant clusters of words where both of the adjacent syllables are accented.

4.3.5 Summary

J-E 2 investigated how English heterorganic stop clusters are perceived by Japanese speakers. It was surprising to find that Japanese speakers are quite successful at identifying the place of articulation of both stops in clusters. Although there is a limitation in the Japanese writing system to show how participants perceived English consonant clusters, it seems that almost 100% of tokens were perceived as containing a closed syllable. Some participants used /Q/ insertion to indicate a closed syllable, and some seemed to have open syllable as their underlying representation and to have applied a vowel deletion rule to account for the closed syllable they perceived. The high percentage of /Q/ perception was surprising, as loanwords which have word-medial clusters do not usually undergo /Q/ insertion. Thus, J-E 2 showed an opposite result from loanword phonology.

It was found that stress patterns significantly influence /Q/ perception. Two stress words were more often perceived with /Q/. The number of stops for which the place of articulation is identified is also influenced by the stress pattern, although this effect was not very strong.

The secondary accent has some effect on identifying the first stop of the cluster, but it has a more significant effect on /Q/ perception. The place of

articulation of the second stop did not influence the identification of the first stop in the cluster.

CHAPTER 5

EXPERIMENTS: JAPANESE PERCEPTION OF KOREAN STOPS

This chapter will investigate how Korean stops are perceived by Japanese speakers. Experiments J-K 1 and 2 will examine how Korean single stops in different word positions, and Korean consonant clusters are perceived by Japanese speakers. The focus will be especially on how or if /Q/ is perceived in different conditions.

5.1 Korean stop perception: Questions and Hypotheses

Experiment J-K 1 will be carried out to examine the following questions regarding perception of Korean stops. There are five main questions which will be addressed by experiment J-K 1 and 2:

Question 5.1: Does the type of stop influence the perception of /Q/?

The first question is how three types of Korean single stops (i.e., plain, aspirated, and tensed stops) are perceived in terms of frequencies of /Q/ perception. Perception of single stops will be tested in word-initial, medial, and final position[42]. Followings are hypotheses for the question 1:

Hypothesis 5.1.1: No stops will be perceived with /Q/ word-initially.

This assumption is based on *kana* transcription of Korean words in Korean textbooks published in Japan and loanwords found in Japanese. In these sources, no Korean stops are preceded by /Q/ word-initially, probably due to the

restriction of the distribution of /Q/ or ッ /tsu/ in Japanese. Plain stops are especially unlikely to be heard with /Q/, as Korean plain stops do not have the qualitative and quantitative features of /Q/.

Word-initial /Q/ does not occur in standard Japanese, but it is observed in emphasized speech or simplified speech, e.g., [ttaku] for /maQtaku/ 'indeed!' Korean textbooks in Japan often give instruction to pronounce Korean tensed stops as Japanese /QCV/; however, this combination in word-initial position might be difficult to perceive and pronounce. Word-initial /Q/ is observed far less commonly than word-final /Q/, in emphasized speech.

Hypothesis 5.1.2: /Q/ will mostly often be perceived word-medially with aspirated and tensed stops.

This assumption is based on Japanese phonology which allow /Q/ to appear only word-medially in the standard speech. Some exceptions exist, but /Q/ is mostly observed in word-medial position in Japanese. Thus, if /Q/ is perceived in Korean words, this position is the most plausible position. This hypothesis is also based on *kana* transcription of Korean words in Korean textbooks published in Japan and loanwords found in Japanese. In these sources, Korean aspirated and tensed stops may be written with /Q/ word-medially, but the writing of /Q/ for these stops is not entirely consistent. For example, the aspirated stop in Korean word [ju**k**^{h}we] 'raw meat' is borrowed with /Q/,

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[42] However, there will be no contrast among three types of Korean stops word-finally unless there is a following vowel. Stops are merged as unreleased plain stops, i.e., /p, p^{h}, p^{t}/→ [p], /t, t^{h}, t^{t}/→ [t], /k, k^{h}, k^{t}/→ [k]. See chapter 2 for details.

ユッケ [ju**kk**e], but [kalbi**t**^{h}aŋ] 'beef rib soup' is borrowed as カルビタン [karubi**t**an] without /Q/. For Korean tensed stops, word [ip'al] 'teeth' is written as イッパル [i**pp**aru] with /Q/, but [kimc^{h}i**c**'ige] 'kimchee soup' is written without /Q/, キムチチゲ [kimu**c**i**c**ige]. As /Q/perception is not consistent , it is not clear how Korean aspirated and tensed stops are actually perceived by Japanese speakers. It is also unknown which type of stop will be more frequently perceived with /Q/. Korean plain stops are never transcribed with /Q/ when it is preceded by an open syllable. Thus, the plain stop is unlikely to be heard with /Q/.

Question 5.2: How do Japanese speakers perceive the voicing of Korean stops in different positions?

The second question asks how Korean stops will be perceived in terms of voicing.

Hypothesis 5.2: Korean stops will be perceived voiceless, except for word-medial plain stops.

Korean stops are phonemically all voiceless. Word-initial plain stops are basically borrowed as voiceless stops[43] except some examples such as *bibinba* 'rice bowl with vegetable and meat topping'. Aspirated and tensed stops are borrowed as voiceless stops, and no exception is found in my references. Thus,

[43] The recent Romanization rule of Korean words by the Ministry of Culture & Tourism of Korea (since July 7th, 2000) requires the use of voiced stops to transcribe Korean plain stops. According to this new regulation, plain stops are voiced except in the coda position, e.g., Pusan (city name) → Busan, Kimpo (place name) → Gimpo. It is possible that plain stops will be introduced as voiced stops in *kana* transcription in the future, reflecting this romanization regulation.

Japanese speakers seem to perceive all Korean stops as voiceless word-initially. If any stops are ever heard as voiced, they must be plain stops.

Korean plain stops are phonetically voiced between vowels. Thus, it is expected that Japanese speakers will hear Korean word-medial plain stops as voiced stops. Aspirated stops and tensed stops are always voiceless in Korean, and will be heard as voiceless stops word-medially. Tensed stops may be heard as geminate consonants because of the tense feature, and such stops will be perceived as voiceless due to the disfavoring of voiced stop geminates in Japanese.

Question 5.3: Can Japanese speakers perceive Korean coda stops? If so, can they identify the point of articulation of a Korean final stop? Do they hear it as geminate or as single, or at all?

How Korean coda stops are perceived is not known, because the *kana* transcription of Korean words is not consistent. As Korean coda stops are unreleased, it may be difficult for Japanese speakers to identify their place of articulation. They may be completely deleted such as in /pipimpa**p**/ → ビビンバ [bibinba] 'rice bowl with vegetable and meat toppings', or may be perceived with the final stop preceded by /Q/ as in [bibinba**ppu**]. They are sometimes written with small 'tsu' ッ such as in /kuk/ → クッ[44] [kuʔ] 'soup'. Word-final /Q/ is not recognized as standard Japanese, but it is not unusual in emphasized speech.

[44] This orthography violates Japanese writing system and is not allowed for loanword transcription. However, such forms are sometimes found in Korean textbooks.

Vance (1987) gives some examples of utterance final /Q/, such as in [aʔ] 'oh!'. It is written as small 'tsu'(ッ) in comic books. Accordingly, perceiving /Q/ in word-final position in Korean should be possible for Japanese speakers.

Question 5.4: How do Japanese speakers perceive /Q/ in syllable boundary Korean stop clusters (e.g.,/ma**t-p**ogi/)?

This question will be examined by experiment J-K2.

Hypothesis 5.4: Korean consonant clusters will be perceived as geminate stop clusters by Japanese speakers due to the influence of Japanese phonology, which does not allow heterorganic stop clusters.

Korean does not have consonant clusters within the same syllable[45]; however, a coda consonant and the following onset may create a consonant cluster, e.g., /mi**p-t**a/ 'to be hateful'. As an influence of Japanese phonology, Japanese speakers may not be able to identify the place of articulation of /p/ in /mip-ta/, and may perceive it as/Q/, without specifying the place of articulation. Then the Korean word /mip-ta/will be perceived as /miQta/ [mit.ta].

Question 5.5: Does a combination of different consonants create the perception of Japanese /Q/? Or can Japanese speakers hear the differences between these clusters?

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[45] Some Korean words have two coda consonants at underlying level. However, one of them will be deleted if the following syllable does not start with a vowel. If a vowel follows the underlying

Hypothesis 5.5: Any combination of stops will be perceived as a geminate stop cluster regardless of the qualities of the stops.

This is because there is no need to perceive the place of articulation of the first segment of consonant clusters in Japanese. There is no factor in Japanese phonology to make certain stops more prominent than other stops, thus all stops will show a similar perception pattern.

Early Korean loanwords indicate that Japanese speakers could not identify the word-medial coda consonant in Korean, and just perceive /Q/. For example, /kuk pap/ 'rice soup' is borrowed as /kuQpa/, which is phonetically realized as [kuppa]. This indicates that the closure of the coda consonant /k/ was perceived without identifying the place of articulation. If this word had been borrowed into Japanese using the same /Q/ insertion pattern for English loanwords described by Kawagoe (1995), the word would have been borrowed without /Q/ but with a vowel insertion, probably as [kukupa]. Additionally, my experience in learning Korean suggests identifying Korean syllable final stops is difficult. Therefore words such as /ikta/ 'to be ripe' might be heard as /itta/ with underlying form /iQta/, rather than heard as /ikuta/. This might cause confusion distinguishing words such as [ikta] and [itta].

However, it is also possible that a universal place cue prominence (Jun, forthcoming) influences stop perception. According to Jun, there is a hierarchy

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consonant cluster, resyllabification occurs. The second member of cluster becomes the onset of the following syllable.

of place cues: /k/> /p/> /t/. Experiment J-K 2 will see whether the hierarchy influences Japanese perception.

5.2 Experiment J-K 1: Korean single stop perception

This experiment tests the perception of three types of single Korean stops (i.e., plain, tensed, and aspirated) by Japanese speakers. Test words contain plain, tensed, and aspirated stops, in word-initial, medial, and final positions[46]. The main questions will be whether Japanese speakers can perceive differences between the three types of stops and whether they perceive /Q/ for Korean singleton stops in different word positions. The hypotheses for experiment J-K 1 are repeated here: No stop will be perceived with /Q/word-initially, /Q/ will most often be perceived word-medially with aspirated and tensed stops, and Korean stops will be perceived voiceless, except for word-medial plain stops. How Korean coda stops are perceived is not known because Korean words' *kana* transcription is not consistent.

5.2.1 Participants

Participants were the same 14 male and 6 female Japanese junior high school students who also participated experiment J-E 1 and 2. According to a brief survey about background information, none of them had lived in Korea or had studied Korean. Personal talk with the participants revealed that they knew very few Korean loanwords.

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[46] Korean stops lose their laryngeal distinctions in coda position. All types of stop merge according to the place of articulation. Thus, only [p, t, k] are allowed in coda position.

5.2.2 Materials

Only bilabial stops were tested in this experiment. Fifteen test words containing bilabial stops were used. There were two test words for each type of Korean stop in word-initial and medial position, and 3 words for word-final position. None of the test words had long vowels, or vowels which were produced long enough to be perceived as long by Japanese speakers[47]. Two word lists, one of a female speaker's reading and the other of a male speaker's reading were prepared. Each test word was put in each list 3 times, and there were 5 distracters. This made two word lists of 50 words. These were put in random order. Word list J-K 1 male (see Appendix B) was read by a male native speaker of Korean, and Word list J-K 1 female (see Appendix B) by a female native speaker of Korean. Both were tape-recorded in a sound-attenuated recording studio. The recorded speech was edited using SoundEdit 16 version 2.0.1. After the recording session, each word was copied and pasted in twice, following the sequencing number read in Japanese. There is a 0.75 second pause between the first and second copy, and a 3 second pause was inserted after the second copy to give participants time for working on the task. Edited recordings were burnt on Memorex CD-R 650MB, as a CD player format.

The vowel length and stop closure length of all tokens were measured using PCquirer. Vowel length was measured from the point where formants started, and the ending point of the vowel is the point where the formants clearly

[47] Modern standard Korean does not have vowel length as a distinctive feature of vowels. However, some vowels are pronounced longer than other vowels and may be heard as 2 moras long by Japanese speakers.

faded in spectrogram. The wave form of each token was also used to determine more precise starting and ending point of vowels. Stop closure was measured from the ending of the preceding vowel to the point where the stop is released, in other words, the beginning of the spike in the spectrogram.

5.2.3 Procedures

The participants listened to the recorded stimuli in a computer laboratory at Fukushima 3rd Junior High School in Fukushima prefecture, Japan. The CD was played using a Macintosh iBook and Subwoofer speaker system (three speakers including two full range satellite speakers). Participants listened to the recorded tokens and chose the best matching *kana* writing from four choices. The choices differ in the voicing of stops and the occurrence of /Q/. For example, a word-medial aspirated stop token [ap^{h}ajo] '(I am) sick' has 4 choices; 1). アパヨ /a**pa**jo/, with voiceless stop, 2). アッパヨ /a**Qpa**jo/, with voiceless stop preceded by /Q/, 3). アバヨ /a**ba**jo/, with voiced stop, and 4). アッバヨ /a**Qba**jo/, with voiced stop preceded by /Q/. A short practice session was conducted before the real experiment. Any questions regarding the experiment were answered before the experiment, and no participant claimed any difficulties in task or tempo during the practice session.

5.2.4 Results and discussion

The results of Experiment J-K 1 will answer Questions 5.1 to 5.3 stated earlier: Question 5.1: Does the type of stop influence the perception of /Q/?; Question 5.2: How do Japanese speakers perceive voicing of Korean stops in different positions?; Question 5.3: Can Japanese speakers perceive Korean coda stops? If so, can they identify the point of articulation of a Korean final stop? Do they hear it as geminate or as single, or at all?

The following tables show the overall results of the Experiment J-K 1. In this experiment, there were 1799 answered tokens. These were 719 initial tokens, 720 word-medial tokens, and 360 word-final tokens. Table 5.1, 5.2, and 5.3 show overall results in J-K 1:

It was found that initial /p, p^h/ were mostly perceived as 'voiceless' (85.8% and 75.4%). /$p^{\prime}$/ was often perceived as 'voiced' (59.2%). Relatively few cases of /Q/ perception was observed: Word-initial 'Q voiceless' was chosen 12.1% for plain stops, 24.2% for aspirated stops, and 5.4% of tensed stops. 'Q voiced' was observed 0.4% for plain stops, 0% for aspirated stops, and 10.8% for tensed stops.

Table 5.1 Perception of Korean stops in word-initial position (number of tokens and (%))

word initial	token	voiceless	Q voiceless	voiced	Q voiced	total
plain	/**p**apo/	102 (85.0)	16 (13.3)	2 (1.7)	0 (0.0)	120 (100)
	/**p**atajo/	103 (86.6)	13 (10.9)	2 (1.7)	1 (0.8)	119 (100)
total		**205 (85.8)**	**29 (12.1)**	**4 (1.7)**	**1 (0.4)**	**239 (100)**
aspirated	/**p^h**anæjo/	93 (77.5)	26 (21.7)	1 (0.8)	0 (0.0)	120 (100)
	/**p^h**anmæ/	88 (73.3)	32 (26.7)	0 (0.0)	0 (0.0)	120 (100)
total		**181 (75.4)**	**58 (24.2)**	**1 (0.4)**	**0 (0.0)**	**240 (100)**
tensed	/**p'**acita/	34 (28.3)	6 (5.0)	67 (55.8)	13 (10.8)	120 (100)
	/**p'**arita/	25 (20.8)	7 (5.8)	75 (62.5)	13 (10.8)	120 (100)
total		**59 (24.6)**	**14 (5.4)**	**142 (59.2)**	**26 (10.8)**	**240 (100)**

Table 5.2 shows that the most frequently observed form for plain stops is 'voiced' for plain stops (87.9%), 'Q voiceless' for aspirated and tensed stops (76.2% and 72.5%).

Table 5.2 Perception of Korean stops in word-medial position (number of tokens and (%))

word medial	token	voiceless	Q voiceless	voiced	Q voiced	total
plain	/ipan/	1 (0.8)	1 (0.8)	116 (96.7)	2 (1.7)	120 (100)
	/supaki/	16 (13.3)	1 (0.8)	95 (79.2)	8 (6.7)	120 (100)
total		**17 (7.1)**	**2 (0.8)**	**211 (87.9)**	**10 (4.2)**	**240 (100)**
aspirated	/ap^{h}ajo/	32 (26.7)	86 (71.7)	0 (0.0)	2 (1.7)	120 (100)
	/op^{h}ani/	19 (15.8)	98 (81.7)	0 (0.0)	3 (2.5)	120 (100)
total		**51 (21.3)**	**184 (76.7)**	**0 (0.0)**	**5 (2.1)**	**240 (100)**
tensed	/ap'ajo/	23 (19.2)	85 (70.8)	1 (0.8)	11 (9.2)	120 (100)
	/op'ato/	18 (15.0)	89 (74.2)	1 (0.8)	12 (10.0)	120 (100)
total		**41 (17.1)**	**174 (72.5)**	**2 (0.8)**	**23 (9.6)**	**240 (100)**

For the word-final position, the most frequent respond was /Q/, which is a irregular usage of /Q/ in standard Japanese (45.8%).

Table 5.3 Perception of Korean stops in word-final position (number of tokens and (%))

word final	token	deleted	/p/V	Q/p/V	/Q/	total
plain	/cikap/	30 (25.0)	14 (11.7)	7 (5.8)	69 (57.5)	120 (100)
	/kihap/	32 (26.7)	12 (10.0)	33 (27.1)	43 (35.8)	120 (100)
	/sasip/	27 (22.5)	14 (11.7)	26 (21.7)	53 (44.2)	120 (100)
total		**89 (24.7)**	**40 (11.1)**	**66 (18.3)**	**165 (45.8)**	**360 (100)**

5.2.4.1 Voicing perception of Korean word-initial stops

First, how voicing of word-initial and medial stops is perceived will be examined. The following graph shows the results for word-initial stops.

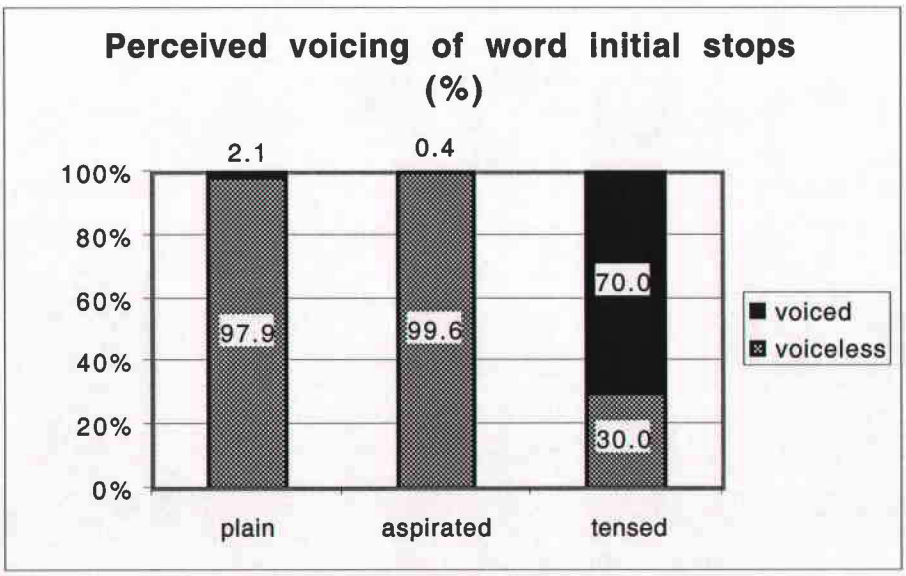

Figure 5.1 Perception of voicing of word-initial Korean stops (%)

The results in Table 5.1 and Figure 5.1 show that most Korean plain stops and aspirated stops at word-initial position were perceived as voiceless stops. On the other hand, only 30% of word-initial tensed stops were perceived as voiceless stops. These are interesting results because loanwords and Korean textbooks published in Japan never seem to treat Korean tensed stops as equivalent to Japanese voiced stops. Word-initial plain stops are the ones which are sometimes realized as voiced stops in loanwords. For example, Korean form /pipimpap/ 'rice bowl with vegetable and meat topping' is borrowed as [bibinba] with word-initial voiced stop. However, in loanwords, even plain stops are usually treated as voiceless word-initially (e.g. キムチ [**k**imuci] 'kimchee', プサン [**p**usan] 'Pusan'), and tensed stops are not realized as voiced stops. When tensed stops are transcribed in Japanese *kana*, they are always transcribed as voiceless stops. In his introductory Korean textbook, Kim (1987) mentioned that Korean stops do not become voiced word-initially, and Sohn (1999) stated that Korean tensed stops are not voiced and are constant in sound quality with a minimum of allophonic variation. However, tensed stops were frequently heard as voiced stops in J-K 1. It seems that Korean tense word-initial stops may be perceptually closer to Japanese voiced stops. This is an interesting result, as Korean speakers often treat word-initial plain stops as equivalent to English voiced stops. However, some English loanwords in Korean are pronounced with word-initial tensed stops by many speakers (e.g. /keim/→[kˈeim] 'game', /pəs/→ [pˈəs] 'bus').

What makes Japanese speakers perceive Korean tensed stops as voiced? One of the factors could be VOT value. The short VOT of Korean tensed stops might have triggered the perception of tensed stops as voiced. Korean tensed stops have the shortest VOT among the three kinds of Korean stops. The average VOT[48] of Korean /p'/ in Han and Weitzman (1967) was about 5 ms. The average of /t'/ is 8.4 ms and /k'/ is 20.9 ms in their study. Homma (1980) reported that Japanese voiced stops have minus value for VOT, although there was an exceptional speaker in her study. Japanese voiced stops may have minus or very short VOT, depending on the speaker. According to the VOT measurement in Homma (1981), the average VOT for 4 Japanese speakers' word-initial Japanese /p/ was 27 ms, and this value is similar to that of Korean plain /p/ reported by Han and Weitzman (1967), which is 21.1 ms. They measured three Korean speakers' VOT for these stops, and each of speaker's average fell between 16.8 to 27.0 ms for /p/. Korean tensed stops, which have much shorter VOT, were often perceived as closer to Japanese voiced stops.

5.2.4.2 Voicing perception of Korean word-medial stops

Now, perception of word-medial stops will be examined. The following graph shows the results.

[48] In their study, average is calculated for each participant but not for all participants.

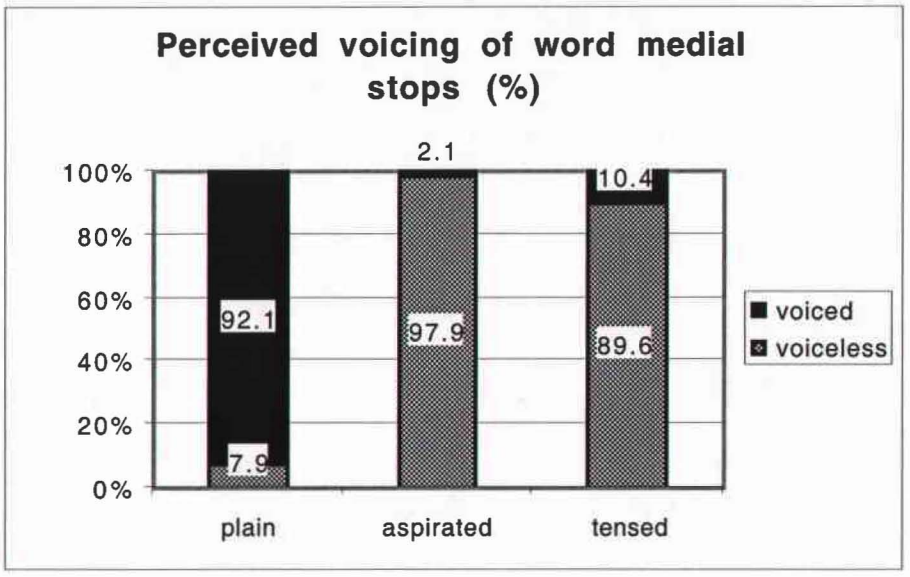

Figure 5.2 Perception of voicing of word-medial Korean stops (%)

As has been hypothesized, plain stops were mostly perceived as voiced stops in word-medial position. This is expected, as Korean plain stops in fact become voiced between vowels. The interesting fact here is that tensed stops, which were mostly recognized as voiced word-initially, were about 90% recognized as voiceless in word-medial position. Korean tensed stops are voiceless in any word position; however, they were often perceived as voiced word-initially, as stated earlier. It seems that the short VOT of tensed stops is ignored word-medially, and Japanese speakers perceived the actual voicing of stops. This is probably due to the long stop closure of word-medial tensed stops. A closure duration comparison in Oh (1998) indicates that closure duration of tensed stops in careful speech is about 3 times that of plain stops. In her study, there is no specific figure, but her graph shows tensed stop duration is about 250 ms while that of a plain stop is about 80 ms. Han (1996) reported a similar result: Closure

of intervocalic tensed stops was almost 3 times as long as that of plain stops (145 ms vs. 54 ms).

The longer closure of tensed stops may cause /Q/ perception word-medially. The results in Table 5.2 show that about 85% of word-medial tensed stops are perceived with /Q/. As /Q/ plus voiced stop is disfavored in Japanese phonology, the short VOT of tensed stops is ignored, and they are mostly perceived as voiceless word-medially. The fact that word-initial tensed stops were frequently perceived as voiced may indicate that the long closure of tensed stops is not crucial word-initially because closure duration is difficult to perceive in this position. Thus the duration of stop closure is ignored but VOT is crucial in word-initial position. On the other hand, VOT is ignored but the duration of stop closure is crucial in word-medial position.

The aspirated stop was almost 100% heard as a voiceless stop word-medially. This is also predicted, as Korean aspirated stops are never voiced in any positions (Sohn, 1999). Figure 5.2 shows that aspirated stops were perceived as voiceless stops significantly more than tensed stops (P-value .0002) and plain stops (P-value <.0001). Although the difference was significant, both aspirated and tensed stops were mostly perceived as voiceless stops. The plain stop, which is mostly heard as a voiced stop, is distinguished in word-medial position by voicing, but tensed stops and aspirated stops are difficult for Japanese speakers to distinguish word-medially.

5.2.4.3 /Q/ perception of word-initial stops

The Figure 5.3 shows that /Q/ was not perceived frequently in word-initial position. For plain and tensed stops, /Q/ is perceived less than 20% of the time. Compared to other types of Korean stops, aspirated stops were heard with /Q/ a little more frequently. Twenty four percent of the aspirated tokens were heard with word-initial /Q/. Chi-square tests showed that significance exists between aspirated and plain stops (P-value .001) and aspirated and tensed stops (P-value .0308), but significance was not found between plain and tensed stops (P-value .2492).

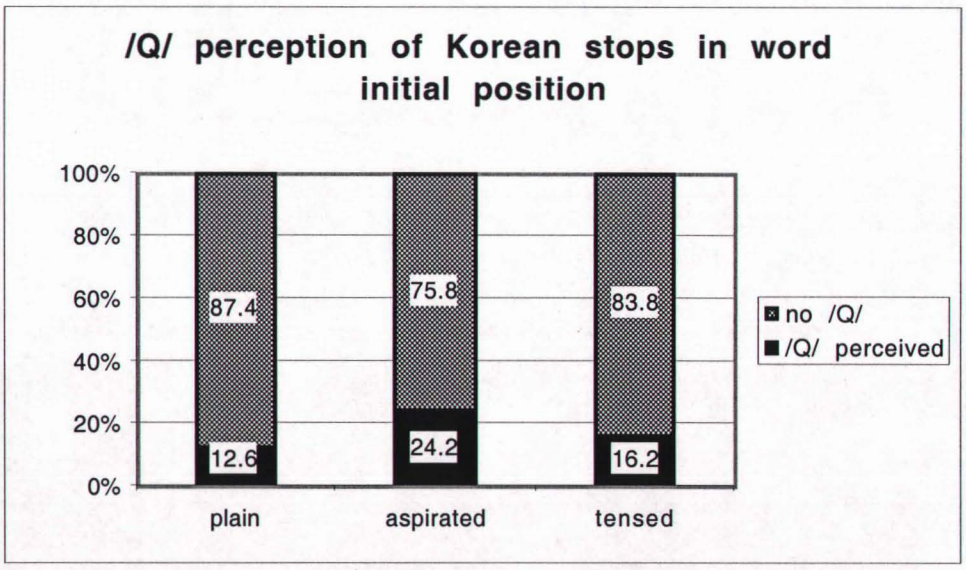

Figure 5.3 Percentage of perceived /Q/ in Korean singleton stops in word-initial position

From the results, it can be said that aspirated stops are more likely to be heard with /Q/ in word-initial position. As noted earlier, Japanese does not have word-initial /Q/ in normal speech and only rarely in emphatic speech.

However, 24.2% of the aspirated tokens were perceived with /Q/ and it could be due to the amount of aspiration. Korean aspirated stops are strongly aspirated compared to aspirated stops in other languages such as English and Japanese (see chapter 2). The strong aspiration might have been heard as /Q/, as pointed by Hirata (1989). Word-initial /Q/ is an irregular usage of /Q/, and it is observed only in emphasized speech. The /Q/ may have been an attempt to indicate the stronger aspiration which might accompany emphasis.

It is interesting that Korean tensed stops, which are phonetically similar (in closure duration and voicing) to Japanese geminate stops, are perceived with/Q/ less often than Korean aspirated stops are, word-initially. Korean tensed stops are in fact often introduced in textbooks as equivalent to Japanese /Q/. However, word-initial tensed stops were perceived as voiced stops, probably due to the short VOT, and that could be the reason why tensed stops were rarely perceived with /Q/ in word-initial position. Short VOT caused word-initial tensed stops to be perceived as voiced, and this condition prevented /Q/ perception.

For some participants, the use of /Q/ might have been helpful to distinguish three types of Korean stops word-initially. As mentioned above, short VOT caused tensed stops to be perceived as voiced. Plain and aspirated stops were perceived as voiceless, but the use of /Q/ can distinguish two types of stop. Aspiration and gemination (i.e. the use of /Q/) are both fortitive processes. As aspiration is not a distinctive feature and cannot be expressed by *kana* writing in Japanese, the use of /Q/could be an alternative device used to

show strong aspiration, a fortitive process. As a result, three stops could be categorized as follows: Most of the cases, plain and aspirated stops were perceived as voiceless single stops, and tensed stops as voiced single stops.

5.2.4.4 /Q/ perception of word-medial stops

Next, the results of word-medial /Q/ perception are shown in Table 5.2 (see earlier section) and the following Figure 5.4:

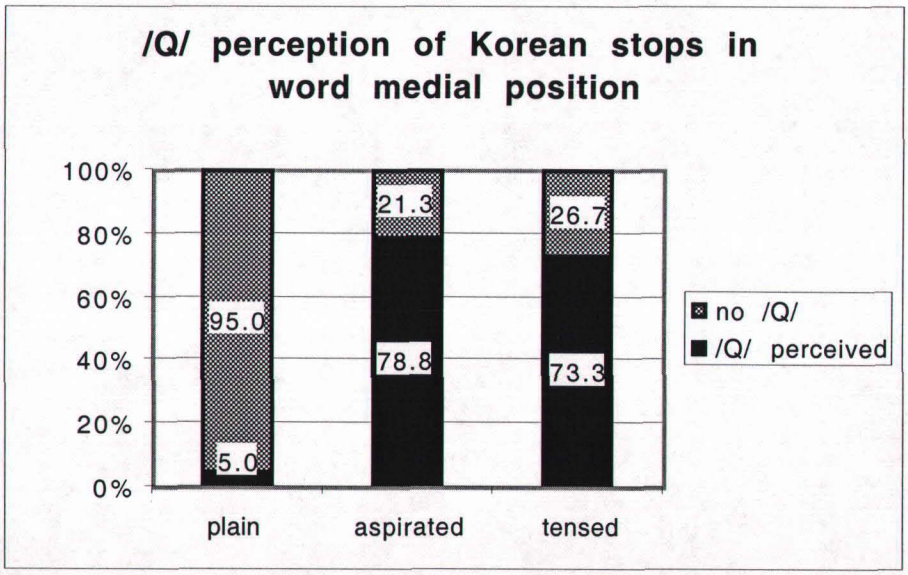

Figure 5.4 Percentage of perceived /Q/ in Korean singleton stops in word-medial position

Figure 5.4 shows that only 5% of plain stops were perceived with /Q/ in word-medial position. Korean plain stops are phonetically voiced in this position, and are equivalent to Japanese voiced singleton stops.

On the other hand, about 79% of aspirated stops and 73% of tensed stops were perceived with /Q/. The difference between these percentages is not

significant (P-value .3575), indicating that tense and aspirated stops behave the same word-medially in terms of /Q/ perception.

A high percentage of /Q/ perception had been expected as Korean tensed stops in word-medial position are generally treated as equivalent to Japanese geminate consonants. Hirata (1989) mentioned that Korean tensed stops are recognized as geminate stops because they are produced with closure of the glottis[49]. Korean tensed stops have longer duration than plain stops in word-medial position. Han (1992) and Oh (1998) reported that word-medial tensed stops are approximately 3 times as long as word-medial plain stops. This ratio is similar to that of Japanese single and geminate stops. Table 5.4 shows that the test words used in J-K 1 also have a similar ratio between word-medial plain stops and tensed stops. Thus, word-medial Korean tensed stops are both qualitatively and quantitatively equivalent to Japanese geminate stops in J-K 1: They are long enough to be perceived as /Q/, and also has glottal feature.

Unlike tensed stops, Korean aspirated stops are not treated as phonetically equivalent to Japanese geminate stops. Table 5.4 shows the average vowel length, stop closure duration, and C/V Ratio (i.e. closure duration divided by vowel duration) of Korean medial stop tokens:

[49] Korean tensed stops are generally transcribed with /Q/ using *kana* in Korean textbooks and travel guide books published in Japan, e.g., /opʰa/ 'big brother' is transcribed as オッパ [oppa].

Table 5.4 J-K 1 test words and their average vowel and closure duration (ms)

token types	test words	Average duration of vowel	Average duration of stop closure	C/V Ratio (C duration / V duration)
plain	iban	114	66	0.58
	subagi	49	61	1.30
Average		**82**	**64**	**0.94**
tensed	op'ado	68	163	2.51
	ap'ajo	59	163	2.85
Average		**64**	**163**	**2.68**
aspirated	op^{h}ani	90	123	1.45
	ap^{h}ajo	70	131	1.92
Average		**80**	**127**	**1.68**

Table 5.4 shows that word-medial aspirated stops have shorter closure than tensed stops, but have longer closure than plain stops. In the data of Table 5.4, the ratio between plain stop and aspirated stop is almost 1 : 2 while that of plain stops and tensed stops is about 1 : 2.5. Some studies (see Chapter 3, section 3.1.2.2) have reported various ratios of closure duration for single and geminate stops. Some studies reported less than 1 : 2, while some reported 1 : 3. The results here show that tense and aspirated stops are equally perceived with /Q/ regardless of the difference in stop closure duration. There are some plausible explanations for this. The ratio of the average duration of vowel length and aspirated stops is 1 : 2, and this ratio may be large enough for /Q/ perception. A longer duration than this does not influence the degree of /Q/ perception: When stop closure is more than 2 times longer than vowel duration, stops may be heard with /Q/.

A second possibility is that not only the duration of closure but the whole duration of voicelessness may cause /Q/perception. If Korean aspirated stops

have shorter closure duration but are equally perceived with /Q/ by Japanese speakers, they may be hearing the whole duration of voicelessness, not only the closure. This may indicate that C/V Ratio (stop closure/vowel length) cannot predict /Q/ perception in Korean.

It is also possible that strong aspiration caused /Q/ perception, because both gemination and aspiration are fortitive processes. The use of /Q/ might have been used to indicate the fortitive feature of aspirated stops in spite of a smaller closure ratio.

5.2.4.5 /Q/ perception of word-final stops

Finally, the results of word-final /Q/ perception are shown in Table 5.3 (see section 5.2.4) and the following Figure 5.5:

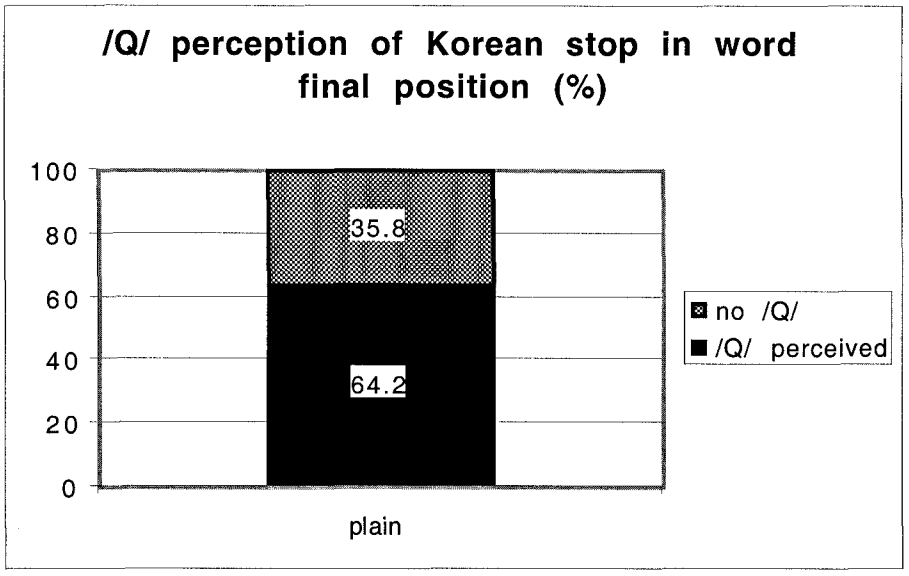

Figure 5.5 Percentage of perceived /Q/ in Korean stops in word-final position

In word-final position, Korean stops are all merged as plain stops, and they are unreleased in this position. Unreleased final stops in English loanwords are not always perceived by Japanese speakers, and are sometimes deleted in the borrowed forms, e.g., *auto bike* borrowed as [o:to bai] (Ohso, 1973). Some Korean loanwords show the same pattern with such English loanwords; /pipimpap/'rice with vegetable and meat topping' has been borrowed as [bibimba] (deletion of final /p/) in Japanese. One of the interesting findings in J-K 1 is that about 65% of word-final stops were perceived by Japanese speakers.

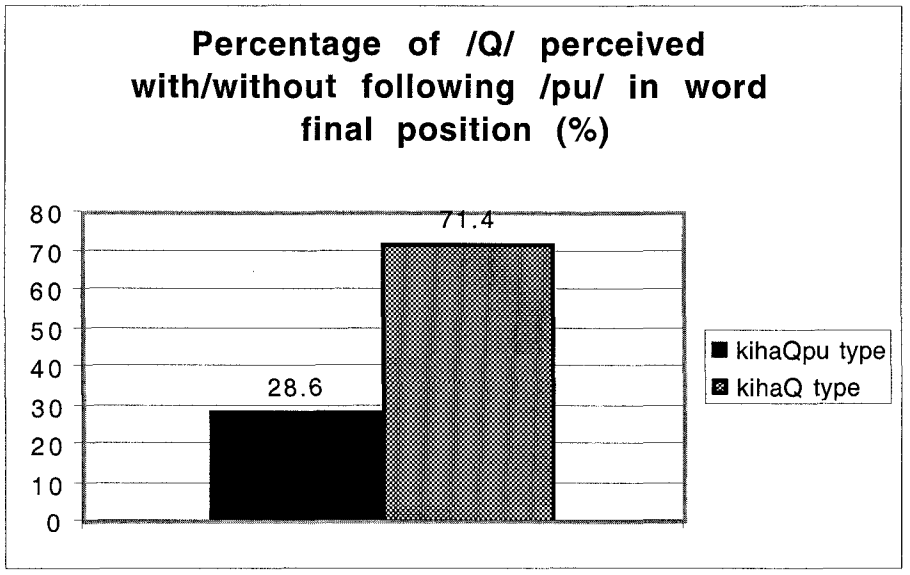

Figure 5.6 Percentage of perceived /Q/ in Korean words with and without following /pu/ in word-final position (total 231 tokens)

Two hundred thirty one words out of 360 were perceived with /Q/. Figure 5.6 shows that 28.6% (66 tokens) of them were perceived with a following /pu/,

such as [kihappu] for /kihap/ 'yelling', and 71.4% (165 tokens) are perceived without a following segment at all, such as /kihaQ/. This result is noteworthy because the use of word-final /Q/ is a nonstandard use of /Q/. It is mostly found in cartoon expressions and emphasized speech. It has been found that this type of response is the highest among the 4 possible responses, as shown in Figure 5.7.

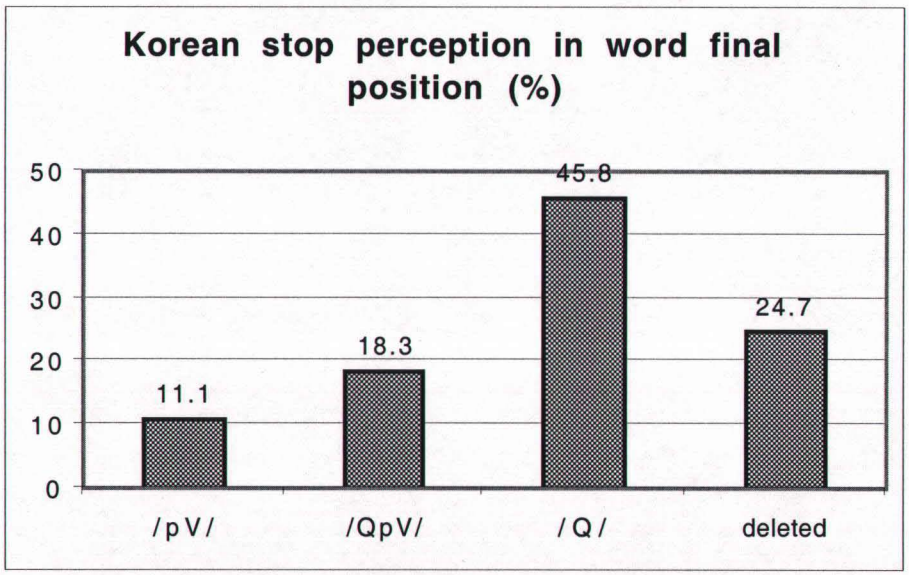

Figure 5.7 The results of perception of word-final Korean singleton stops (%)

The above figure shows that about 75% of Korean coda stops were perceived, either with or without identifying the place of articulation. For example, /kihap/ was perceived either as [kihapu] (/pV/), [kihappu] (/QpV/), or as [kiha?] (/Q/). About 30% of tokens are perceived with identified place of articulation of the coda, either as /pV/ or /QpV/. As mentioned earlier, well-established Korean loanwords ending with a coda consonant are generally borrowed without any

segment at all. In other words, coda consonants are completely deleted from the borrowed forms, e.g., /pipimpap/ → [bibimba] 'rice with vegetable and meat topping', /kukpap/ → [kuppa] 'rice soup'. However, such responses were found only 25% of the data in the experiment J-K 1.

Recently some Korean loanwords show variations in forms which preserve the coda consonants, e.g., /pipimpap/ → [bibimba]~ [bibimpapu]. From the results of J-K 1, it can be assumed that such recent loans are more spelling-based and that is why they preserve the coda without deletion. ビビンバ *bibimba* (phonemically /pipimpap/ in Korean) is often transcribed as ビビンパプ *bibimpapu* or ビビンパップ *bibimpappu* in recently published travel guide books and textbooks in Japan. The interesting fact in the experiment J-K 1 is that the highest response was not any of such loanword forms. These three forms found in loanwords (deletion, /pV/, and /QpV /) obey Japanese phonology. However, ッ /Q/in word-final position is not a standard usage of /Q/ in Japanese. It is interesting to find that such an irregular form was the highest in the experiment: Nearly 50% the responses were perceived as this nonstandard form. This shows a difference between perception and orthographic rules for loanwords.

When Korean coda consonants are not perceived at all, the words are borrowed without coda consonants, such as ビビンバ *bibimba* (Korean

underlying form /pipimpap/) or クッパ *kuppa* (Korean underlying form /kukpap/). Recently developed variations such as ビビンパプ *bibimpapu* and ビビンパップ *bibimpappu* are probably more spelling based so that the coda consonants are preserved. The second instance ビビンパップ *bibimpappu* preserves both the closed syllable and the place of articulation of the coda consonant by the use of geminate /pp/. Furthermore, this form is perfectly acceptable in Japanese phonology and orthography. On the other hand, the form ending with ッ /Q/ such as *ビビンパッ **bibimpaQ* is not found in loanwords. I found one instance of such transcription トッ *toQ*, (Korean underlying form /tʰək/) 'rice cake' in Jun (1984), but this form violates Japanese standard phonology and orthography, and it is not an established loanword. Therefore, even if Japanese speakers actually hear /Q/ word-finally, such forms may not be introduced in loanwords. In the experiment, Korean coda stops might be perceived as a glottal stop word-finally by Japanese speakers. The phoneme /Q/ is realized as [ʔ] in emphasized speech, e.g., あ /a/ 'oh!' as あっ[aʔ] and ね /ne/ 'right?' as ねっ [neʔ]. In these examples, there is no following consonant to which /Q/ can assimilate; therefore it is produced as a glottal stop. As there is no need in Japanese to identify a place of articulation of /Q/, the Korean coda consonants could simply be categorized as /Q/, without identified place of articulation. That Japanese speakers chose the answers ending with /Q/ may

suggest that /Q/ is in fact a phoneme in Japanese. As noted in Chapter 3, scholars have different views toward Japanese geminate consonants (i.e. moraic obstruent), and it has been controversial to treat /Q/ as a separate phoneme in Japanese. However, /Q/ might be obtaining status as a phoneme and a new phonological environment (i.e., word-final, sometimes word-initial position) among the young generation.

There is also the possibility that the participants perceived the coda /p/ without a following vowel (i.e., /kihap/ as it is). It is possible that participants chose forms such as /kihaQ/, because they could not write /p/ itself in the Japanese writing system. In this case, the small ッ is used for indicating the word-final closed syllable, not a glottal stop. In any case, it seems that ッ has gotten a new status, not only as a first segment of a geminate cluster, but also as a symbol representing a closed syllable or a new phoneme /Q/.

5.2.5 Summary

It has been found that perception of Korean stops shows a different pattern from loanword phonology. Korean aspirated stops and plain stops are perceived as voiceless stops in word-initial position. On the other hand, tensed stops are mostly perceived as voiced stops. Korean plain stops and aspirated stops are difficult for Japanese speakers to distinguish word-initially. One of the factors for the association of voiced stop with word-initial Korean tensed stop could be the VOT value. Korean tensed stops have the shortest VOT among the

three kinds of Korean stops, and short VOT might have triggered the voicing perception of tensed stops. An interesting point was that some Japanese speakers chose voiced geminates to transcribe word-initial tensed stops. Although such a response was rare, this result was surprising, as word-initial voiced geminates are not found in Japanese, even as an irregular usage of /Q/.

It was found that aspirated stops and tensed stops are mostly heard as /Q/ + voiceless stop sequences word-medially. Plain stops were heard as voiced singleton stops in this position, and were clearly distinguished from other types of stops. Word-medially, tensed stops and aspirated stops are difficult for Japanese speakers to distinguish. Word-medial tensed stops were qualitatively similar to Japanese geminate stops. As Japanese disfavors /Q/ before a voiced stop, the short VOT which might have caused voicing perception (even though they were actually voiceless) of tensed stops word-initially seemed to be ignored word-medially. This may indicate that the durational feature, glottal feature, and actual voicing (tensed stops are voiceless in any word positions) are more prominent than VOT word-medially.

Korean coda stops are unreleased, and often perceived with /Q/. About 50% of the tokens are perceived as the /kihaQ/ type form, without an identified final stop. This is a form which is not accepted in standard Japanese. It seems that Korean coda stops are most frequently perceived as something similar to the utterance final glottal stop in emphasized speech in Japanese.

5.3 Experiment J-K 2: Korean Stop1 + Stop2 perception

This experiment tests how Japanese speakers perceive Korean heterorganic stop clusters. The main purpose is to see when Japanese speakers perceive /Q/ in these clusters. If they perceive Japanese /Q/ in Korean words, is there any particular combination of stops which triggers /Q/ perception? This experiment will address Questions 5.4 and 5.5 stated earlier: How do Japanese speakers perceive /Q/ in syllable boundary Korean stop clusters?; Does a combination of different consonants create the perception of Japanese /Q/? Or can Japanese speakers hear the differences between these clusters?

5.3.1 Participants

The participants were 20 Japanese junior high school students who had also participated in the other experiments.

5.3.2 Materials

Plain stops /p, t, k/ were combined in 6 ways to create heterorganic stop clusters[50] word-medially. Homorganic stops clusters were not tested here because they are phonetically realized as equivalent to single tensed stops /p', t', k'/, and these tensed sounds were tested in J-K 1. [ps] and [ks] clusters were added to the tokens to see how different manners affect the perception of consonant clusters. [ts] was not used here as it is phonetically realized as a single tensed stop [s'] and does not form a consonant cluster.

Twelve Korean words containing word-medial stop clusters and 4 words containing stop plus fricative clusters were used as tokens (see Appendix A). They were put in a word list three times in random order with 8 distracters, creating two word lists, each containing 56 words. Word list J-K 2 male (see Appendix B) was read by a male native speaker of Korean, and word list J-K 2 female (see Appendix B) by a female native speaker of Korean, and tape-recorded in a sound- attenuated recording studio. All words were read without place assimilation or simplification of clusters (see Korean phonology section 2.3.3 in Chapter 2). The recorded speech was edited using SoundEdit 16 version 2.0.1. After the recording session, each word was copied and pasted twice, following the sequence number read in Japanese. There was a 0.75 second pause between the first and second copy, and a 3 second pause was inserted after the second copy to give participants time for working on the task. Edited recordings were burnt on Memorex CD-R 650MB, in a CD player format.

The vowel length and stop closure length of all tokens were measured using the same methods used in other experiments.

5.3.3 Procedures

Experiment J-K 2 required a multiple choice. The participants listened to the recording, and were asked to choose the best answer from 4 given *kana* transcriptions. This task aimed at investigating if Japanese speakers perceive the place of articulation of the first member of obstruent clusters. For example, the

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[50] Consonant clusters in Korean occur only at a syllable boundary. Consonant clusters within a syllable are simplified or resyllabified at the phonetic level. See Chapter 2 for details.

/pt/ cluster in /mipta/ 'to be hateful' has 4 choices; ミプタ[mi**pu**ta] (both stops were perceived with vowel insertion), ミッタ [mi**Q**ta] (the first stop is realized as /Q/ without specifying the place of articulation), ミップタ [mi**Qpu**ta] (the place of articulation of the first stop is recognized, and the closed syllable is expressed by inserting a /Q/), ミタ [mita] (the first stop is not recognized at all). A brief practice session was conducted before the actual experiment, and any questions regarding the task were answered.

5.3.4 Results

Each test word has 120 tokens, and total of responses is 1919. The following Table 5.5 show the results of J-K 2. Stop + Fricative tokens will be analyzed separately.

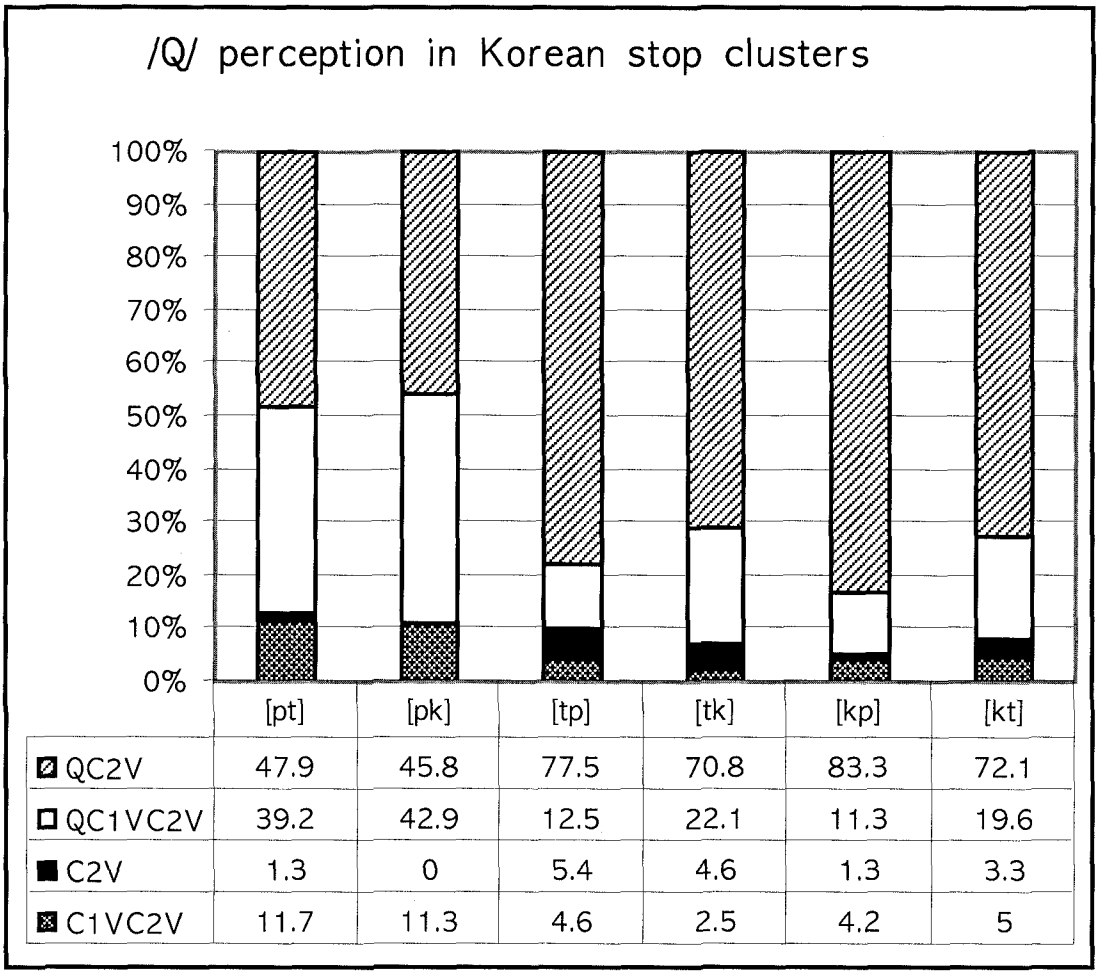
C_2V form was hardly ever chosen in responds. For all tokens, QC_2V was the most frequently observed token type. For [pt] and [pk] tokens, both QC_1VC_2V and QC_2V were equally often observed.

Table 5.5 Number of Stop1 + Stop2 tokens for each respond type (% in ( ))
/C_1VC_2V/ stands for the form with identified C_1 without /Q/, /C_2V/ the form perceived without C_1 at all, /QC_1VC_2V/ the form perceived with /Q/ and C_1, /QC_2V/ the form with /Q/ but without identified C_1

cluster type	token	C_1VC_2V	C_2V	QC_1VC_2V	QC_2V	total
[pt]	[mi**pt**ˈa]	11 (9.2)	3 (2.5)	40 (33.3)	66 (55.0)	120 (100)
	[si**pt**ˈe]	17 (14.2)	0 (0.0)	54 (45.0)	49 (40.8)	120 (100)
total [pt]		**28 (11.7)**	**3 (1.3)**	**94 (39.2)**	**115 (47.9)**	**240 (100)**
[pk]	[i**pk**ˈo]	19 (15.8)	0 (0.0)	54 (45.0)	47 (39.2)	120 (100)
	[ci**pk**ˈe]	8 (6.7)	0 (0.0)	49 (40.8)	63 (52.5)	120 (100)
total [pk]		**27 (11.3)**	**0 (0.0)**	**103 (42.9)**	**110 (45.8)**	**240 (100)**
[tp]	[ma**tp**ˈogi]	2 (1.7)	3 (2.5)	13 (10.8)	102 (85.0)	120 (100)
	[cʰə**tp**ˈən]	9 (7.5)	10 (8.3)	17 (14.2)	84 (70.0)	120 (100)
total [tp]		**11 (4.6)**	**13 (5.4)**	**30 (12.5)**	**186 (77.5)**	**240 (100)**
[tk]	[u**tk**ˈida]	3 (2.5)	9 (7.5)	3 (2.5)	105 (87.5)	120 (100)
	[pa**tk**ˈo]	3 (2.5)	2 (1.7)	50 (41.7)	65 (54.2)	120 (100)
total [tk]		**6 (2.5)**	**11 (4.6)**	**53 (22.1)**	**170 (70.8)**	**240 (100)**
[kp]	[ku**kp**ˈo]	1 (0.8)	1 (0.8)	7 (5.8)	111 (92.5)	120 (100)
	[si**kp**ˈi]	9 (7.5)	2 (1.7)	20 (16.7)	89 (74.2)	120 (100)
total [kp]		**10 (4.2)**	**3 (1.3)**	**27 (11.3)**	**200 (83.3)**	**240 (100)**
[kt]	[i**kt**ˈa]	9 (7.5)	4 (3.3)	24 (20.0)	83 (69.2)	120 (100)
	[ma**kt**ˈe]	3 (2.5)	4 (3.3)	23 (19.2)	90 (75.0)	120 (100)
total [kt]		**12 (5.0)**	**8 (3.3)**	**47 (19.6)**	**173 (72.1)**	**240 (100)**
general total		**94 (6.5)**	**38 (2.6)**	**354 (24.6)**	**954 (66.3)**	**1440 (100)**

5.3.4.1 Perception of Korean stops in syllable boundary consonant clusters

How do Japanese speakers perceive two heterorganic stops in Korean stop clusters? The following graph shows the overall results of Korean stop cluster perception for each cluster type:



	[pt]	[pk]	[tp]	[tk]	[kp]	[kt]
QC2V	47.9	45.8	77.5	70.8	83.3	72.1
QC1VC2V	39.2	42.9	12.5	22.1	11.3	19.6
C2V	1.3	0	5.4	4.6	1.3	3.3
C1VC2V	11.7	11.3	4.6	2.5	4.2	5

Figure 5.8 Perception of Korean stop clusters (%). /QC2V/ stands for the form with /Q/ but without identified C1, /QC1VC2V/ stands for the form perceived with /Q/ and C1, /C2V/ stands for the form perceived without C1 at all, and /C1VC2V/ stands for the form with identified C1 without /Q/

Figure 5.8 shows that the most of the tokens with word-medial consonant clusters were heard with two segments; either with or without identifying the place of articulation of the first stop (i.e. C_1). In other words, most of the tokens were perceived, for example, as /miQta/ or /miQputa/ or /miputa/ for /mipta/ 'to be hateful'. In the case of [mitta], the first stop /p/in the underlying form is perceived as /Q/without identified place of articulation. In Japanese production, /Q/ assimilates to the following /t/.

In the case of /miQputa/, both /p/ and /t/ in Korean form are identified, and /Q/ indicates the closed first syllable. Then it underwent place assimilation to the following /p/.

In the case of [miputa], both /p/ and /t/ in Korean form are identified, and /u/ is inserted after /p/. The inserted /u/ might have been reconstructed using Japanese vowel devoicing and deletion rule.

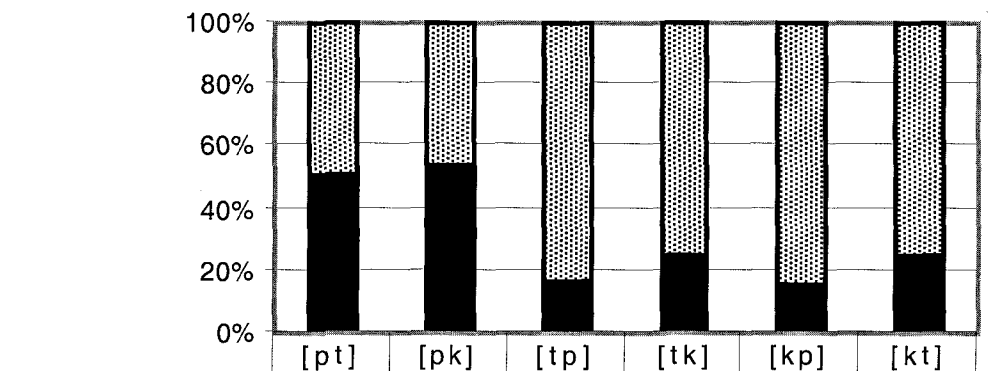
Complete deletion of the first stop (i.e., response type C_2V), such as [mita] was rarely found in the data: It is only 2.6% of the whole data.

The most frequent answer was QC_2V, such as /miQta/. The first stop was perceived as /Q/, thus, the word was heard with geminate stop [tt].

The tendency for most heterorganic stop clusters to be perceived as geminate stop clusters was predicted from Japanese phonology, which does not allow underlying heterorganic stop clusters. As discussed in Chapter 3, the

artificial pronunciation [ke**tk**on] and the natural pronunciation [ke**kk**on] could be perceived as variations of /keQkon/ 'marriage', although the first instance is extremely unlikely in natural speech. This means that the actual phonetic realization of the first stop may be ignored in Japanese phonology. Any stop cluster /VC_1C_2V/ in a foreign language may be perceived as /VQC_2V/, and this form is the underlying representation of any stop clusters in Japanese. Thus, Korean syllable boundary heterorganic consonant clusters were predicted to be heard as /VQC_2V/, with /Q/ for the unspecified first stop.

However, the results showed that each token type exhibited a little different pattern. The number of identified stops was higher with /p/+ $Stop_2$ clusters as seen in the following figure:



	[pt]	[pk]	[tp]	[tk]	[kp]	[kt]
1 stop identified	49.2	45.8	82.9	75.4	84.6	75.4
2 stops identified	50.8	54.2	17.1	24.6	15.4	24.6

Figure 5.9 The number of identified stops in Korean syllable-boundary consonant clusters ('2 stops heard' indicates the places of articulation of Stops 1 and 2 are both identified. '1 stop heard' indicates that the only the place of articulation of the second stop was identified.)

Tokens in which /p/ is the first member of the consonant clusters (i.e. /pt/ and /pk/) are perceived with two stops significantly more than other types of clusters. The results shown in the above figure indicates that more than 50% of the places of articulation of both stops are identified in /p/ + C_2 tokens. On the other hand, only 15 to 25% of C_1 of other types of stop clusters are identified: /t, k/ + C_2 tokens are more often perceived without identifying the first stop. C_1 in these clusters were mostly realized as unspecified /Q/. This may indicate that /p/ in /p/ + C_2 clusters has stronger place cues than other stops in C_1 position.

It is often said that the difference in place of articulation may cause a difference in place identification. Jun (forthcoming) claims that the hierarchy of stop perception saliency is:

alveolar < labial < velar

This hierarchy is based on assimilation patterns of world languages. Jun (forthcoming) claims that place assimilation occurs based on perceptual saliency of places of articulation: Stops which have perceptually weak place cues undergo place assimilation. Thus /t/ assimilates to the following /p, k/, /p/ assimilates to following /k/, but /k/ does not undergo place assimilation.

In /$V_1C_1C_2V_2$/ structure, stops in the C_1 position do not bear place cues during closure, therefore the formant transition from V_1 to C_1 will be the only cue for identifying the place of C_1. Coronals give the weakest place cues, because the underlying gesture with which coronals are realized is articulated more rapidly than non-coronals (Browman & Goldstein, 1990; Kang, 1999). This rapid articulatory gesture causes a rapid transition cue which is less prominent than that of non-coronals. This is because when the gesture for C_1 is articulated rapidly, the formant transitions at the end of V_1 (i.e. the vowel preceding C_1) will be affected not just by C_1, but also by the overlapping C_2.

On the other hand, tongue dorsum and lip gestures are more sluggish and give rise to longer transitions. When the gesture for C_1 is made slowly, the transitions in V_1 will result almost entirely from C_1. Thus /p, k/, which have

longer articulatory gestures, will be more identifiable than a shorter-gesture consonant /t/.

There is a further perceptual prominence ranking between /p/and /k/(cf. Winits et. al., 1972; Jun 1995): Unreleased velars are more salient than bilabials. Velars can be characterized by a noticeable convergence of the F2 and F3 of neighboring vowels. These two formants can form a prominence in the mid-frequency range and provide a clearer place cue (Jun, forthcoming).

The results in the Experiment J-K 2 do not support the perceptual ranking described above. As seen in the Figure 5.9, a high rate of /p/ identification and a lower rate of /t/ identification are confirmed. However, /k/, which should be the most perceptually salient stop, was far less often identified than /p/ in the experiment. Furthermore, there is no significant difference in stop identification rate between /t/ and /k/ (P-value .75). This means that /k/ and /t/ behaved similarly in Experiment J-K 2.

An explanation for the low rate of /t/ identification was suggested earlier: A short articulatory gesture of coronals cause unclear formant transitions which are perceptual cues for C_1 place identification. However, a short articulatory gesture does not explain the low identification of /k/ in the C_1 position: /k/ has a long articulatory gesture, and a noticeable convergence of F2 and F3 of neighboring vowels makes /k/ the most salient stop in C_1 position. Then what is the cause of low identification rate of /k/ in C_1 position?

One possible factor is the vowel context. Hume et. al. (1999) investigated the perceptual saliency across stops in onset position, and found that the perceptual salience hierarchy 'dorsal > labial > coronal'[51] could be influenced by the neighboring vowel context. In their study, /k/ followed by /i/ was less salient compared to the /u, a/ context. This study implies that the vowel context in Experiment J-K 2 could have lowered the identification rate for velar stop tokens. For example, the /p / tokens were preceded by /i/ in the experiment. The transition from /i/ to the following /p/ may be clearer than vowel context of /Vt/ or /Vk/ tokens. /i/ has relatively high F2 and F3, and that labial place is characterized by downward movement of these formants, adjacent to any vowel. It is possible that the downward transitions of labial are more salient when F2 and F3 of the preceding vowels are relatively high. That would make labials more perceptible adjacent to /i/. On the other hand, the /k/ tokens in the experiment may not have such clear formant transitions. It was also found that /kukpo/ 'national treasure' showed a lower percentage of C_1 identification than other /k/ tokens. This could be due to the vowel-to-stop transition: The /u/ to /k/ transition is less clear, and this may have lowered the rate of C_1 perception. Although /k/ is generally considered to have the clearest place cue, the formant transition from the preceding vowel can influence place perception.

[51] This hierarchy is originally proposed by Jun (1995).

However, vowel context may not be the only factor which influenced the results of Experiment J-K 2. It is possible that non-vowel-contextual factors have influenced the results. This is presumed because other /k/ + C_2 tokens do not show a strong influence of the vowel context. For tokens with /k/ as C_1, the tokens /s**ik**pi/, /**ik**ta/ and /m**ak**te/ do not show much difference in /k/ identification (see Table 5.5). As both front vowel and back vowel contexts showed similar patterns, it is possible that there could be some other factors than vowel context which influenced C_1 place identification.

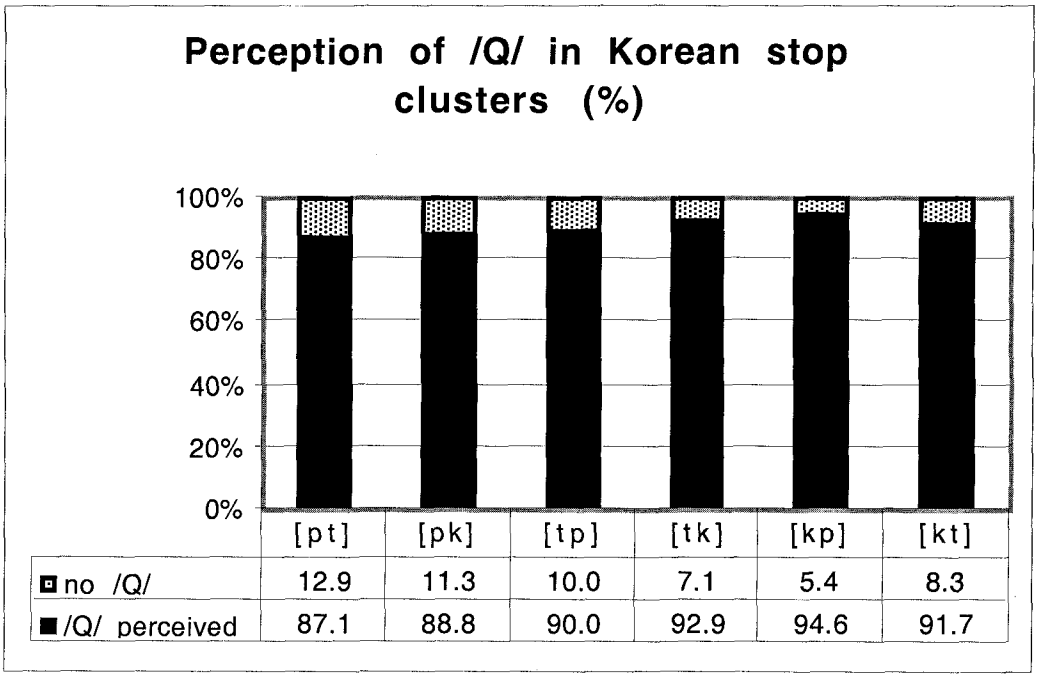
Hume et al. (1999) also mentioned the possibility of the influence of some factors which are not related to the vowel-stop formant transition. They mentioned that L1 experience of the participants may influence the results. Hume et al. (1999) found that the stop perception ability among native speakers of English and Korean differed. The study did not explain which factors in the languages might have caused such a difference among two groups, but for some vowel contexts, one group did better than the other one. Thus Hume et al. claim that it may be that the perceptual abilities or strategies could be shaped by the L1 experience. This would imply that the high identification rate of bilabial stop and lower rate for velars could be due to Japanese L1 influence. However, since Japanese speakers do not have to attend to place distinctions in stops before consonants (i.e. Japanese does not have /pk/ vs. /tk/ vs. /kk/ contrast), it is not reasonable to claim that Japanese speakers are particularly sensitive to syllable-final /p/. Therefore, the results of Experiment J-E 2 speak against the possibility

of L1 influence mentioned by Hume et al. Some other factors must be examined in future research.

Overall results indicate that the vowel-C_1 transition may influence Korean stop cluster perception. Clearer vowel-consonant transitions may give perceptual cues for identifying C_1 place. Basically, Japanese speakers perceive two stops in Korean stop clusters. The first stops may be perceived as /Q/ if the place of articulation of C_1 is not identified.

5.3.4.2 /Q/ perception in syllable boundary stop clusters

In this section, the pattern of /Q/ perception will be examined. Whether the place of articulation is perceived or not is not the question; whether /Q/ is perceived or not will be the focus. The following figure shows the percentage of perceived /Q/ for each token type:



	[pt]	[pk]	[tp]	[tk]	[kp]	[kt]
no /Q/	12.9	11.3	10.0	7.1	5.4	8.3
/Q/ perceived	87.1	88.8	90.0	92.9	94.6	91.7

Figure 5.10 Percentage of tokens heard with and without /Q/ ('No /Q/' means that /Q/ was not perceived at all. '/Q/ perceived' means that a token was perceived with /Q/.)

The above figure shows that all token types were often perceived with /Q/. On average, more than 90% of the tokens were perceived with /Q/; either as /QC1VC2V/ or /QC2V/. In an earlier section, it was found that the combination of stops may influence the identification rate of the first stop in heterorganic stop clusters. However, all types of stop clusters behaved similarly in terms of /Q/ perception. Thus, it can be said that Korean stop clusters are mostly perceived with /Q/ and the stop place does not influence the pattern of /Q/ perception.

There are two possible factors which may cause /Q/ perception in Korean stop clusters. First factor is the tense feature of the stop. The second stops of Korean stop clusters are in fact tensified. This is due to the tensification rule: In

Korean, when plain stops are preceded by obstruents except /h/[52], the plain stops are tensified and may undergo other optional phonological processes. For example;

	/mit-ko/	'believe and~'
tensification rule:	[mitk'o]	
place assimilation rule:	[mikk'o]	
consonant reduction rule:	[mik'o]	

The Korean speakers who read the testing words for J-K experiments were asked not to apply the stop place assimilation rule and consonant reduction rule after the tensification rule (see Chapter 2, section 2.3.3 for details), but the second stops were pronounced as tensed stops due to the tensification rule. The participants might have heard Korean consonant clusters as something equivalent to Japanese geminate stop clusters because of the tense feature of the second stop. This tense feature of the second stop of Korean stop clusters is one of the conditions for /Q/ perception. However, a more important factor might be the duration of stop clusters. Tensified stops may be heard as /Q/+ stop clusters by Japanese speakers because of the length of voicelessness. As discussed in J-K 1 section 5.2.4.4 (word-medial /Q/ perception of singleton stops), it was found that Korean tensed stops are mostly perceived as geminate stops by Japanese speakers. Additionally, word-medial aspirated stops are equally perceived with /Q/. This means that a Korean stop may be perceived as

[52] Ahn (1998) treats /h/ as a fricative.

a geminate stop cluster without the tenseness feature. As Korean stop clusters have tenseness and long enough voiceless duration[53] to be similar to Japanese geminates, it is reasonable that Japanese speakers hear Korean consonant clusters with /Q/.

The results of J-K 2 may be used for predicting the difficulty of stop cluster perception and production. Some combinations of stops may be harder to perceive, and will cause difficulty in pronunciation due to errors in perception.

As noted earlier in this chapter, tokens which have /p/ as the first stop were significantly more often perceived with 2 different stops. Thus, /p/ tokens may not be as difficult as other types of stop clusters. Additionally, a place assimilation rule (Jun, 1996) in Korean may create real geminate clusters. /pk/ and /tk/ clusters optionally become the geminate [kk] (Jun, 1996), and /tp/ becomes [pp] (Sohn, 1999)[54]:

/mitko/	→	[mit¬k'o]	→	[mikk'o]	'believe and~'
/nupko/	→	[nup¬k'o]	→	[nukk'o]	'lie and~'
/k'oc^h pat^h/	→	[kot¬p'at¬]	→	[kop¬p'at¬]	'flower garden'

[53] Depending on speech style, such clusters may not have consonant duration similar to Japanese geminate stops.

[54] Other combination of stop clusters do not have place assimilation, and also reverse assimilation (e.g., /pk/→ *[pp]) does not occur in Korean.

The tokens used in J-K experiments were read without applying this rule; however, in a real life, the assimilation rule may change /C1k/ tokens into [kk], and /tp/ tokens into [pp] geminate clusters. So in fact there should be little problem for Japanese speakers with these types of clusters (i.e. /C1k/ and /tp/), even if they hear these clusters as /VQC2V/ without identifying the place of articulation of the C1. Even if Japanese speakers perceive and pronounce these clusters as equivalent to Japanese geminate clusters, the outcomes will be acceptable variants of Korean underlying representations. For example, /mitko/ 'believe and ~' has three variants if the cluster assimilation rule and the pre-tense/aspirated reduction rule[55] are applied; [mitk'o], [mikk'o], and [mik'o]. The actual pronunciation by Korean speakers in J-K 2 was [mitk'o]; however, even if Japanese speakers hear the underlying representation of this word as /miQko/ and pronounce it as [mikko], it is equivalent to one of the variants of Korean. The pronunciation of the cluster will be one of the target-like forms if Japanese speakers perceive the word with geminate consonants and attempt to pronounce the perceived form correctly. The problematic stop clusters for Japanese speakers may be /pt/, /kp/, and /kt/ clusters, which do not undergo the place assimilation described above. As 50% of/pC2/ tokens were perceived with /p/

[55] Plain stops and /s/ may be deleted in front of a homorganic tensed or aspirated consonant (Sohn, 1999). See chapter 2 for Korean phonological rules.

identified, /pt/ tokens may be less problematic than /kC2/ tokens. Thus the most difficult Korean stop clusters for Japanese speakers may be the ones which have /k/ as the first member of stop clusters.

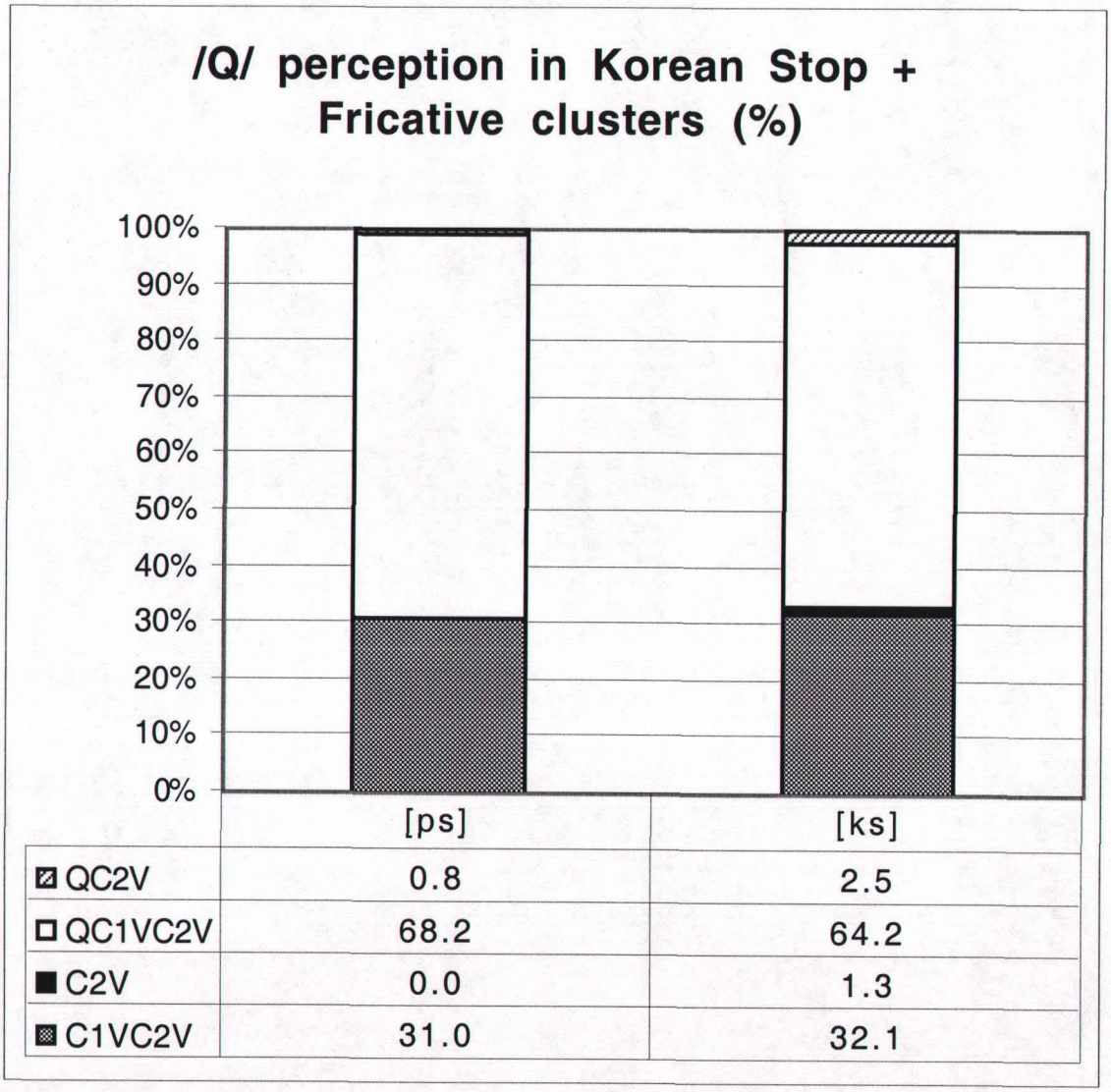
5.3.4.3 Perception of Korean stop + fricative clusters

Now perception of Stop + Fricative clusters will be briefly discussed in comparison with Stop1 + Stop2 clusters. Table 5.6 shows the overall results, and Figure 5.11 shows perception pattern for Stop + Fricative clusters, and Figure 5.12 shows a comparison of Stop1 + Stop2 clusters with Stop + Fricative clusters.

Table 5.6 shows that stop + /s/ tokens are almost always perceived with C1 with identified place. The most frequently perceived form was QC1VC2V, the form with /Q/ and identified C1 place:

Table 5.6 Number of Stop + Fricative tokens for each response type (% in ( )) /C1VC2V/ stands for the form with identified C1 without /Q/, /C2V/ the form perceived without C1 at all, /QC1VC2V/ the form perceived with /Q/ and C1, /QC2V/ the form with /Q/ but without identified C1.

cluster type	token	C1VC2V	C2V	QC1VC2V	QC2V	total
[ps]	[ips'i]	45 (37.5)	0 (0.0)	74 (61.7)	1 (0.8)	120 (100)
	[aps'ə]	29 (24.4)	0 (0.0)	89 (74.8)	1 (0.8)	119 (100)
total		**74 (31.0)**	**0 (0.0)**	**163 (68.2)**	**2 (0.8)**	**239 (100)**
[ks]	[jəks'a]	16 (13.3)	2 (1.7)	98 (81.7)	4 (3.3)	120 (100)
	[hoks'i]	61 (50.8)	1 (0.8)	56 (46.7)	2 (1.7)	120 (100)
total		**77 (32.1)**	**3 (1.3)**	**154 (64.2)**	**6 (2.5)**	**240 (100)**
		151 (31.5)	**3 (0.6)**	**317 (66.2)**	**8 (1.7)**	**479 (100)**



	[ps]	[ks]
QC2V	0.8	2.5
QC1VC2V	68.2	64.2
C2V	0.0	1.3
C1VC2V	31.0	32.1

Figure 5.11 Perception of Korean Stop + Fricative clusters (%). /QC2V/stands for the form with /Q/ without identified C1, /QC1VC2V/ stands for the form perceived with /Q/ and C1, /C2V/ stands for the form perceived without C1 at all, and /C1VC2V/ stands for the form with identified C1 without /Q/.

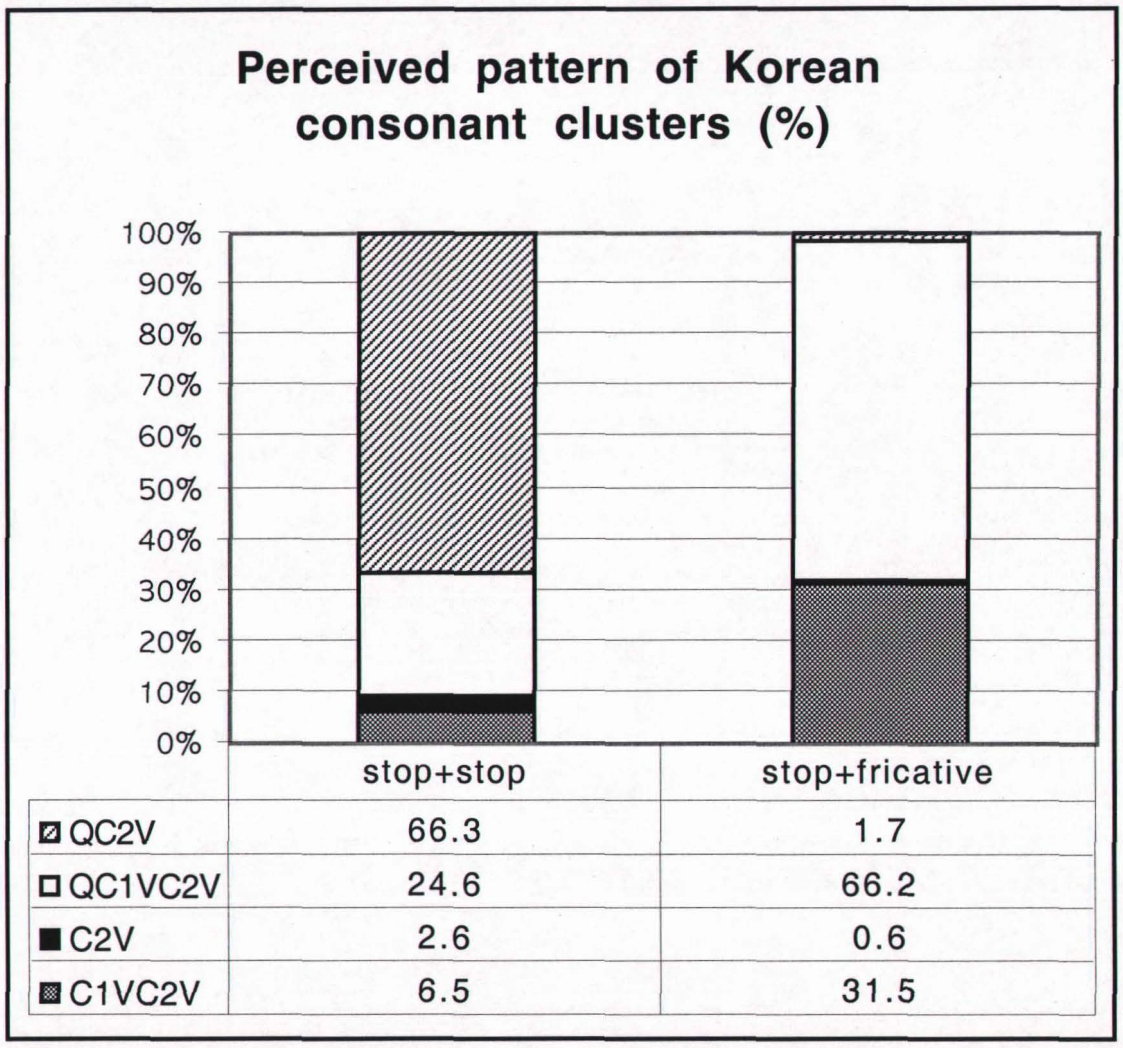


Figure 5.12 Perception pattern of Korean consonant clusters (%). /QC2V/ stands for the form with /Q/ but without identified C1, /QC1VC2V/ stands for the form perceived with /Q/ and C1, /C2V/ stands for the form perceived without C1 at all, and /C1VC2V/ stands for the form with identified C1 without /Q/.

Table 5.6 shows that each token displays a different perception pattern in terms of /Q/ perception, but all tokens behaved similarly in terms of place identification. The percentage of perceived /Q/ (QC1VC2V and QC2V tokens) varies from less than 50% for [hoksi] to 85% for [jəksa]. However, as also seen in

Figure 5.11, there is no significant difference among tokens in terms of /Q/ perception and stop place identification (P-value .1503). Both /ps/ and /ks/ clusters show a similar pattern of perceived forms. This means that place of articulation of the stop does not influence the perception pattern in Stop + Fricative clusters. For both clusters, more than 60% of tokens are perceived with /Q/ and an identified place of articulation. More than 30% of tokens were perceived with an identified stop but without /Q/. The total indicates that more than 95% of tokens were perceived with identified stops. This pattern is quite different from $Stop_1$ + $Stop_2$ clusters which showed only 30% of tokens perceived with identified $Stop_1$: When the second member of a consonant cluster is /s/, the preceding stop is almost always identified. As seen in Figure 5.12, the first stop is far less often identified in $Stop_1$ + $Stop_2$ clusters.

Another difference between $Stop_1$ + $Stop_2$ clusters and Stop + Fricative clusters is token type variation. The following figure shows stop place identification in [ps] and [ks] clusters:

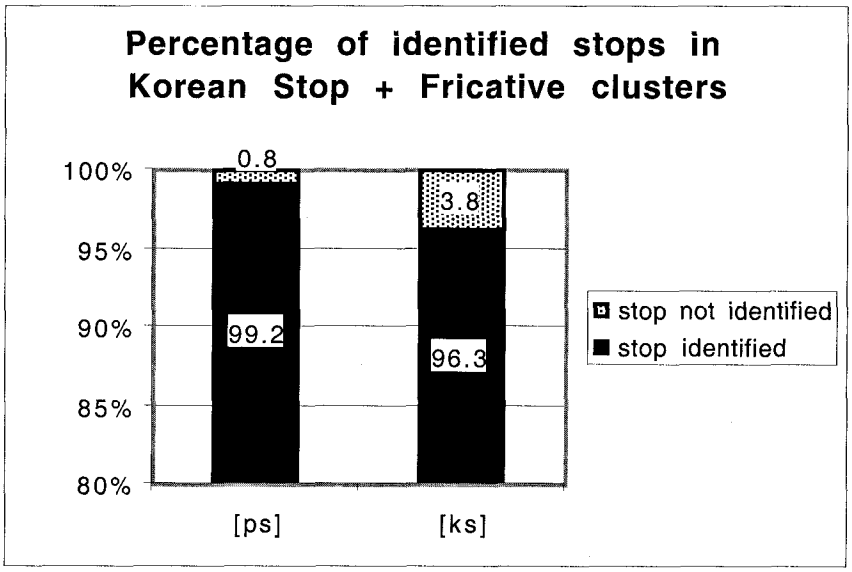


Figure 5.13 Percentage of identified stops in Korean Stop + Fricative clusters

Figure 5.13 shows that almost all tokens were perceived with identified syllable final /p/ and /k/. As discussed in section 5.3.4.1, $Stop_1$ + $Stop_2$ place identification pattern varied among token types: The percentage of identified C_1 varied from 15.4% ([kp] tokens) to 54.2% ([pk] tokens) for stop clusters. The high percentage of perceived stops for /s/ clusters implies that the type of the C_2 in a consonant cluster influences identification of the place of articulation of the first segment. Additionally, the preceding vowel context seems not to influence the identification pattern of the stop in Stop + Fricative clusters.

One similarity of $Stop_1$ + $Stop_2$ clusters and Stop + Fricative clusters is that there were almost no instances which were perceived with complete loss of the first member of the consonant cluster. In Figure 5.12, it is seen that /C_2V/ tokens (i.e. complete deletion of C_1) are only 2.6% of $Stop_1$ + $Stop_2$ tokens, and 0.6% of Stop + Fricative tokens. Other tokens are perceived either with/Q/ or with

identified stops (i.e. /p/ or /k/), or both. This means that both $Stop_1$ + $Stop_2$ clusters and Stop + Fricative clusters are recognized as having two or more segments by Japanese speakers.

Next, the perception of /Q/ in Stop + Fricative clusters will be examined. The following figure shows the percentage of tokens perceived with and without /Q/:

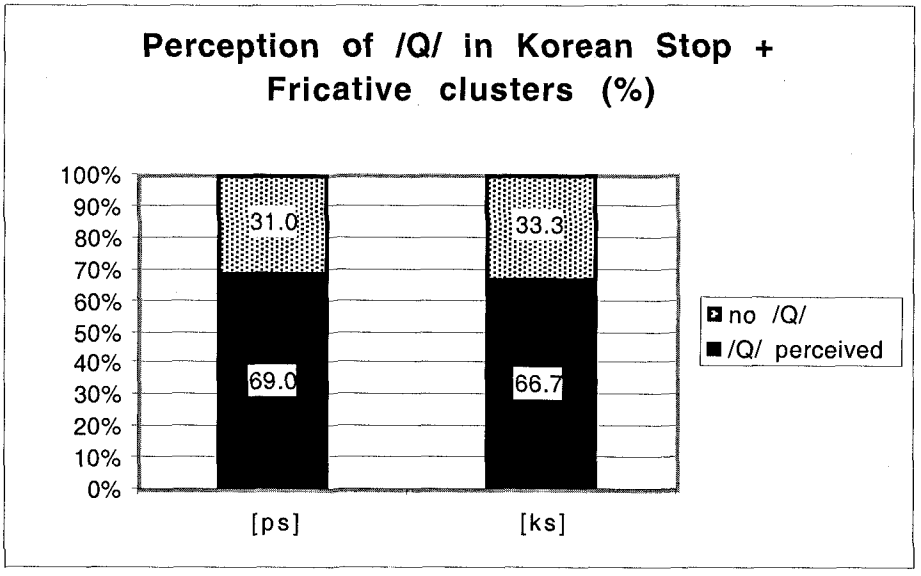


Figure 5.14 Percentage of tokens heard with and without /Q/ in Korean Stop + Fricative clusters

The percentage of perceived /Q/ was lower than that of $Stop_1$ + $Stop_2$ clusters. As seen in Figure 5.14, there were significantly more tokens perceived as C_1VC_2V (e.g., /ipsi/ as [ipusi]) than in the $Stop_1$ + $Stop_2$ data (see section 5.3.4.1).

5.3.5 Summary

The experiment J-K 2 tested how Japanese speakers perceive Korean heterorganic stop clusters. It was found that Korean stop clusters were almost always perceived with /Q/. The combination of stops did not influence the degree of /Q / perception.

The participants perceived different stop combination differently in terms of identifying the first stop in stop clusters. The difference was found in tokens which have /p/ as the first member of the consonant clusters. About 50% of /p/ + Stop2 tokens were perceived with identified places of articulation for both stops (e.g., /mi**pt**a/ was perceived either as [miQ**puta**] or [mi**puta**]). The preceding vowel-to-/p/ transition seems to have been clearer for bilabial tokens. Other stop clusters (i.e. /t, k/) were mostly perceived without identified places of articulation for the first stops. For these stop clusters, the first stops were simply realized as /Q/, the unspecified stop. The reasons could be less clear vowel-to-consonant transitions.

Stop + Fricative clusters showed different patterns from Stop1 + Stop2 clusters. /p, k/ + /s/ clusters were examined, and it was found that regardless of the place of articulation of the stop, all clusters were equally highly perceived with the identified stops (e.g., /i**psi**/ was perceived as [i**pusi**] or [iQ**pusi**]).

/Q/ was perceived equally among all tokens, but the percentage of /Q/ perception was about 20% lower than that of Stop1 + Stop2 clusters.

The difference between $Stop_1$ + $Stop_2$ clusters and Stop + Fricative clusters is that tokens of $Stop_1$ + $Stop_2$ clusters are equally perceived with /Q/, but the place identification pattern varied among tokens. On the other hand, for Stop + Fricative tokens, /Q/ perception varied among tokens but place identification did not show token type variation.

CHAPTER 6

CROSS-LINGUISTIC DISCUSSION

Chapter 4 and 5 discussed the results of English and Korean stop perception by Japanese speakers. The main purpose of this chapter is to discuss whether there are important similarities or differences between English and Korean in terms of stop perception.

6.1 Summary of experiment results

In this section, main findings in Chapter 4 and 5 are introduced again.

6.1.1 Summary of English stop perception

First, the findings in Chapter 4 will be briefly summarized here. English coda stop perception has shown characteristics as follows:

1. *The relationship between vowel tenseness and /Q/ perception in monosyllabic words:*

In loanword phonology, a monosyllabic word which has a lax vowel followed by a stop is, as a rule, borrowed with /Q/, especially when the coda stop is voiceless. The results showed that vowel tenseness has some influence on /Q/ perception: Only 4.1% of tense vowels were perceived with /Q/. On the other hand, 25% of all lax tokens were perceived with /Q/. This is probably because tense vowels in the experiment were mostly perceived long regardless of the voicing of the coda consonant. However, there was no absolute relationship between a lax vowel and /Q/ perception, as seen in loanword phonology.

2. *The relationship between perceived vowel length and /Q/ perception:*

Vowels heard as long are almost always perceived without /Q/. /Q/ was mostly heard with voiceless tokens which contain vowels perceived as short: 62.3% of such tokens were perceived with /Q/. Thus, it cannot be said that /Q/ is always perceived when a vowel is perceived short.

3. *The relationship between voicing of the coda stops and /Q/ perception:*

/Q/ was rarely observed with voiced stop tokens. Japanese phonology disfavors voiced geminates. Regardless of perceived vowel length, voiced geminates were rarely found in the data. Japanese phonology also disfavors a long vowel plus /Q/. As a vowel is likely to be heard long when the coda consonant is voiced, voiced stop tokens were likely to be heard without /Q/.

However, this does not mean that voiceless tokens were mostly perceived with /Q/: Lax vowel + voiceless stop tokens were 74.9% perceived with /Q/, but tense vowel + voiceless stop tokens were only 13.9% perceived with /Q/.

4. *How do Japanese speakers perceive English stop clusters?*

Almost all tokens with stop clusters were perceived as containing two segments. Additionally, participants were quite successful at identifying the place of articulation of both stops. The high percentage of /Q/ perception showed opposite result from loanword phonology, which usually does not allow /Q/ insertion for word-medial stop clusters.

It was found that stress patterns significantly influence /Q/ perception. The secondary accent has some effect on identifying the first stop of the cluster,

but it has much more significant effects on /Q/ perception: Words with secondary stress were more likely to be perceived with /Q/.

The place of articulation of the second stop did not influence the identification of the first stop in the cluster.

6.1.2 Summary of Korean stop perception

The findings in Chapter 5 will be briefly summarized here. Korean stop perception has shown characteristics as follows:

1. Perception of /Q/ with Korean single stops (plain, aspirated, tensed) in word-initial and medial position:

/Q/ was mostly observed with Korean word-medial aspirated and tensed stops. This is due to their long duration of closure or voicelessness. Plain stops, which are phonetically voiced intervocalically, are usually perceived without /Q/ word-medially.

Word-initial /Q/s were found with all types of stops, but the percentages were between 10-25%, much lower than word-medial /Q/occurrence.

2. Perception of Korean stops in terms of voicing in word-initial and medial position:

All Korean stops are phonologically voiceless, but the experiment revealed that perceived voicing depends on type of stop and word position. Word-initially, Korean plain and aspirated stops were perceived as voiceless. On the other hand, tensed stops were mostly perceived as voiced.

Aspirated and tensed stops were mostly heard as voiceless word-medially. Plain stops, which are phonetically voiced between vowels, were mostly perceived as voiced.

3. *Perception patterns of Korean coda stops:*

Nearly 65% of word-final tokens were perceived with /Q/. Most of these were perceived without any segment following /Q/, such as [kihaQ] for /kihap/ 'yelling'. Complete deletion of the final stop, which is commonly seen in Korean loanwords, was observed with 24.7% of tokens. The /CV/ pattern, e.g. /kihap/ → /kihapu/, was found in only 11% of the data.

4. *Perception pattern of Korean heterogeneous stop clusters:*

It was found that Korean stop clusters were almost always perceived with /Q/. About 50% of /p/ + Stop2 tokens were perceived with places of articulation identified for both stops. The /t/ and /k/ of /VtC/ and /VkC/ tokens were less often perceived correctly than /p/ of /VpC/. These stop clusters were mostly perceived without identifying the places of articulation for the first stop, which was simply identified as /Q/.

6.2 Cross-linguistic word-final coda perception by Japanese speakers

First, the perception of word-final single stops of English and Korean will be compared in terms of /Q/ occurrence and stop identification patterns. The overall results of English and Korean single stops from J-E 1 and J-K 1 are shown in the following table and graphs.

Table 6.1 shows that places of English C2 are almost always identified, on the other hand, C2 in Korean words are more likely to be perceived as [ʔ], or deleted.

Table 6.1 Perception patterns of English and Korean word-final coda stops (C_1VC_2V stands for the form with coda but without /Q/, C_1VQC_2V stands for the form with perceived /Q/ and coda, C_1VQ stands for the form with perceived /Q/ and deleted coda, and C_1V stands for the form)

	C_1VC_2V	C_1VQC_2V	C_1VQ	C_1V	total
English total	1089 (82.1)	187 (14.1)	0 (0.0)	50 (3.8)	1326 (100)
English short + vl.	93 (35.1)	165 (62.3)	0 (0.0)	7 (2.6)	265 (100)
Korean	40 (11.1)	66 (18.3)	165 (45.8)	89 (24.7)	360 (100)

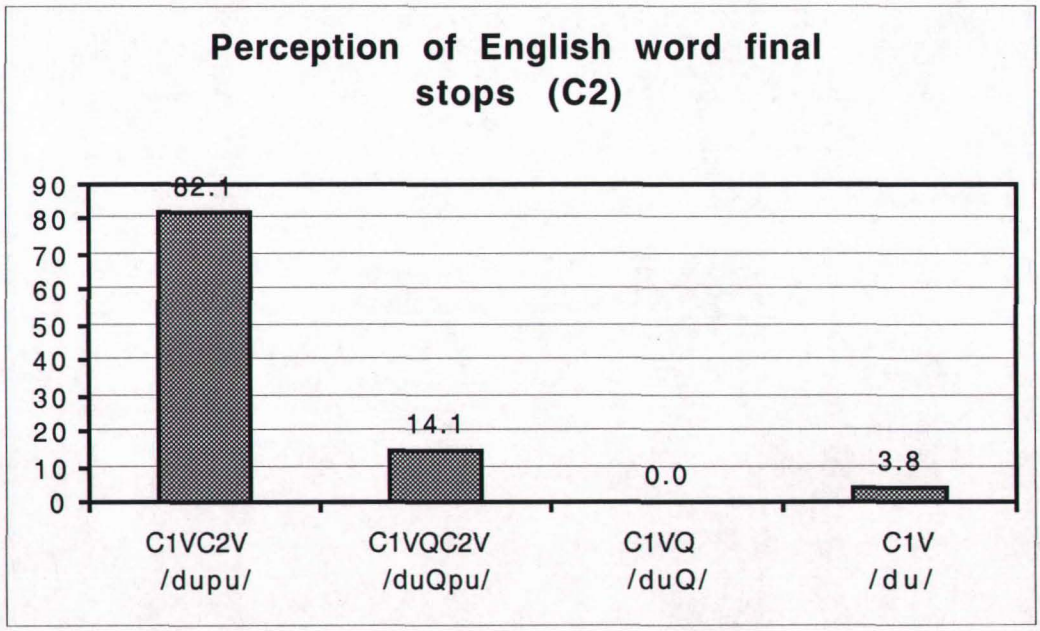


Figure 6.1 Percentage of coda perception in English words (all tokens used in J-E 1)

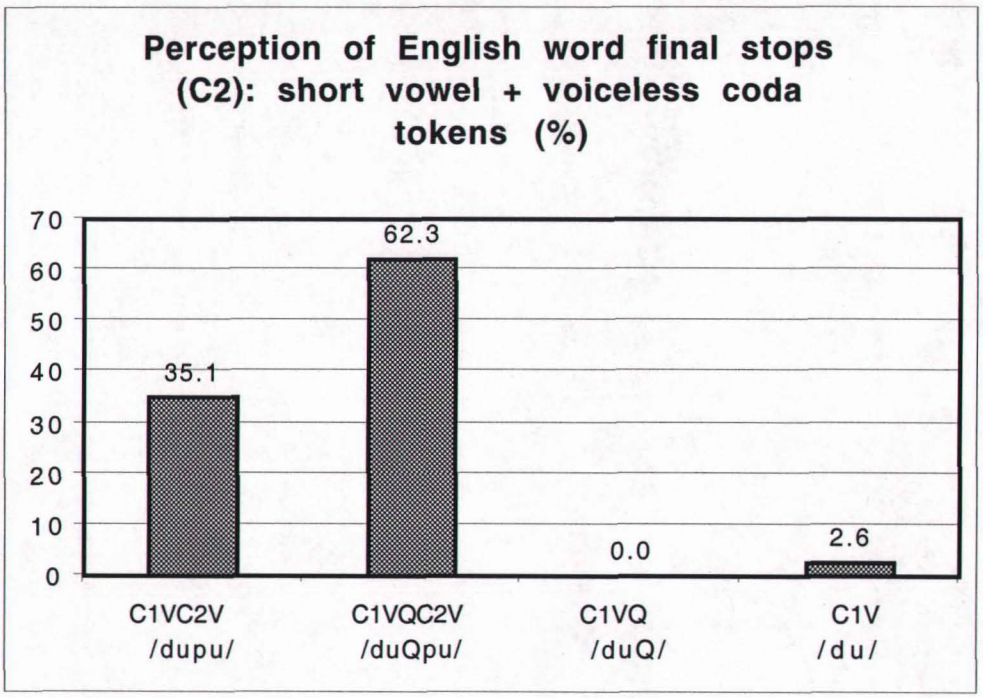


Figure 6.2 Perception of codas in English short vowel (perceived length) + voiceless coda tokens

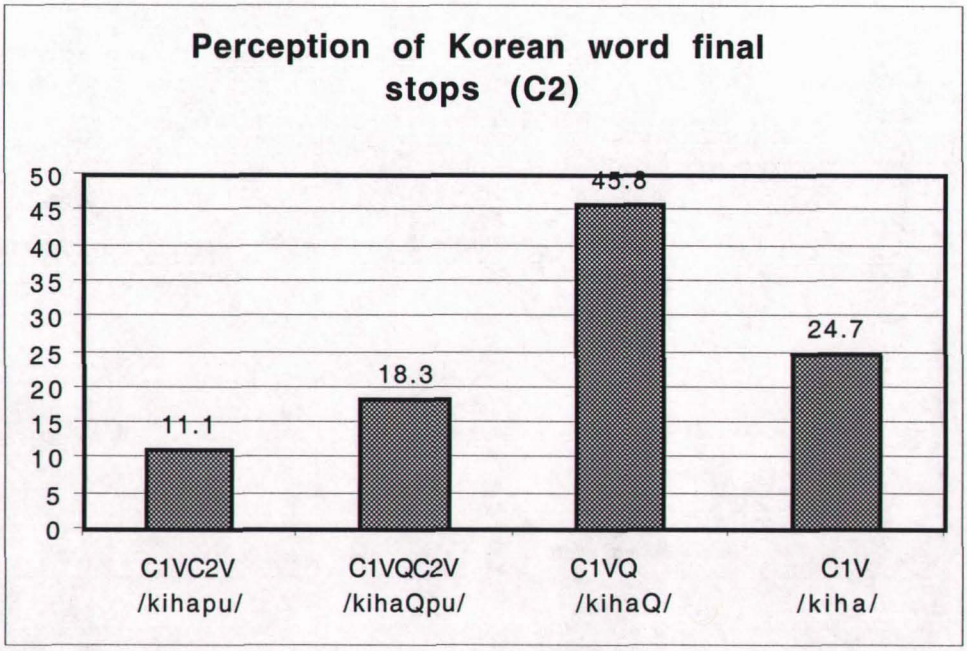


Figure 6.3 Perception of Korean word-final stops (%)

Table 6.1 and Figure 6.1-6.3 show some similarities and differences between English and Korean coda perception. For the English data, the results of tokens with short vowel (i.e. vowel perceived short) + voiceless coda stop are shown separately, as in Figure 6.2. This is because J-E 1 used test words which have long vowels (i.e. vowels perceived long) + voiced coda stops. Thus, it is necessary to see the perception pattern of the tokens which have similar phonological conditions with Korean tokens which have short vowel and voiceless coda stops.

First, we note that short vowel + voiceless tokens behaved differently from the overall results of English words. Figure 6.1 and 6.2 clearly show the differences: Tokens which were perceived C_1VC_2V (perceived coda without /Q/, such as /tip/ as [tipu]~[ti:pu]) were far more often observed in the overall results seen in Figure 6.1, compared to short vowel + voiceless tokens seen in Figure 6.2. As discussed in Chapter 4, J-E 1 section 4.2.4.2, this is because 72.9% of all tokens had long (perceived length) nuclei, which is a disfavored condition for /Q/ perception. /Q/ perception of English word-final coda stops was found to be sensitive to stop voicing and the perceived length of the preceding vowel. Thus when we look at the whole English data set (Figure 6.1), the perception of /Q/ is low: As seen in Figure 6.1, more than 85% of the data were perceived without /Q/. Because such a difference exists, it is better to use only short vowel + voiceless stop tokens for comparison with Korean data. Figure 6.4 is a combined graph of Figure 6.2, English results (short vowel + voiceless stop), and Figure 6.3 (Korean results).

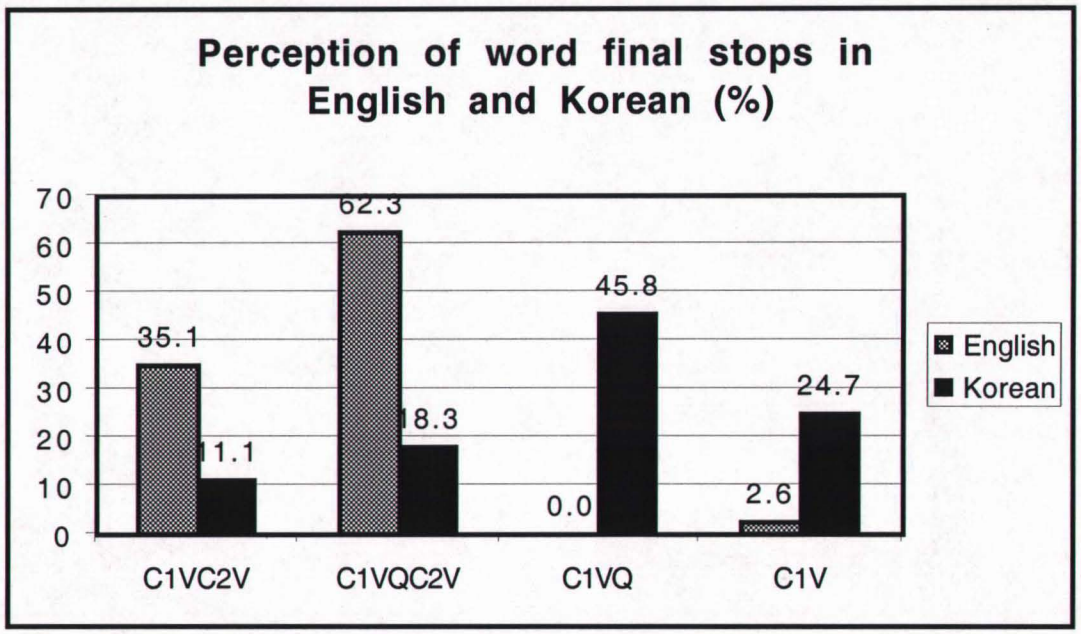


Figure 6.4 Perception of word-final single stops in English and Korean words (combination of Figure 6.2 and 6.3)

As shown in Figure 6.4, the perception patterns of English and Korean word-final stops are quite different. First of all, the most frequently selected pattern is C_1VQC_2V for English tokens: More than 60% of tokens were perceived with /Q/ and a coda consonant C_2. On the other hand, the Korean data shows that the most frequent response was C_1VQ form, which has unidentified /Q/ representing C_2; e.g. /kihap/ as [kiha?]. More than 45% of tokens were heard as this form.

6.2.1 Word-final /Q/ perception in English and Korean

The /Q/ perception pattern of English short vowel + voiceless tokens will be compared with the Korean results. To make the comparison of /Q/easier, C_1VQC_2V and C_1VQ are combined as '/Q/ perceived tokens' and shown in the

following figure. In Figure 6.5, '/Q/ perceived' stands for the tokens perceived as either C_1VQC_2V (e.g., /kihap/ as [kihappu]) or as C_1VQ (e.g., /kihap/ as [kiha**ʔ**]), and 'no /Q/' stands for the forms either as C_1VC_2V (e.g., /kihap/ as [kihapu]) or as C_1V (e.g., /kihap/ as [kiha]).

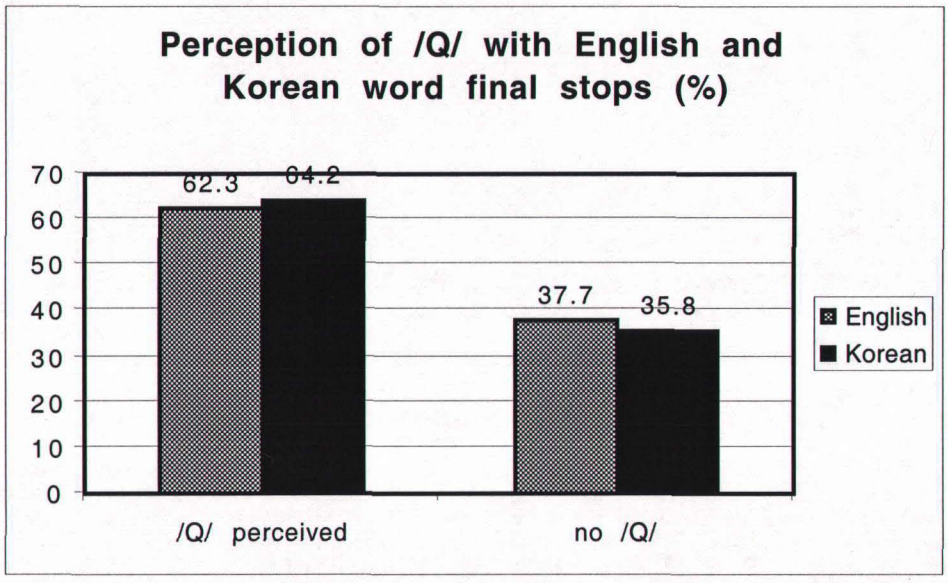


Figure 6.5 Perception of /Q/ with English and Korean word-final stops.

Figure 6.5 shows that English and Korean behaved almost identically in terms of total /Q/ perception. In the English data, 62.3% of the tokens were heard with /Q/, and in Korean, 64.1% of data was heard with /Q/. This is the major similarity between English and Korean word-final stop perception. Japanese speakers perceived /Q/ to the same degree in both languages. English and Korean single coda stops are phonetically different in the J-E and J-K experiments. Although final stop release is an option in English, all coda stops are released in J-E 1. On the other hand, Korean coda stops are never released.

As English and Korean tokens behaved identically in /Q/ perception, it can be said that stop release may not be an important factor for Japanese speakers to perceive a closed syllable. Whether the release exists or not, a word-final closed syllable is recognized. However, final release may influence the place identification pattern of final stops in the two languages. This will be discussed in the following section.

Another finding is that Japanese speakers frequently chose the form ending with /Q/, e.g. /kihaQ/ キハッ for /kihap]/ in Korean. This indicates that Japanese speakers are willing to use small ッ in an irregular way to indicate a non-geminate stop. When Japanese speakers hear Korean words, such a form apparently seems useful. This may indicate that in Japanese, disfavoring of word-final ッ is basically at the level of orthography, not at the level of perception. Or perhaps the younger generation may use such expressions due to the influence of comics, TV, internet, etc. As mentioned earlier, there are no instances of such perceptions with English: Words like /mæp/ are never perceived as マッ [maʔ].

6.2.2 Word-final stop place perception in English and Korean

Although English and Korean coda stops are perceived equally by Japanese speakers in terms of frequency of /Q/ perception, the actual English and Korean perception patterns as seen in Figure 6.4 are quite different. This difference is due to the perception of place of the word-final coda stops. Figure

6.6 shows the perception pattern of final stop C_2 stop place in English and Korean. In Figure 6.6, 'C_2 place perceived' stands for tokens which were perceived with identified place of articulation, either as C_1VC_2V (e.g., /kihap/ as [kiha**pu**]) or C_1VQC_2V (e.g., /kihap/ as [kiha**ppu**]). And 'no C_2 place' stands for tokens which were perceived without identified place of the final stop, either as C_1VQ (e.g., /kihap/ as [kihaʔ]) or C_1V (e.g., /kihap/ as [kiha]).

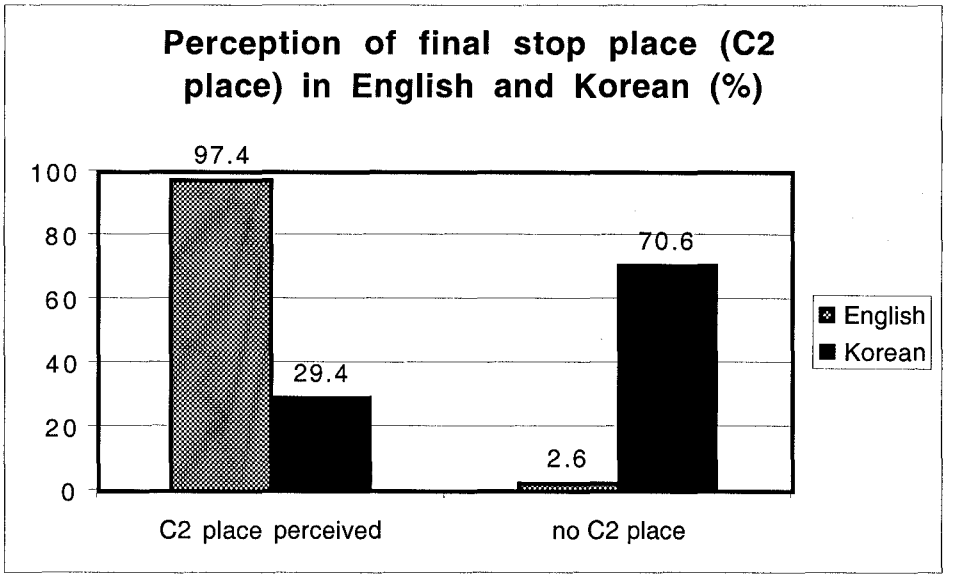


Figure 6.6 Perception of word-final stop place (C_2 place) in English and Korean.

As seen in Figure 6.6, almost all English tokens (97.4%) were perceived with identified coda stops, C_2. Interestingly, no English tokens were perceived as /C_1VQ/. Only 2.6% of tokens were heard as C_1V, with completely deleted C_2. Although not all places of articulation were correctly identified, the results

suggest that Japanese speakers do not have difficulty identifying word-final stops (C_2) in English words.

The stop release helped Japanese speakers to identify the place of articulation of the coda: The place of released coda stops is highly identifiable. However, there are a few tokens which were misperceived in terms of voicing. The following graph shows the pattern of coda perception of English.

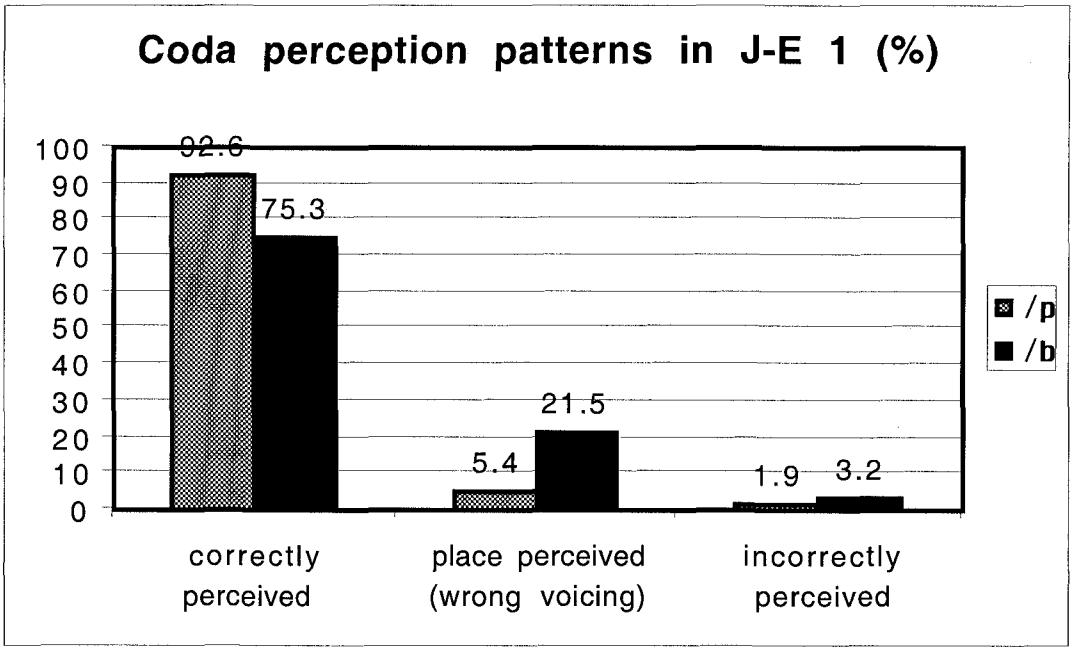


Figure 6.7 Coda (/p/ and /b/) place perception of English words in J-E 1 ('Correctly perceived' means that the stop is correctly heard, 'place perceived' means place (bilabial) is perceived but voicing or manner is wrong, and 'incorrectly perceived' means the tokens perceived completely wrong)

The above figure indicates that Japanese speakers can hear and identify English released coda stops quite successfully. Only a few tokens were perceived with completely wrong codas, but basically it can be said that place of articulation is always correctly identified (98.1% for /p/ and 96.8% for /b/). As seen in Figure

6.7, the voiceless coda /p/ is more correctly identified than /b/. This indicates that voiced coda stop perception is harder than voiceless coda stop perception. This accords with the fact that voiced coda stops are often devoiced in loanword phonology. For example, English words such as *dog* and *bed* are pronounced as [dokku] and [betto] by many Japanese speakers. This is because English monosyllabic words with coda stops are usually borrowed with geminate stops, as seen in *pet* → [petto] and *map* → [mappu]. As voiced geminates are basically not allowed in Japanese phonology, forms such as [doggu] and [beddo] undergo devoicing and become [dokku] and [betto]. However, results in the experiment indicate that coda stop devoicing may not be always caused by articulatory difficulty, but can also occur at the level of perception[56].

On the other hand, Korean final stops (C2) were much less often correctly perceived. As seen in Figure 6.6, less than 30% of tokens were perceived with C2 place. However, the form without identified C2 place but with a unspecified coda /Q/, such as /kihap/ as [kihaʔ] were frequently observed: 45.8% of all tokens were heard as this form (see Figure 6.3). This indicates that Japanese speakers often perceive the word-final consonant of Korean words as /Q/, but find it very difficult to hear the place of articulation. In Chapter 3.3, Korean loanwords are found to have non-consistent forms, but word-final codas are rarely borrowed as /Q/, and well-established loanwords indicate the coda stops can be deleted.

[56] It is also possible that stop devoicing occurs in the English speakers' productions.

The reason why English and Korean showed a difference in terms of final stop (C_2) perception may exist in the phonetic difference of English and Korean coda stops. A major difference between the two languages in this study is the release of the coda stops. All English tokens used in J-E 1 had released codas. On the other hand, Korean coda stops are phonetically never released. Stop release obviously helped the Japanese speakers to perceive C_2 place.

The findings here and in the previous section 6.2.1 are inconsistent with Ohso (1973) who claims that word-final coda release promotes /Q/ perception. She further claims that if unreleased forms of English words are borrowed, the final consonants may be deleted. In section 6.2.1, we saw that released English codas and unreleased Korean codas behaved in a very similar manner in terms of /Q/ perception. It seems that release of stops does not influence /Q/ perception, but it does influence place identification. Additionally, unreleased Korean coda stops are mostly not deleted: Only 24.7% of Korean coda stops are completely deleted, and this indicates that unreleased codas are usually perceived, even if their place is not identified. However, unreleased stops are more susceptible to deletion than released stops (24.7% vs. 2.6%).

6.2.3 Summary of word-final coda stop perception

In the English and Korean experiments, word-final coda perception in the two languages shows both similarities and differences. The major similarity is the percentage of /Q/ perception: In both languages, /Q/ is perceived in more than 60% of tokens. The major difference between the two languages is final stop (C_2) place perception. In English, C_2 place identification is very successful.

Almost 100% of tokens have C_2 place identified. On the other hand, Korean C_2 place is perceived in less than 30% of Korean words. There were no English tokens heard with word-final /Q/, such as /C_1VQ/; however, many Korean tokens were perceived as this form. As [± release] is the major difference of English and Korean word-final coda stops, we can conclude that release is an important factor in place identification, but does not have much influence on /Q/ perception.

6.3 Cross-linguistic word-medial coda perception by Japanese speakers

In this section, English and Korean word-medial coda perception will be compared.

In J-E 2, two types of consonant clusters were tested: The first type is words with a single stress such as *chapter* [ˈtʃæ**p˺**tər], and the second type is two-stressed words (usually compounds) which have a word boundary stop cluster such as *sap can*, [ˈsæ**p˺** ˌ**k**ʰæn]. In J-K 2, perception of word-medial stop clusters in words such as *mipta* [mi**p˺t**ˈa] 'to be hateful' are examined. The results of J-E 2 and J-K 2 are shown in the following Table 6.2 and Figure 6.8:

Table 6.2 Perception patterns of English and Korean word-medial stop clusters ($C_0VQC_1VC_2V$ stands for the form perceived with /Q/ and C_1, C_0VQC_2V stands for the form with perceived /Q/ but without C_1 place, $C_0VC_1VC_2V$ stands for the form with C_1 but without /Q/, and C_0VC_2V stands for the form perceived without C_1 and /Q/)

	$C_0VQC_1VC_2V$ mipputa type	C_0VQC_2V mitta type	$C_0VC_1VC_2V$ miputa type	C_0VC_2V mita type	total
English 1-stressed	242 (33.6)	241 (33.5)	229 (31.8)	8 (1.1)	720 (100)
English 2-stressed	372 (51.7)	194 (26.9)	141 (19.6)	13 (1.8)	720 (100)
Korean	354 (24.6)	954 (66.3)	94 (6.5)	38 (2.6)	1440 (100)

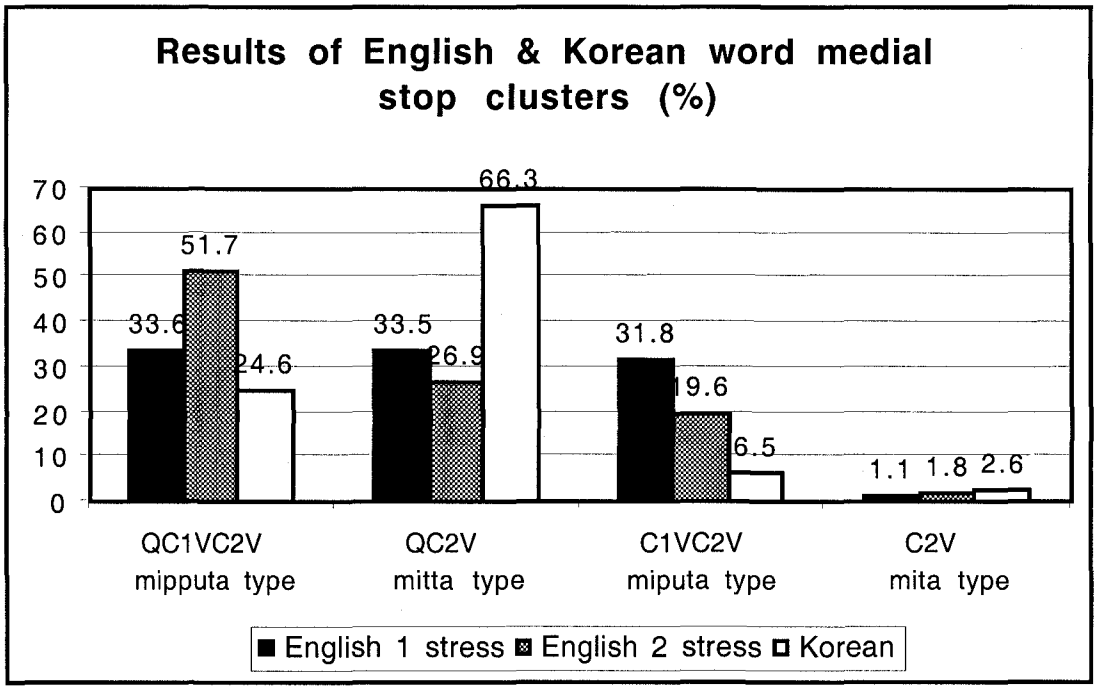


Figure 6.8 Perception patterns of English and Korean word-medial stop clusters (a figure based on Table 6.2)

The above table and figure show that each token type shows some differences.

For English, the /QC_1VC_2V/ form is the most frequently perceived form

for both 1-stressed and 2-stressed words, although /QC1VC2V/, /QC2V/ and /C1VC2V/ are perceived almost equally for English 1-stressed words.

For Korean words, the most frequently perceived form is /QC2V/, with /Q/ but without perceiving the place of articulation of the syllable-final consonant, C1.

The only common factor among all token types is that complete deletion of C1 is found very rarely: Such tokens are 1.1% of English 1-stressed words, 1.8% of 2-stressed English words, and 2.6% of Korean words.

6.3.1 /Q/ perception in English and Korean word-medial stop clusters

/Q/ perception in English and Korean word-medial stop clusters is shown in Figure 6.9:

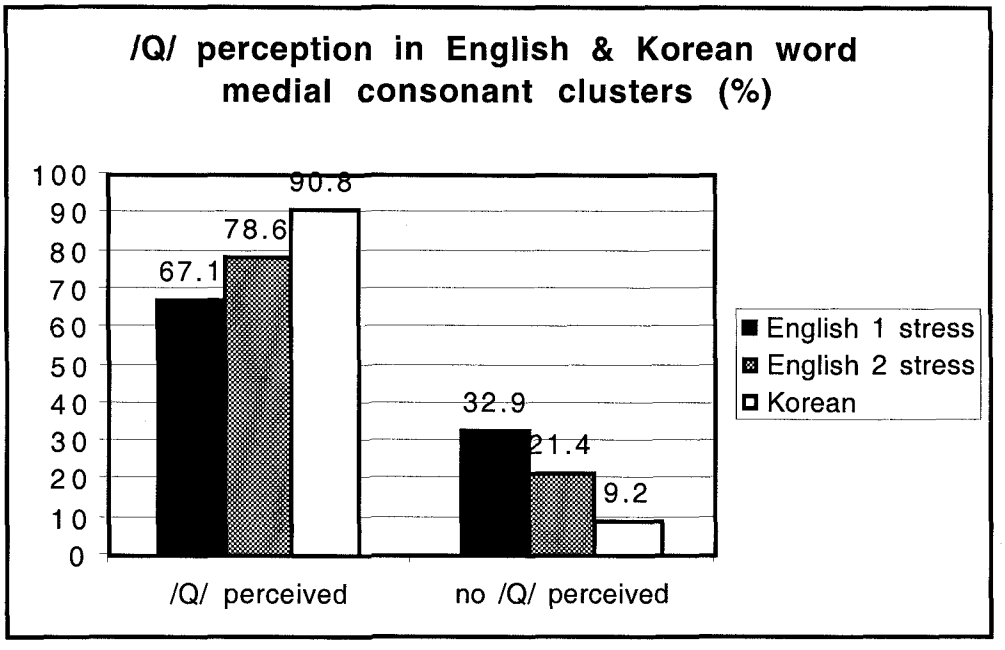


Figure 6.9 /Q/ perception of English and Korean word-medial stop clusters ('/Q/ perceived' means that the perceived form is either /QC1VC2V/ or /QC2V/, 'no /Q/ perceived' form is either /C1VC2V/ or /C2V/)

The figure above shows that /Q/ is perceived in most consonant clusters in both English (1 and 2-stressed) and Korean words. This suggests that Japanese speakers perceive word-medial consonant clusters (i.e. closed syllables) in both English and Korean words.

However, as seen in the figure, each token type shows some differences in degree of /Q/ perception: English 1-stressed words are the least often perceived with /Q/ (67.1%), Korean words (90.8%) are most often perceived with /Q/, and English 2-stressed words fall in between (78.6%). As seen in Figure 6.9, /Q/ is perceived about 10% more (found to be significant) when an English word has 2 stresses. Thus secondary stress may have some influence on /Q/ perception, and this is one of the assumptions made in Chapter 4: "2-stress words are significantly more often perceived with /Q/ than 1-stressed words" (See Chapter 4.3.3). However, when English and Korean words are cross-linguistically compared, the stress patterns (i.e. 1-stressed, 2-stressed, no stress) do not seem to influence /Q/ perception. Korean words, which are said not to be stressed at the word level, are perceived with /Q/ more than 90%.

The high rate of /Q/ perception in Korean might be seen as going against Hypothesis 4.4.3 in Chapter 4, since it has been predicted that stress on both adjacent vowels will increase the frequency of /Q/perception. But when it is said that Korean words are not stressed, this could be taken to mean that Korean words are evenly accented; i.e., that Korean words lack the kind of unstressed, very short syllables that characterize "stress-timed" languages like English. One could say that unlike the truly *un*stressed syllables of English, all Korean

syllables receive some degree of stress. We might reinterpret the hypothesis, then, and claim that words with an *un*stressed syllable are least often perceived with /Q/. Then the results for English two-stressed words and Korean words would be consistent, though not exactly equivalent.

In any case, we can say that if there is a word-medial stop cluster, it is likely to be heard with /Q/ by Japanese speakers, regardless of the stress patterns.

Another possible explanation for the high /Q/ perception in Korean word-medial stop clusters may be the low place identification rate. Place of articulation of Korean word-medial C_1 is poorly identified. As reported in Chapter 4 section 4.3.2, J-E 2 experiment, Japanese speakers often choose an open syllable form /$C_0V\underline{C_1VC_2V}$/, such as *chapter* as /tʃaputa:/ when they perceive the place of articulation of C_1. As noted in Chapter 2 (section 2.1.2 and 2.1.3) Japanese high vowels are often devoiced and deleted between voiceless consonants. As the participants perceived the place of articulation of C_1, they may have perceived the English tokens as the results of vowel deletion between two voiceless stops. The following is an example that shows how the test word *chapter* underwent vowel devoicing and deletion:

English input: /tʃæptər/	*Japanese UR*:	/tʃaputaː/
	Vowel devoicing:	[tʃapu̥taː]
	Vowel deletion:	[tʃaptaː]
	Japanese phonetic form:	[tʃaptaː]

With this derivation, Japanese speakers would choose /tʃaputaː/ as the underlying form of *chapter*. This indicates that Japanese speakers, who must perceive 2 aspects of C_1 in C_1C_2 clusters (C_1 as a stop with a place and C_1 as a coda), have two ways of perceiving C_1 place and word-medial closed syllable. The first strategy is to insert a /Q/ before C_1, /C_0V<u>QC_1VC_2V</u>/ as in /tʃaQputaː/ for *chapter*, and the second type is to insert a vowel between C_1 and C_2, and delete it at underlying representation level, /C_0V<u>C_1VC_2V</u>/ as in /tʃaputaː/ for *chapter*. The second strategy is possible only when Japanese speakers identify the place of articulation of C_1. As most of C_1 place of Korean words are not identified, the only way to show perceived closed syllable is /Q/ insertion without identified C_1. Thus, failure of C_1 place identification might have increased the rate of /Q/ perception in Korean words.

Another finding is that the J-K 1 experiment shows that word-medial aspirated and tensed stops (e.g., Korean /ap^{h}ajo/, /ap'ajo/) are also frequently perceived with /Q/ (both /ap^{h}ajo/ and /ap'ajo/ → [appajo]). It seems that /Q/ insertion in English loanwords (e.g., /mæp/ → [mappu]) is used to preserve a

closed syllable. However, as Korean words are perceived with /Q/ word-medially in onset position, it can be said that /Q/ perception is not only for preserving a closed syllable of an original foreign word, but also for indicating some phonetic characteristics (i.e. longer duration of voicelessness) of consonants.

6.3.2 Place perception in English and Korean word-medial stop clusters

In this section, place perception patterns in English and Korean will be compared. The following Figure 6.10 shows that C_1 place is identified far more frequently in English words than in Korean words.

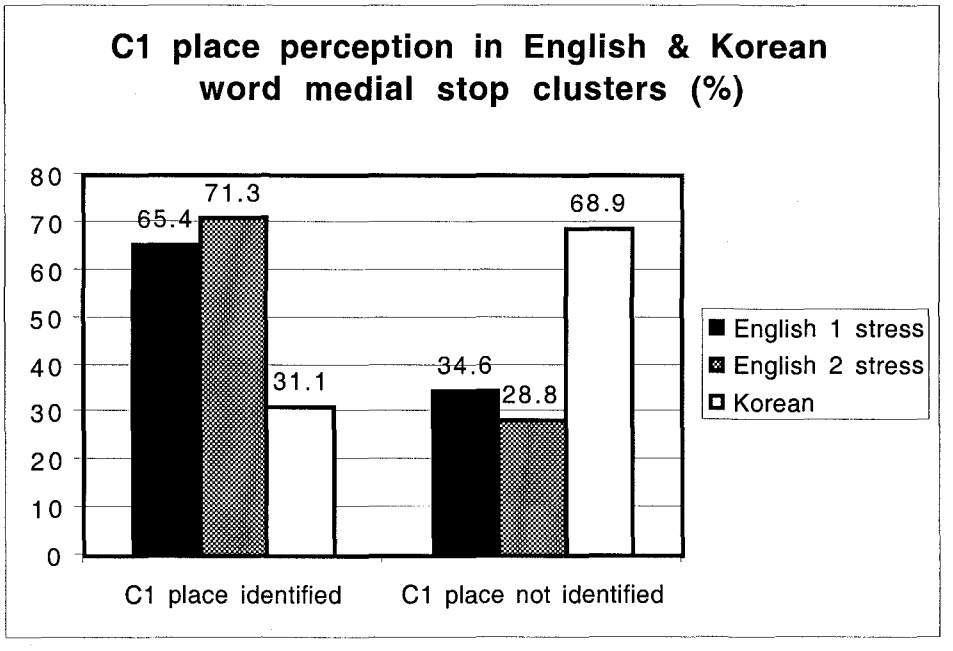


Figure 6.10 Perception of place of articulation of C_1 in /VC_1C_2V/

The figure shows that C_1 in English words are mostly perceived with identified place regardless of the number of stresses: It is found that 65.4% of 1-

stressed English words and 71.3% of 2-stressed English words are heard with identified C_1. The difference between English 1-stressed and 2-stressed words is not great, about 6%, but it was found that the difference is significant (P-value = 0.0173). On the other hand, the place of C_1 is much less often identified in Korean words: Only 31.1% of Korean tokens are heard with identified C_1.

The relationship of stress to place identification is a bit difficult to interpret. For English words, the presence of a secondary stress appears to increase place identification of the C_1 that ends the primary-stressed syllable by a small but significant percentage. But in the Korean words, the place of C_1 was not usually identified. We might conclude that the absence of stress in Korean caused this, but if we say that all Korean syllables have some minor degree of stress, we must look further. It may be that the English primary-stressed initial syllables are longer than the Korean initial syllables, and that this increased the place identification rate. In a longer syllable, the vowel-to-coda stop transition may be clearer, and this may have helped Japanese speakers to perceive the coda stop place in English. But without further study, this remains only a speculation.

One may think the low rate of place identification of Korean words may be due to place assimilation rule in Korean. In normal speech, Korean word-medial stop clusters are often pronounced with reduced place or as geminates or as single tensed stops after applying the place assimilation rule (see Chapter 2 section 2.3.3 for details). This could be why the place of heterogeneous stop clusters was poorly identified. However, the Korean tokens were read without applying the place assimilation rule at the recording session, and they were

double-checked by a Korean speaker (who was not a reader in the recording session) to see that stop cluster assimilation did not apply. Thus, the reason that Korean words are less identified with their C_1 place is not due to place assimilation.

6.3.3 Summary of word-medial stop cluster perception

/Q/ was perceived in most of the English and Korean word-medial stop clusters. The number of stresses has some influence on the degree of /Q/ perception when English 1-stressed and 2-stressed words are compared; however, stress is not a crucial factor for /Q/ perception, as Korean words, which are said not to have lexical stress, are the most frequently perceived with /Q/. Alternatively, we might say that the presence of unstressed syllables in English decreases the rate of perception of /Q/.

Although both English and Korean words are often perceived with word-medial /Q/, C_1 place identification patterns show a difference between the two languages. English words are mostly perceived with identified C_1 place, on the other hand, Korean words are much less often perceived with C_1 place.

CHAPTER 7

CONCLUSION

This dissertation has investigated how English and Korean stops and closed syllables are perceived by Japanese speakers who are at the beginning level of English learning and who do not have any Korean learning experience. Twenty Japanese 7th graders participated in 4 experiments.

Experiment J-E 1 tested word-final coda stops of English one syllable words which have /CVStop/ structure, such as /gop/ and /gob/. J-E 1 was conducted to see how English vowel tenseness, perceived vowel length, and voicing of coda stops influence /Q/ perception.

The results of experiment J-E 1 show the difference between loanword forms and actual L2 perception. Perceived vowel length does not show the systematic "lax vowel equals short vowel, tense vowel equals long vowel" association which seems to be a convention in loanword phonology. This is because the actual English vowel length is strongly controlled by coda consonant's voicing, by speech rate, and so on. As perceived vowel length is not as systematic as it is in loanwords, so /Q/ perception is not consistent as in loanword phonology: It cannot be said that /Q/ always occurs after a lax vowel in perception. The association of the tense/lax distinction and the durational feature (i.e. tense = long, lax = short) mentioned in Jakobson, Fant, and Halle (1969) , and the rule for loanwords that "/Q/ is perceived when the vowel is lax" are not supported, and may not be maintained in actual speech perception.

Additionally, voiced stops preceded by /Q/ in loanwords such as /doQgu/ for *dog* appear to be spelling-based, because /Q/ + voiced stop is strongly disfavored in the actual perception test.

The data in J-E 1 also suggests that some Japanese speakers may perceive a tense/lax distinction not due to quantitative feature (i.e. long vs. short) but qualitative feature. This is indicated by the use of unusual *kana*, which is not observed in standard Japanese nor in loanword phonology.

Experiment J-E 2 examined the Japanese perception of English word-medial heterogeneous stop clusters which do not exist in Japanese. Differences in perception due to stress pattern were also examined.

It appears that Japanese speakers hear /Q/ for the coda stop in many English word-medial heterogeneous stop clusters (67.1% for one-stressed words, and 78.6% of two-stressed words). And the place of articulation of the word-medial syllable-final stop is frequently identified in clusters (65.4% for one-stressed words, and 71.3% of two-stressed words). However, the identification rate is much lower than for word-final single coda stops which are identified almost 100% of the time. Stress patterns also have some influence on /Q/ and C_1 place perception, but the influence is slight. The perception patterns in this study are different from the /Q/ perception pattern reported by Kawagoe (1995), who claims that word-medial stop clusters do not undergo /Q/ insertion. Japanese speakers in J-E 2 inserted /Q/ in word-medial heterogeneous stop clusters, and this suggests that Japanese speakers hear closure of syllables which have word-medial coda stops.

Additionally, it is found that the consonant/ vowel ratio cannot always correctly predict /Q/ perception (see chapter 4, section 4.2.4.5).

J-K 1 tested how three kinds of Korean single stops (i.e. plain, aspirated, and tensed) are perceived in different word positions in terms of voicing and /Q/. Perception of Korean single stops is complicated: It is influenced by the word position, VOT, and actual voicing and phonetic features of the stops. In word-initial position, VOT determines the perceived voicing: The short VOT value of tensed stops causes 70% of them to be perceived as voiced stops word-initially. However, word-medial Korean stops are perceived as voiceless, except for plain stops, which are phonetically voiced in this position. Also, Korean aspirated and tensed stops are equally perceived with /Q/. The common feature of two types of stops is a longer voiceless period than plain stops. Thus even without glottal tenseness, aspirated stops are heard with /Q/.

The word-final /Q/ perception pattern shows that non-standard usage of /Q/ is quite common among the participants. Well-established Korean loanwords indicate that word-final Korean stops are deleted when they are borrowed into Japanese, such as Korean word *kukpap* 'rice soup' becomes /kuQpa/ in Japanese. However, the perception test J-K 1 indicates that Japanese speakers often use "illegal" forms ending with a /Q/, followed by no segments at all. This may indicates that the acceptable distribution of /Q/ in Japanese is changing, at least among younger generation.

Experiment J-K 2 tested perception of Korean word-medial stop clusters. /Q/ and place perception of stop clusters were examined. It is found that both

C_1 place and /Q/ are often perceived word-medially, but the place of articulation of C_1 is identified less often in Korean words than in English ones.

The results of the four experiments indicate that Japanese speakers perceive /Q/ in a foreign word when there is a closed syllable either a word-medial consonant cluster or a word-final single stop. In addition, as found in J-K 1, intervocalic single aspirated (78.8%) and tensed (73.3%) stops are perceived with /Q/, probably due to the long duration of voicelessness. This suggests that /Q/ perception can occur even with open syllables, and that glottal closure or tenseness is not always necessary for /Q/ perception. It seems that if one of the characteristics of Japanese /Q/ is recognized in foreign words, Japanese speakers can perceive /Q/. These phonetic characteristics that favor /Q/ perception seem to be coda stop closure, long duration of voicelessness, and tenseness.

Additionally, "illegal" usage of /Q/ in L1 and loanwords is frequently observed in all experiments. Bloch (1950) says, that the distribution of /Q/ is limited to V_C environment in standard Japanese. However, this is not the case in the four experiments. This means that the distribution of /Q/ has expanded, and /Q/ has obtained a new status in Japanese, at least among the younger generation. As mentioned in Chapter 3, section 3.1.1, it has been controversial to use /Q/ as a phoneme to indicate the first part of a geminate stop cluster. One of the reasons is the limited distribution of /Q/. However, it seems that /Q/ is acquiring the status of a phoneme, as distribution is no longer limited to the first part of geminate stop clusters. As found in J-K 1, /Q/ can occur in non-geminate

environments like word-final position. As words such as /a/ 'oh' and /aQ/ 'oh!' (emphasized speech) do not contrast in meaning, it is hard to say that /Q/ has become a real phoneme. But it can be said that /Q/ has obtained the status of something like a 'quasi-phoneme'.

Cross-linguistic comparison between English and Korean reveals that stop perception, especially place perception, shows different patterns in the two languages. Factors such as stress patterns and phonetic features (e.g., released coda vs. unreleased coda, aspirated & tensed vs. plain), can greatly influence stop perception. This indicates that different learning strategies and teaching methods are necessary for different languages.

The Japanese-English experiments show that Japanese speakers are quite successful with perceiving coda stops in English despite very limited foreign language learning experience and the lack of various coda stops and clusters in their L1. The results indicate that Japanese speakers mostly do not perceive English heterogeneous stop clusters as equivalent to Japanese geminate stop clusters. The interference of L1 is not strongly observed.

The results of the four experiments provide some pedagogical suggestions for English and Korean teachers in Japan.

For teaching English, the two English experiments imply that English stops are quite successfully perceived by Japanese speakers from the beginning stage of language learning. Therefore, listening practice at this stage is important and should not be ignored in classroom. As it is found that some phonetic features and stress patterns can increase correctness in stop perception, such

features have to be used in listening practice. For example, it may be helpful to introduce word-final stops with release. As found in J-E 1, final stop release can help increase the correct identification rate.

It is also important not to depend on the idea that lax vowels are short and tense vowels are long, as the actual perception patterns show that perceived (and produced) vowel lengths are strongly influenced by factors such as consonant environment and speech rate. It is true that the short-lax, long-tense association is observed in loanword phonology (see Sunaoshi, 1995), but students must learn that that association does not always work in real speech. Rather, it is necessary to give language learners some practice in hearing the qualitative difference between lax and tense vowels so that they do not rely on a quantitative feature for the tense/ lax distinction. Distinguishing tense/ lax vowel by qualitative features is important, because the results in J-E 1 indicates that both tense and lax vowels are perceived long when coda stops are voiced. Thus the words such as *bead* and *bid* may be perceived and pronounced identically, with a long vowel. As there is evidence in J-E 1 that Japanese speakers may hear the tense/ lax distinction, such listening practice at an earlier stage of English learning will be important and helpful.

The Japanese-Korean experiments suggest that Japanese speakers may have difficulty distinguishing different stops (i.e. plain, aspirated, tensed) in different word positions. As J-K 1 indicates, plain stops and aspirated stops are perceived similarly word-initially. However, aspirated and tensed stops are perceived similarly word-medially. This means that Japanese speakers must

learn to distinguish plain stop vs. aspirated stop word-initially, and aspirated stop vs. tensed stop word-medially.

Also, as it is found that Japanese speakers showed difficulty identifying Korean coda stops, listening excises must emphasize this area. For word-final codas, forms ending with /Q/ such as /kihaQ/and complete deletion of the coda such as /kiha/ are in the majority. For producing word-final coda stops, it may work well to teach students to pronounce word-final "small /tsu/" (i.e. /Q/) with mouth shaped for target place, e.g., with lip closure for final /p/. Watching the mouth shape may also help Japanese speakers to identify the place of articulation of word-final coda stops.

For Korean word-medial heterogeneous clusters, most of the participants hear /Q/, and this means that they mishear heterogeneous stop clusters as geminates. This is not a serious problem when clusters are the one which may undergo place assimilation, as stated in Jun (1995, 1996, forthcoming). Thus the type of clusters which Japanese speakers need to practice most are /pt/, /kt/, and /kp/ clusters.

There are some limitations in this study. For example, the experiments used *kana* transcriptions, which is basically an open syllable system and cannot transcribe easily closed syllables, so the identification of these results with coda stop perception is, to some degree, an extrapolation. This is a difficult problem to solve as the participants are not familiar with a phonetic alphabet. But the

study sheds some new light on the perception issue even if some issues of the relationship between perception and orthography are not yet resolved.

Another limitation is that all tests except J-E 1 used multiple choice. Multiple choice was used to reduce stress and fatigue on the participants. However, because of the vowel length and coda voicing variations, the multiple choice options could not cover all possible choices for J-E 1. Arai and Kawagoe (1996, 1998) point out that testing methods can greatly influence testing results. For future studies, it will be necessary to find alternative testing methods to compare with these results.

The findings here may not be applicable for certain dialects. A future study needs to test if similar results will be obtained with Japanese speakers of dialects which lack mora timing or which lack a vowel devoicing/deletion rule. Some dialects in Japan are apparently syllable timed (i.e. 'syllabeme dialects' spoken in Aomori, Kagoshima, etc.), and speakers of such dialects may perceive vowel length and /Q/ differently from speakers of mora timing dialects. Also, speakers of dialects in the Kinki area (Osaka, Nara, Kyoto, etc.) use the vowel devoicing/deletion rule less frequently. It will be interesting to see how speakers of such dialects perceive coda stops and vowel length in foreign words.

Although the experiments in this study have some limitations, I hope the findings will provide some light on second language perception and on the relationship of perception to production in phonology. Further I hope it will suggest some pedagogic strategies for English teachers in Japan, and will help in promoting Korean language education in Japan.

Appendix A

Test words

a. Experiment J-E 1

/ɪ/		/i/	
tɪp	tɪb	tip	tib
/ʊ/		/u/	
dʊp	dʊb	dup	dub
/ɛ/		/o/	
gɛp	gɛb	gop	gob

Additional Words (distracters)

tibu	sobi
kopu	gɛpi

b. Experiment J-E 2

[p̂t]	[ṕt^h]	[ṕk̚]	[ṕk^h]
optima	zip tie	ripken	sap can
chapter	pep toe	Hopkin	dip key
septum	nap ten	sepker	tip cone

Additional Words (Distracters)

factor

victim

sick time

pack tea

c. Experiment J-K 1

Word-initial position

[p]	pat.a.jo	[padajo]	'(I) receive'
	pa.po	[pabo]	'fool'
[pˈ]	pˈa.ri.ta	[pˈarida]	'fast'
	pˈa.ci.ta	[pˈajĩda]	'to fall into'
[pʰ]	pʰan.mæ	[pʰanme]	'sale'
	pʰa.næ.jo	[pʰanejo]	'(I) dig out'

Word-medial position

[p]	ip.an	[iban]	'inside the mouth'
	su.paki	[subagi]	'watermelon is~'
[pˈ]	a.pˈa.jo	[apˈajo]	'(he is) father'
	o.pˈa.to	[opˈado]	'brother also ~'
[pʰ]	a.pʰa.jo	[apʰajo]	'(I am) sick'
	o.pʰan.i	[opʰani]	'misjudge is~'

Word-final position

[p]	ki.hap	[kihap]	'yelling'
	sa.sip	[sasip]	'forty'
	ci.kap	[cigap]	'purse'

Distracters

mæ.il.i	[meiri]	'everyday is~'
han.mi	[hammi]	'Korea and USA'
jo.ri	[jori]	'cooking'
ma.mu.ri	[mamuri]	'conclusion'
sa.sil	[sasil]	'truth'
sa.man	[saman]	'forty thousand'

d. Experiment J-K 2

[pt]	mip.ta	[mipt'a]	'to be hateful'
	sip^{h}.tæ	[sipt'e]	'(she says she) wants to do~'
[tp]	mas.po.ki	[matp'ogi]	'tasting'
	c^{h}əs.pən	[c^{h}ətp'ən]	'first'
[pk]	ip.ko	[ipk'o]	'to put a car in the garage'
	cip.ke	[cipk'e]	'nipper'
[kp]	kuk.po	[kukp'o]	'national treasure'
	sik.pi	[sikp'i]	'food budget'
[tk]	us.ki.ta	[utk'ida]	'to make one laugh'
	pat.ko	[patk'o]	'receive and~'
[kt]	ik.ta	[ikt'a]	'to get used to'
	mak.tæ	[makt'e]	'enormous'
[ps]	ip.si	[ips'i]	'entrance exam'
	ap^{h}.sə	[aps'ə]	'in advance'
[ks]	jək.sa	[jəks'a]	'history'
	hok.si	[hoks'i]	'by any chance'

Distracters

pa.p'ɨ.ke	[pap'ɨge]	'busily'
na.p'ɨ.ke	[nap'ɨge]	'badly'
ki.p'ə.sə	[kip'əsə]	'because (I am) happy~'
a.k'i.ta	[ak'ida]	'to cherish'
sik.ku.to	[sik'udo]	'family also~'
pi.nu	[pinu]	'soap'
pa.ro	[paro]	'right, straight'
ne.si	[nesi]	'four o'clock'
so.kæ	[soge]	'introduction'

Appendix B

Tests and answer sheets

a. Test: J-E 1 Female

1. gɛpi
2. tɪb
3. dup
4. dʊb
5. gop
6. sobi
7. tip
8. gɛp
9. gob
10. tibu
11. gɛb
12. dʊp
13. tib
14. kopu
15. dub
16. tɪp
17. dup
18. gɛb
19. dʊp
20. kopu
21. dub
22. tib
23. gop
24. dʊb
25. tɪp
26. gob
27. tibu
28. gɛp
29. tɪb
30. sobi
31. tip
32. gop
33. dʊb
34. gɛpi
35. tib
36. gob
37. gɛpi
38. dup
39. gɛb
40. tibu
41. tip
42. gɛp
43. tɪb
44. dʊp
45. kopu
46. tɪp
47. dub
48. sobi

b. Test: J-E 1 Male

1. sobi
2. dup
3. gɛp
4. dʊb
5. tɪp
6. kopu
7. tɪb
8. tip
9. gob
10. dʊp
11. gɛb
12. tib
13. gop
14. tibu
15. dub
16. gɛpi
17. gɛb
18. dʊb
19. gɛp
20. tip
21. sobi
22. dʊp
23. gop
24. tɪp
25. gob
26. gɛpi
27. tib
28. kopu
29. dub
30. tibu
31. dup
32. tɪb
33. gɛp
34. dup
35. gob
36. tip
37. gɛpi
38. tib
39. dʊp
40. tibu
41. dub
42. gɛb
43. tɪb
44. kopu
45. dʊb
46. gop
47. tɪp
48. sobi

c. Test: J-E 2 Female

1. pack tea
2. zip tie
3. sap can
4. victim
5. chapter
6. dip key
7. septum
8. pep toe
9. ripken
10. sick time
11. nap ten
12. Hopkin
13. tip cone
14. sepker
15. optima
16. factor
17. septum
18. victim
19. ripken
20. dip key
21. optima
22. pep toe
23. factor
24. chapter
25. Hopkin
26. zip tie
27. tip cone
28. sepker
29. pack tea
30. chapter
31. sap can
32. sick time
33. nap ten
34. dip key
35. pep toe
36. victim
37. sap can
38. Hopkin
39. factor
40. septum
41. tip cone
42. optima
43. sepker
44. sick time
45. zip tie
46. ripken
47. nap ten
48. pack tea

d. Test: J-E 2 Male

1. factor
2. chapter
3. tip cone
4. sick time
5. ripken
6. nap ten
7. septum
8. Hopkin
9. sap can
10. pack tea
11. optima
12. dip key
13. pep toe
14. victim
15. zip tie
16. sepker
17. tip cone
18. factor
19. sap can
20. sick time
21. pep toe
22. Hopkin
23. dip key
24. sepker
25. optima
26. victim
27. chapter
28. zip tie
29. nap ten
30. pack tea
31. ripken
32. septum
33. pep toe
34. dip key
35. ripken
36. chapter
37. factor
38. Hopkin
39. nap ten
40. victim
41. sepker
42. optima
43. sap can
44. pack tea
45. septum
46. zip tie
47. tip cone
48. sick time

e. Test: J-K 1 Female

1.	sa.man	[saman]	26.	p'a.rɨ.ta	[p'arɨda]
2.	pa.po	[pabo]	27.	ki.hap	[kihap]
3.	p^{h}an.mæ	[p^{h}anme]	28.	o.p'a.to	[op'ado]
4.	a.p^{h}a.jo	[ap^{h}ajo]	29.	p^{h}a.næ.jo	[p^{h}anejo]
5.	p'a.ci.ta	[p'aj̃ida]	30.	sa.sip	[sasip]
6.	sa.sip	[sasip]	31.	pa.po	[pabo]
7.	ip.an	[iban]	32.	p^{h}an.mæ	[p^{h}anme]
8.	pat.a.jo	[padajo]	33.	a.p'a.jo	[ap'ajo]
9.	ma.mu.ri	[mamuri]	34.	han.mi	[hammi]
10.	a.p'a.jo	[ap'ajo]	35.	p^{h}a.næ.jo	[p^{h}aneyo]
11.	p^{h}a.næ.jo	[p^{h}anejo]	36.	su.pak.i	[subagi]
12.	ci.kap	[cigap]	37.	pat.a.jo	[padajo]
13.	su.paki	[subagi]	38.	o.p^{h}an.i	[op^{h}ani]
14.	p'a.rɨ.ta	[p'arɨda]	39.	a.p'a.yo	[ap'ajo]
15.	han.mi	[hammi]	40.	p'a.ci.ta	[p'aj̃ida]
16.	o.p^{h}an.i	[op^{h}ani]	41.	ki.hap	[kihap]
17.	ki.hap	[kihap]	42.	ip.an	[iban]
18.	o.p'a.to	[op'ado]	43.	p^{h}an.mæ	[p^{h}anme]
19.	pat.a.jo	[padajo]	44.	ci.kap	[cigap]
20.	su.pak.i	[subagi]	45.	o.p'a.to	[op'ado]
21.	ci.kap	[cigap]	46.	pa.po	[pabo]
22.	p'a.ci.ta	[p'aj̃ida]	47.	a.p^{h}a.jo	[ap^{h}ajo]
23.	a.p^{h}a.jo	[ap^{h}ajo]	48.	p'a.rɨ.ta	[p'arɨda]
24.	ip.an	[iban]	49.	sa.sip	[sasip]
25.	o.p^{h}an.i	[op^{h}ani]	50.	ma.mu.ri	[mamuri]

f. Test: J-K 1 Male

1. jo.ri	[jori]	26. ki.hap	[kihap]
2. ki.hap	[kihap]	27. a.p^{h}a.jo	[ap^{h}ajo]
3. p^{h}an.mæ	[p^{h}anme]	28. p^{h}a.næ.jo	[p^{h}anejo]
4. su.pak.i	[subagi]	29. o.p^{h}an.i	[op^{h}ani]
5. a.p^{h}a.jo	[ap^{h}ajo]	30. pat.a.jo	[padajo]
6. sa.sip	[sasip]	31. sa.sip	[sasip]
7. pat.a.jo	[padajo]	32. p^{l}a.rɨ.ta	[p^{l}arɨda]
8. o.p^{h}an.i	[op^{h}ani]	33. ci.kap	[cigap]
9. pa.po	[pabo]	34. su.pak.i	[subagi]
10. sa.sil	[sasil]	35. p^{h}an.mæ	[p^{h}anme]
11. p^{l}a.ci.ta	[p^{l}aj̃ ida]	36. sa.sil	[sasil]
12. ip.an	[iban]	37. a.p^{l}a.jo	[ap^{l}ajo]
13. p^{h}a.næ.jo	[p^{h}anejo]	38. p^{l}a.rɨ.ta	[p^{l}arɨda]
14. p^{l}a.rɨ.ta	[p^{l}arɨda]	39. o.p^{h}an.i	[op^{h}ani]
15. a.p^{l}a.jo	[ap^{l}ajo]	40. pat.a.jo	[padajo]
16. ci.kap	[cigap]	41. a.p^{h}a.jo	[ap^{h}ajo]
17. o.p^{l}a.to	[op^{l}ado]	42. ki.hap	[kihap]
18. p^{h}an.mæ	[p^{h}anme]	43. p^{l}a.ci.ta	[p^{l}aj̃ ida]
19. a.p^{l}a.jo	[ap^{l}ajo]	44. mæ.il.i	[meiri]
20. pa.po	[pabo]	45. p^{h}a.næ.jo	[p^{h}anejo]
21. ip.an	[iban]	46. ip.an	[iban]
22. p^{l}a.ci.ta	[p^{l}aj̃ ida]	47. pa.po	[pabo]
23. su.pak.i	[subagi]	48. sa.sip	[sasip]
24. ci.kap	[cigap]	49. o.p^{l}a.to	[op^{l}ado]
25. o.p^{l}a.to	[op^{l}ado]	50. mæ.il.i	[meiri]

g. Test: J-K 2 Female

1. pa.ro	[paro]	29. mip.ta	[mipt'a]
2. ap^h.sə	[aps'ə]	30. mas.po.ki	[matp'o.gi]
3. sip^h.tæ	[sipt'e]	31. ik.ta	[ikt'a]
4. sik.ku.to	[sik'udo]	32. ip.si	[ips'i]
5. kuk.po	[kukp'o]	33. ki.p'ə.sə	[kip'əsə]
6. cip.ke	[cipk'e]	34. pat.ko	[patk'o]
7. jək.sa	[jəks'a]	35. mak.tæ	[makt'e]
8. a.k'i.ta	[ak'ida]	36. ap^h.sə	[aps'ə]
9. c^{h}əs.pən	[c^{h}ətp'ən]	37. c^{h}əs.pən	[c^{h}ətp'ən]
10. mas.po.ki	[matp'o.gi]	38. ip.ko	[ipk'o]
11. mak.tæ	[makt'e]	39. kuk.po	[kukp'o]
12. ip.si	[ips'i]	40. jək.sa	[jəks'a]
13. pat.ko	[patk'o]	41. pi.nu	[pinu]
14. ik.ta	[ikt'a]	42. sip^h.tæ	[sipt'e]
15. us.ki.ta	[utk'i.da]	43. ip.si	[ips'i]
16. sik.pi	[sikp'i]	44. mak.tæ	[makt'e]
17. ip.ko	[ipk'o]	45. c^{h}əs.pən	[c^{h}ətp'ən]
18. hok.si	[hoks'i]	46. ap^h.sə	[aps'ə]
19. ki.p'ə.sə	[kip'əsə]	47. sik.pi	[sikp'i]
20. mip.ta	[mipt'a]	48. mip.ta	[mipt'a]
21. us.ki.ta	[utk'i.da]	49. pat.ko	[patk'o]
22. pi.nu	[pinu]	50. mas.po.ki	[matp'o.gi]
23. sik.pi	[sikp'i]	51. hok.si	[hoks'i]
24. jək.sa	[jəks'a]	52. ip.ko	[ipk'o]
25. sip^h.tæ	[sipt'e]	53. ik.ta	[ikt'a]
26. kuk.po	[kukp'o]	54. cip.ke	[cipk'e]
27. hok.si	[hoks'i]	55. us.ki.ta	[utk'i.da]
28. cip.ke	[cipk'e]	56. pa.p'ɨ.ke	[pap'ɨge]

h. Test: J-K 2 Male

1.	na.pˈɨ.ke	[napˈɨge]	29.	ip.si	[ipsˈi]
2.	mas.po.ki	[matpˈo.gi]	30.	a.kˈi.ta	[akˈida]
3.	ik.ta	[iktˈa]	31.	hok.si	[hoksˈi]
4.	ip.si	[ipsˈi]	32.	mip.ta	[miptˈa]
5.	pat.ko	[patkˈo]	33.	sik.pi	[sikpˈi]
6.	kuk.po	[kukpˈo]	34.	kuk.po	[kukpˈo]
7.	hok.si	[hoksˈi]	35.	pa.ro	[paro]
8.	cip.ke	[cipkˈe]	36.	jək.sa	[jəksˈa]
9.	mip.ta	[miptˈa]	37.	cʰəs.pən	[cʰətpˈən]
10.	a.kˈi.ta	[akˈida]	38.	mas.po.ki	[matpˈo.gi]
11.	mak.tæ	[maktˈe]	39.	kuk.po	[kukpˈo]
12.	apʰ.sə	[apsˈə]	40.	pat.ko	[patkˈo]
13.	cʰəs.pən	[cʰətpˈən]	41.	hok.si	[hoksˈi]
14.	ip.ko	[ipkˈo]	42.	ip.ko	[ipkˈo]
15.	us.ki.ta	[utkˈida]	43.	ik.ta	[iktˈa]
16.	sik.pi	[sikpˈi]	44.	cip.ke	[cipkˈe]
17.	jək.sa	[jəksˈa]	45.	mas.po.ki	[matpˈo.gi]
18.	ne.si	[nesi]	46.	ne.si	[nesi]
19.	sipʰ.tæ	[siptˈe]	47.	cʰəs.pən	[cʰətpˈən]
20.	ik.ta	[iktˈa]	48.	jək.sa	[jəksˈa]
21.	apʰ.sə	[apsˈə]	49.	sipʰ.tæ	[siptˈe]
22.	pat.ko	[patkˈo]	50.	ip.si	[ipsˈi]
23.	ip.ko	[ipkˈo]	51.	mak.tæ	[maktˈe]
24.	so.kæ	[soge]	52.	apʰ.sə	[aps,ə]
25.	sipʰ.tæ	[siptˈe]	53.	sik.pi	[sikpˈi]
26.	us.ki.ta	[utkˈi.da]	54.	mip.ta	[miptˈa]
27.	cip.ke	[cipkˈe]	55.	us.ki.ta	[utki.da]
28.	mak.tæ	[maktˈe]	56.	na.pˈɨ.ke	[napˈɨge]

i. Sample answer sheet: J-E 1

英語テスト１Ｆ　　出席番号　　男　女

今から英語の単語が読まれます。カタカナで聞こえたとおりに書いてください。
単語は２回ずつ読まれます。

1	24	47
2	25	48
3	26	
4	27	
5	28	
6	29	
7	30	
8	31	
9	32	
10	33	
11	34	
12	35	
13	36	
14	37	
15	38	
16	39	
17	40	
18	41	
19	42	
20	43	
21	44	
22	45	
23	46	

j. Sample answer sheet: J-E 2

英語テスト２Ｆ　　出席番号　　男　女

今から英語の単語が読まれます。聞こえたものに一番近いものにマルをつけてください。単語は番号に続いて２回ずつ読まれます。

1. パティー	パッティー	パクティー	パックティー
2. ジタイ	ジップタイ	ジッタイ	ジプタイ
3. サプキャーン	サッキャーン	サキャーン	サップキャーン
4. ビックテム	ビテム	ビッテム	ビクテム
5. チャター	チャップター	チャプター	チャッター
6. ディキー	ディッキー	ディップキー	ディプキー
7. セテム	セプテム	セップテム	セッテム
8. ペットー	ペップトー	ペプトー	ペトー
9. リプケン	リップケン	リケン	リッケン
10. シタイム	シッタイム	シックタイム	シクタイム
11. ナプテン	ナップテン	ナッテン	ナテン
12. ホプキン	ホップキン	ホキン	ホッキン
13. ティコーン	ティップコーン	ティプコーン	ティッコーン
14. セプカー	セッカー	セップカー	セカー
15. オプティマ	オップティマ	オッティマ	オティマ

16.	ファッター	ファックター	ファター	ファクター
17.	セプテム	セッテム	セップテム	セテム
18.	ビッテム	ビックテム	ビテム	ビクテム
19.	リップケン	リプケン	リッケン	リケン
20.	ディッキー	ディキー	ディプキー	ディップキー
21.	オップティマ	オッティマ	オプティマ	オティマ
22.	ペットー	ペプトー	ペトー	ペップトー
23.	ファクター	ファッター	ファックター	ファター
24.	チャプター	チャッター	チャップター	チャター
25.	ホップキン	ホプキン	ホキン	ホッキン
26.	ジタイ	ジッタイ	ジプタイ	ジップタイ
27.	ティコーン	ティップコーン	ティッコーン	ティプコーン
28.	セカー	セプカー	セップカー	セッカー
29.	パッティー	パクティー	パックティー	パティー
30.	チャッター	チャプター	チャップター	チャター
31.	サッキャーン	サップキャーン	サキャーン	サプキャーン
32.	シクタイム	シックタイム	シッタイム	シタイム
33.	ナップテン	ナッテン	ナテン	ナプテン

34.	ディップキー	ディプキー	ディッキー	ディキー
35.	ペップトー	ペットー	ペプトー	ペトー
36.	ビクテム	ビテム	ビッテム	ビックテム
37.	サップケーン	サプケーン	サッケーン	サケーン
38.	ホプキン	ホッキン	ホップキン	ホキン
39.	ファッター	ファクター	ファター	ファクター
40.	セテム	セップテム	セッテム	セプテム
41.	ティプコーン	ティッコーン	ティコーン	ティップコーン
42.	オップティマ	オティマ	オプティマ	オッティマ
43.	セッカー	セップカー	セプカー	セカー
44.	シタイム	シックタイム	シッタイム	シクタイム
45.	ジップタイ	ジタイ	ジプタイ	ジッタイ
46.	リケン	リプケン	リッケン	リップケン
47.	ナッテン	ナプテン	ナップテン	ナテン
48.	パッティー	パティー	パックティー	パクティー

k. Sample answer sheet: J-K 1

韓国語テスト１Ｍ　　出席番号　　男　女

今から韓国語の単語が読まれます。聞こえたものに一番近いものにマルをつけてください。単語は番号に続いて２回ずつ読まれます。

1. ヨリ	ヨーリ	ヨリッ	ヨリン
2. キハ	キハプ	キハッ	キハップ
3. バンメ	ッバンメ	ッパンメ	パンメ
4. スパギ	スッパギ	スバギ	スッバギ
5. アッパヨ	アッバヨ	アパヨ	アバヨ
6. サーシプ	サーシ	サーシップ	サーシッ
7. ッパダヨ	バダヨ	ッバダヨ	パダヨ
8. オバニ	オパニ	オッパニ	オッバニ
9. バーボ	ッパーボ	ッバーボ	パーボ
10. サーシル	サーシ	サシッ	サシル
11. バジダ	ッパジダ	パジダ	ッバジダ
12. イパン	イッパン	イバン	イッバン
13. バネヨ	ッバネヨ	ッパネヨ	パネヨ
14. ッパルダ	バルダ	パルダ	ッバルダ

15.	アッパヨ	アパヨ	アッバヨ	アバヨ
16.	チガプ	チガッ	チガップ	チガ
17.	オバド	オッバド	オパド	オッパド
18.	パンメ	バンメ	ッパンメ	ッバンメ
19.	アバヨ	アパヨ	アッバヨ	アッパヨ
20.	パーボ	バーボ	ッパーボ	ッバーボ
21.	イッパン	イバン	イパン	イッバン
22.	ッバジダ	ッパジダ	バジダ	パジダ
23.	スバギ	スパギ	スッパギ	スッバギ
24.	チガ	チガップ	チガプ	チガッ
25.	オッパド	オバド	オッバド	オパド
26.	キハプ	キハ	キハッ	キハップ
27.	アパヨ	アバヨ	アッパヨ	アッバヨ
28.	パネヨ	ッパネヨ	バネヨ	ッバネヨ
29.	オパニ	オッパニ	オバニ	オッバニ
30.	パダヨ	ッパダヨ	ッバダヨ	バダヨ
31.	サーシッ	サーシプ	サーシ	サーシップ
32.	ッパルダ	ッバルダ	バルダ	パルダ

33.	チガップ	チガ	チガッ	チガプ
34.	スパギ	スッパギ	スッバギ	スバギ
35.	バンメ	ッパンメ	パンメ	ッバンメ
36.	サーシ	サーシッ	サーシル	サシル
37.	アッバヨ	アッパヨ	アバヨ	アパヨ
38.	パルダ	ッパルダ	バルダ	ッバルダ
39.	オッパニ	オッバニ	オパニ	オバニ
40.	バダヨ	ッパダヨ	パダヨ	ッバダヨ
41.	アパヨ	アバヨ	アッパヨ	アッバヨ
42.	キハプ	キハップ	キハ	キハッ
43.	パジダ	バジダ	ッパジダ	ッバジダ
44.	メリッ	メイリ	メリ	メリー
45.	ッバネヨ	ッパネヨ	バネヨ	パネヨ
46.	イパン	イッパン	イバン	イッバン
47.	ッパーボ	バーボ	パーボ	ッパーボ
48.	サーシ	サーシップ	サーシッ	サーシプ
49.	オパド	オッバド	オバド	オッパド
50.	メイリ	メリー	メリッ	メリ

l. Sample answer sheet: J-K 2

韓国語テスト２Ｍ　　出席番号　　男　女
今から韓国語の単語が読まれます。聞こえたものに一番近いものにマルをつけてください。単語は番号に続いて２回ずつ読まれます。

1. ナプゲ	ナブゲ	ナップゲ	ナップゲ
2. マッポギ	マットポギ	マトポギ	マポギ
3. イックタ	イクタ	イッタ	イタ
4. イッシ	イップシ	イシ	イプシ
5. パコ	パッコ	パットコ	パトコ
6. ククボ	クックボ	クッボ	クボ
7. ホッシ	ホクシ	ホシ	ホックシ
8. チッケ	チケ	チプケ	チップケ
9. ミタ	ミプタ	ミップタ	ミッタ
10. アキダ	アッキダ	アーキダ	アギダ
11. マクテ	マックテ	マッテ	マテ
12. アソ	アップソ	アッソ	アプソ
13. チョポン	チョットポン	チョトポン	チョッポン
14. イッコ	イコ	イップコ	イプコ
15. ウキダ	ウットキダ	ウッキダ	ウトキダ

16.	シックピ	シクピ	シピ	シッピ
17.	ヨッサ	ヨクサ	ヨックサ	ヨサ
18.	ネッシー	ネシ	ネシッ	ネーシ
19.	シプテ	シテ	シッテ	シップテ
20.	イッタ	イックタ	イクタ	イタ
21.	アソ	アッソ	アップソ	アプソ
22.	パットコ	パッコ	パコ	パトコ
23.	イップコ	イプコ	イコ	イッコ
24.	ソッゲ	ソゲ	ソーゲ	ソゲッ
25.	シッテ	シプテ	シップテ	シテ
26.	ウトキダ	ウットキダ	ウキダ	ウッキダ
27.	チケ	チップケ	チッケ	チプケ
28.	マクテ	マックテ	マテ	マッテ
29.	イシ	イッシ	イプシ	イップシ
30.	アッキダ	アギダ	アキダ	アッギダ
31.	ホシ	ホクシ	ホックシ	ホッシ
32.	ミプタ	ミタ	ミップタ	ミッタ
33.	シッピ	シピ	シックピ	シクピ

34.	ククボ	クッボ	クックボ	クボ
35.	パーロ	パロッ	パロ	パロー
36.	ヨサ	ヨクサ	ヨッサ	ヨックサ
37.	チョトポン	チョポン	チョッポン	チョットポン
38.	マポギ	マットポギ	マトポギ	マッポギ
39.	クボ	クッボ	クックボ	ククボ
40.	パトコ	パットコ	パッコ	パコ
41.	ホシ	ホクシ	ホックシ	ホッシ
42.	イッコ	イップコ	イプコ	イコ
43.	イクタ	イックタ	イタ	イッタ
44.	チップケ	チケ	チッケ	チプケ
45.	マッポギ	マポギ	マットポギ	マトポギ
46.	ネシ	ネーシ	ネッシー	ネシッ
47.	チョポン	チョットポン	チョトポン	チョッポン
48.	ヨックサ	ヨサ	ヨッサ	ヨクサ
49.	シッテ	シプテ	シップテ	シテ
50.	イッシ	イップシ	イシ	イプシ
51.	マクテ	マッテ	マックテ	マテ

52.	アソ	アプソ	アッソ	アップソ
53.	シッピ	シクピ	シピ	シックピ
54.	ミップタ	ミタ	ミプタ	ミッタ
55.	ウッキダ	ウットキダ	ウキダ	ウトキダ
56.	ナプゲ	ナップゲ	ナッブゲ	ナブゲ

Appendix C

Japanese *katakana* (above) and *hiragana* (below) writing

	/a/	/i/	/u/	/e/	/o/	Ø
Ø	アあ	イい	ウう	エえ	オお	
/k/	カか	キき	クく	ケけ	コこ	ッっ
/s/	サさ	シし	スす	セせ	ソそ	ッっ
/t/	タた	チち	ツつ	テて	トと	ッっ
/n/	ナな	ニに	ヌぬ	ネね	ノの	
/h/	ハは	ヒひ	フふ	ヘへ	ホほ	
/m/	マま	ミみ	ムむ	メめ	モも	
/j/	ヤや		ユゆ		ヨよ	
/r/	ラら	リり	ルる	レれ	ロろ	
/w/	ワわ				ヲを	
/N/						ンん
/g/	ガが	ギぎ	グぐ	ゲげ	ゴご	ッっ
/z/	ザざ	ジじ	ズず	ゼぜ	ゾぞ	ッっ
/d/	ダだ	ヂぢ	ヅづ	デで	ドど	ッっ
/b/	バば	ビび	ブぶ	ベべ	ボぼ	ッっ
/p/	パぱ	ピぴ	プぷ	ペぺ	ポぽ	ッっ

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