Australian English Back Vowel Perception by Korean and Japanese Learners of English

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This paper deals with perception of Australian English back vowels by Korean and Japanese learners of English. The results of the experiment revealed that although language-specific factors played a main role, language-universal factors, in particular with regard to the Australian vowel /ɒ/, also influenced the perception of L2 learners. Three models, the CAH, Flege's model and Best's model, did not provide a perfect prediction on the perception of Australian English back vowels by Korean and Japanese listeners.

1. Introduction

Recent models of inter-language vowel perception have modified the traditional Contrastive Analysis Hypothesis (CAH) model that listeners' perceptions of foreign speech sounds are strongly determined by the phonemic contrasts of their native language. These models seek to improve the predictive power of the CAH, by specifying more precisely the influence of prior phonological learning and how it interacts with the phonetic basis of vowel discrimination.

Flege (1987a, b) refined the CAH with the notion of a Perceptual Equivalence Classification to account for the purported effect that some non-native vowels are more readily accommodated than others by second language learners. Certain L2 sounds are sufficiently phonetically different from their nearest L1 neighbours to be perceived as "new" or "foreign" whereas others are sufficiently close to L1 targets to be classified as "similar", though not identical to some L1 phonemic target. Flege maintains that sounds which obtain a "new/foreign" classification will eventually be acquired in production and perception by second language learners, whereas

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those classified as "similar" to L2 targets will not improve with exposure to L2. Thus, English learners will hear French /y/ as "foreign" and eventually acquire its pronunciation, but French /u/, which they will hear as "similar" to English /u/, will not undergo accommodation to L2.

Although, Flege (1987a, b) claims support for his theory's predictions, close consideration of both the acoustic and perceptual findings [1] show a complex pattern of changes, perhaps more influenced by French pronunciation teaching strategies than the initial perceptual classifications of the language learners. Contrary to the prediction of progressive accommodation to the native L2 target, the group of inexperienced English speakers produced tokens of French /y/ that were as readily identified by native listeners as those of the experienced group. Nor did the second formant F2 measurements for /y/ differ significantly from the native F2 target, for either group of non-native speakers. On the other hand, and also counter to predictions, learners' productions of French /u/ did appear to undergo significant perceptual and acoustic accommodation with greater L2 exposure.

Bohn & Flege (1992) examined German learners of English productions of the English front vowels /i, I, e, æ/, comparing them with their "similar" native targets /i, I, e/. It was predicted that the "new" vowel, English /æ/, would show greater accommodation than the other three. Acoustic comparisons (formant measurements) on the productions of experienced and inexperienced learners suggested that there was greater accommodation for /æ/, as predicted. However, intelligibility ratings by native English listeners did not support the acoustic findings. The evidence for Flege's Equivalence Classificaiton Hypothesis is, at best, mixed.

Flege (1995) accommodated all the criticism and other opinions on his original Speech Learning Model. He set up a modified Speech Learning Model by establishing 4 Postulates and 7 Hypotheses. This was the outcome of accommodation of all the criticism of his original Speech Learning Model. Even though the revised Speech Learning Model could defend his original theory from the challenging opinions, this also seemed to possess a possibility of conflict among the Postulates and Hypotheses.

Best (1993, 1994) has proposed a model in which the perception of foreign sounds is explained in terms of assimilation to native categories, but which also incorporates a distinction between phonetic and non-phonetic levels of

[1] The author reanalyzed Flege's acoustic and perceptual findings during reading his papers.

processing, by postulating that relationships of phonetic similarity have gestural feature basis, whereas perception of non-speech sounds may be accounted for solely in terms of psychoacoustic dimensions.

Best (1993, 1994) based the classification of the perception of individual non-native phones on the gestural properties of the native phonology, and established a model for predicting differences in how non-native contrasts may be assimilated to native phonological contrasts, which should result in differences in discriminability for diverse non-native contrasts (see Table 1).

If two contrasting L2 phones are each perceived as an exemplar belonging to different L1 phone categories, then discrimination should be excellent. Such a pattern can be called a Two Category (TC) assimilation. If both phones are assimilated to the same native phoneme category but differ in the goodness of fit to the category (e.g., one is a 'good' exemplar and the other is deviant), this assimilation pattern is called as a Category Goodness (CG) pattern, where discrimination will be good but lower than for a Two-Category assimilation.

Table 1. Assimilation Effects on Discrimination of Non-Native Contrasts

Contrast Assimilation	Discrimination Effect
Two-Category (TC)	**excellent discrimination** each non-native phone assimilated to a different native phoneme category
Category-Goodness (CG)	**good to moderate discrimination** both non-native phones assimilated to the same native category, but differ in discrepancy from native phone
Single-Category (SC)	**poor discrimination** both non-native phones assimilated to the same native category, but are equally distant from native phone
Uncategorisable (UNC)	**poor to moderate discrimination** both non-native phones fall within uncommitted phonetic space
Non-Assimilable (NA)	**good to moderate discrimination** both non-native phones fall outside the bounds of native phonetic space and are heard as non-speech

Best (1993: 296)

In some cases, both non-native members could be perceived as equally deviant (or equally good) exemplars of a Single Category (SC) in the native phonology, and should thereby result in poor discrimination. Uncategorisable (UNC) contrasts, where the contrasting non-native phones both fall in uncommitted phonetic space, are also expected to be poorly discriminated, but somewhat better than SC contrasts from time to time. That is, discriminability will vary with degree of discrepancy between the two L2 phones in uncommitted phonetic space, but should be biased toward low performance. If both the contrasting L2 phones fall outside of native phonetic space, they will be classified as Non Assimilable (NA) to the native phonology and will be heard as nonspeech sounds. This pattern, as in the CG one, is expected to have good to moderate discrimination dependent upon the magnitude of auditory differences between the phones.

Best's research work has placed the emphasis on consonant contrasts, rather than vowel contrasts (Best et al., 1988; Best & Strange, 1992; Best, 1990, 1993, 1994). Best & Strange (1992) experimented with Japanese listeners' performance on synthetic stimuli series for three English glide consonant contrasts. The result was consistent with assimilation predictions based on phonetic gestural similarities and discrepancies in relation to Japanese phonological categories and contrasts. /w-j/ is a phonemic distinction in both Japanese and English (TC contrast for Japanese listeners). The /w-r/ distinction is phonemic in English but not in Japanese (phonetic), where /w/ is similar to Japanese /w/ but English /r/ is less similar to Japanese /w/ (CG contrast for Japanese listeners). The English /l-r/ distinction is clearly phonemic in English, but both members of /l-r/ are discrepant from Japanese /r/ (SC or UNC contrast for Japanese listeners). The discrimination of Japanese listeners over the three contrasts followed the predicted order: /w-j/ > /w-r/ > /r-l/.

The first application of Best's model to non-native vowel contrasts was Polka (1995)'s study. In her study, perception of natural productions of two German vowel contrasts, /y/ vs /u/ and /Y/ vs /U/, was examined in monolingual English speaking adults. Most of the subjects failed to attain 'nativelike' discrimination accuracy for the lax vowel pair, /U/ vs /Y/, but they achieved nativelike performance in discriminating the tense vowel pair /u/ vs /y/. Overall, English adults' performance can be classified as a Category Goodness (CG) difference assimilation and the difference in category goodness was more prominent for the tense vowel pair than for the lax vowel pair.

Whereas Flege's model deals only with the case where one vowel falls within the boundaries of an L1 target as opposed to one that does not, Best's model generates predictions of relative perceptual discriminability on a range of L1 assimilation possibilities. Discrimination of two non-native sounds will be maximised where each is assimilated to a different native phoneme category (a two-category contrast). Where both sounds are assimilated to a single phonemic category, but where one sound constitutes a closer phonetic match to that category than the other, moderate discriminability is predicted. However, where two foreign sounds are equally good candidates for a single category, discrimination will be poor. Uncategorisable contrasts in which neither of the sounds can be readily assimilated to a native category will also be poorly discriminated.

Flege & Best's models follow the CAH in postulating that the effects of phonological experience upon vowel perception follow from perceptual categorisation of speech stimuli. However, these two models differ in the viewpoint of L2 leareners' perceptual criterion on L2 sounds. While Best insists that the basis for the judgement of category membership and goodness of match of L2 sounds to a native prototype is assumed to be the perceived gestural content of discrimination by L1 listeners, Flege, even though not clearly stated by himself, seemed to select the acoustic discriminability of L2 sounds by using F1-F2 plane.

Park & Ingram (1995a), Ingram & Park (1996, 1997) tried to figure out whose model is more appropriate to predict the L2 learners' L2 vowel perception by measuring Korean and Japanese learners' Australian English (AE) front vowel perception and production. Both models yield reasonably accurate predictions on Korean and Japanese learners' AE front vowel perception and production. However, the outcome of the experiment did not show clear difference between the two models since only frontness and length features were engaged with AE front vowels.

This paper once again tries to elucidate the identical question of which model is more appropriate and accurate for predicting Korean and Japanese learners' L2 vowel perception by looking at L2 learners' Australian English back vowel perception. As one may expect, the experiment result might yield discrepant outcome on the predictions of the two models because AE back vowels possess an extra feature, roundedness, in addition to frontness, vowel height and length which were the basic features of AE front vowels. For instance, AE /a:/ is distinguishable from AE /ɒ/ in length, tongue frontness and lip rounding features. Thus, the outcome of this experiment

may elicit the differing points of the two models.

2. Korean, Australian and Japanese Back Vowels

2.1. Phonetic Comparisons

In the central/back areas of the vowel quadrilateral, AE has seven vowels (/ʉː, ɜː, a, aː, U, ɔː, ɒ/), Korean has five (six)[2] (/ɯ, a, u, o, ʌ ([ʌ, əː])/) and Japanese three (/u, o, a/). The distribution of respective central/back vowels in the three languages is presented in Figure 1.

The Australian English vowel /ʉː/ occupies the central area of the vowel quadrilateral. This vowel is distinct from the high back Korean and Japanese vowel /u/. However, AE /ʉː/ falls close to Korean /ɯ/ on the vowel quadrilateral.

A back rounded short vowel /U/ in AE is located further back in the quadrilateral compared to the AE long vowel /ʉː/. The distribution area of the AE vowel /U/ is almost identical to that of the Korean vowel /u/ (refer to 2.2. acoustic comparisons section). The Japanese vowel /u/, however, does not occupy a similar area to that of the AE vowel /U/. Rather, Japanese /u/ is located approximately between the AE vowels /ʉː/ and /U/. Although the mid central vowel /ɜː/ in AE has no corresponding vowel in either the Korean or the Japanese vowel systems, the distribution of this vowel is nevertheless quite close to that of the Korean vowel /ʌ/([əː])[3] and thus Korean listeners are unlikely to face a major difficulty in identifying the AE mid central vowel /ɜː/. However, as the Japanese vowel inventory does not possess any vowel corresponding or close to the AE vowel /ɜː/, Japanese listeners may, at least for the first stage of facing this vowel, feel some difficulty since /ɜː/ in AE would be a completely novel vowel to them.

According to Clark & Yallop (1990: 69), the two AE vowels /a/ and /aː/ share an almost identical distribution area in the quadrilateral space. Therefore, distinguishing these two vowels by virtue of quality would be

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[2] Even though the vowels [əː] and [ʌ] possess quite different qualities, since they belong to one vocalic phoneme /ʌ/ in Korean phonology, the author will deal with these two allophones as a phoneme /ʌ/. However, from time to time, if necessary, the author will treat these two allophones separately.

[3] In Standard Korean, the Korean vowel /ʌ/(ㅓ) has two different acoustic values depending upon the length difference. A long version of this vowel is realised at a more central and higher area than is a short version of this vowel (Lee et al., 1984: 50).

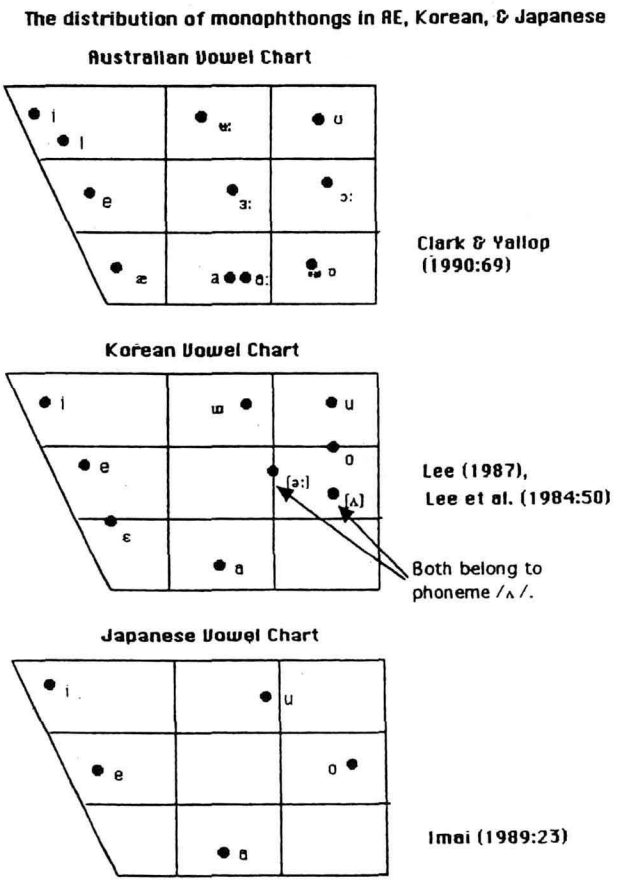

Figure 1. The Distribution of Monophthongs in AE, Korean and Japanese Based on the Phonetic and Auditory Judgement of the Respective Authors; Length Factor Not Included

fairly difficult. However, as they differ remarkably in their length, the length difference of these two vowels would be a clear cue for their distinction. Korean and Japanese possess a counterpart, /a/, to the AE vowel /a:/ and possibly /a/ in their vowel inventories. However, considering that the status of the length distinction is clearer in Japanese than in Korean phonology, the superiority of Japanese listeners to Koreans in distinguishing the AE vowel /a:/ from /a/ might be predicted.

The AE mid back vowel /ɔ:/ would be equivocal for Korean listeners to identify in terms of vowel quality, since two candidates (the Korean vowels

/o/ and /ʌ/ ([ʌ])), which can be the counterpart of the AE vowel /ɔ:/, exist above and below the distribution area of the AE vowel /ɔ:/ at the same distance in the vowel quadrilateral. On the other hand, the Japanese vowel system has only one candidate, /o/, which can be a counterpart to the AE vowel /ɔ:/.

Finally, the low back vowel /ɒ/ in AE will be idiosyncratic for both Korean and Japanese listeners. The vowel quadrilaterals of Korean and Japanese in Figure 1 do not show any vowel corresponding to the AE vowel /ɒ/.

2.2. Acoustic Comparisons

As Keating & Huffman (1984: 194) claim, F1 values correspond in a relatively straightforward manner to vowel height differences, while F2 values correspond to the combined effect of differences in vowel backness and vowel roundedness. This means that the acoustic measurement of back vowels, which normally possess [+back], [+round] features, would produce a different output from the traditional articulatory comparison, especially on the F2 axis.

In the case of the front vowels amongst the three languages in question there would be no discrepancy of vowel distribution between both in the phonetic vowel quadrilateral space (vowel height, vowel backness) and in the F1-F2 space. Because no front AE vowel possesses the lip-rounding feature.

However, with regard to back vowels, the situation is quite different. For instance, the more centralised position of the Japanese unrounded back vowel /u/ in F1-F2 space can be interpreted in two different ways: firstly, the vowel's lack of roundedness made it move to a more centralised position; or, secondly, the actual front position of the tongue for this vowel caused this vowel's centralised position. It is hard, however, to judge which factor played a crucial role in the centralisation of Japanese /u/.

In Figure 2, this problem clearly appears. The Korean vowel /ʌ/ and the AE vowel /ɒ/ occupy an almost identical place. According to this F1-F2 space graph, these two vowels must have nearly identical vowel quality. However, as will be shown later, Korean listeners did not identify the AE vowel /ɒ/ as the Korean vowel /ʌ/ at all. These two vowels have quite different features: AE /ɒ/ is a rounded vowel but Korean /ʌ/ is unrounded; Korean /ʌ/ arises at a more retracted point than does the AE vowel /ɒ/.

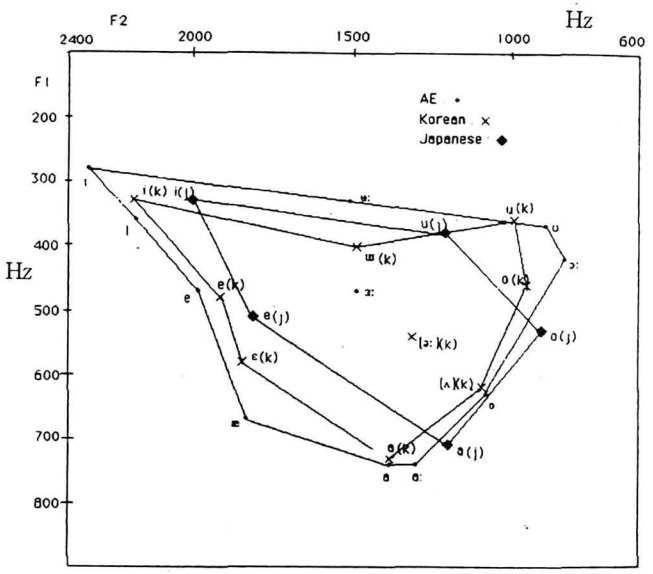

Figure 2. The Distribution of Korean, Japanese and AE Vowels in an F1-F2 Acoustic Space (Korean: Yang 1990; Japanese: Keating & Huffman 1984; AE: Bernard 1989); Length Factor Not Included.

Thus, the overlap in distribution of the two vowels as shown in Fig. 2 might have occurred for different reasons: while the backness of Korean /ʌ/ lowered its value of F2, the AE vowel /ɒ/'s low value of F2 was related to its roundedness.

With this result, it can be argued that using acoustic comparisons for the prediction of L2 learners' L2 vowel acquisition would be dangerous. Thus, in the following section, all predictions will be established on the traditional phonetic frontness-vowel height comparison as well as consideration of roundedness of AE back vowels. Therefore, the reader should refer to Figure 1 rather than Figure 2.

2.3. Length Comparisons

Length is clearly a phonological property of Japanese word forms. This means that by length difference, one can discriminate similarly pronounced words (see Table 2). Also, the Japanese orthographic system clearly supports this phonological function of length discrimination in both Hira Gana and

Kata Kana orthography[4]. In Hira Gana, for native vocabulary, Japanese use an extra Kana letter for representing long vowels. On the other hand, in Kata Kana, for transcribing loan words mainly from English, they use hyphens for long vowels. In Japanese long and short vowel distinction in orthography is fairly important in that it has a meaning-distinctive function.

Length in Korean, however, is more equivocal as a phonological feature. Traditionally, Korean phonology put emphasis on the distinction between long and short vowels for making clear meaning distinction between homonyms. Lee, H-B. (1989a) stated that length in Korean is phonologically distinctive, referring to it a 'suprasegmental phoneme', and cited a number of minimal pairs. Regardless of this traditional phonological function of length difference in Korean, this length distinction seems now to be disappearing. Of many candidates causing weakening of length distinction amongst Korean speakers, lack of apparatus representing vowel length distinction in its orthographic system seems to be crucial[5](see Table 2).

In addition, some linguists pointed out loss of the vowel length distinction in Korean phonology. Lee, H-B. (1989b: 12-14) reported that "The most prominent confusion in Korean phonology is the mispronunciation of long vowels as short vowels ··· This mispronunciation directly influences the distinction of meaning of homonyms such as '사과 /sagwa/ apple' and '사과 /sa:gwa/ apology'." Huh, W. (1983: 263) enumerated several efforts of Korean speakers to avoid the confusion between homonyms along with losing vowel length distinction; 1) using context or situation of utterances, 2) putting modifying words in front of homonyms. These statements may indicate that length factor has already lost its phonological status in Korean phonology.

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[4] Hira Gana is mainly used for representing normal Japanese words while Kata Kana is used for loan words, and sometimes emphasis.

[5] In the dictionary or some poems, hyphens, colons, or extra vowel-only syllables for representing long vowels are found. However, the usage of extra symbols for long vowels is not ordinary but special case for convenience of reader or emphasis of word meaning in poems.

Table 2. Length Differentiation in Korean and Japanese Orthographic Systems

Korean		Japanese		
밤 [pam] (short) night	Hira	おじいさん	[oziːsaN]	grandfather
밤 [pam] (long) chestnut[6]	Gana	おじさん	[ozisaN]	uncle
로얄 [rojal] royal	Kata	ロニヤル	[roːjaru]	royal
리시버 [riʃibɜ] receiver	Kana	レシニバニ	[resiːbaː]	receiver

Australian English vowel system possesses inherent distinction in length as well as quality for respective vowels. Therefore while Korean people may face difficulties to correctly perceive the length of AE vowels, Japanese listeners may feel less severe difficulty for distinguishing the length of AE vowels than Korean listeners.

As a conclusion, Japanese people appear to be more sensitive than Korean people in distinguishing length differences of AE vowels.

3. Prediction

In this section, predictions of perception of AE back vowels by Korean and Japanese speakers of English are introduced based on three different models, that is, traditional view, Flege's model and Best's model.

3.1. Predicted L1 Transfer Effects (Prediction based on Contrastive Analysis Hypothesis (CAH))

Since the importance of the length feature as well as the quality of vowels was demonstrated in the AE front/central vowel perception and production by Korean and Japanese learners of English (Park, 1997; Park & Ingram, 1995a; Ingram & Park, 1996, 1997), whenever available both length and quality factors are taken into to account for the prediction in this section (see Table 3).

[6] The older generation of Korean speakers (in their 50s or older) can distinguish the length difference of '밤' (night) and '밤' (chesnut).

Table 3. Prediction based on Traditional View

1) Without consideration of lip-rounding feature

	AE vowels						
	ʉː	U	ɜː	aː	a	ɔː	ɒ
Korean	easy	easy	easy	easy	diffi.	diffi.	diffi.
Japanese	diffi.	diffi.	diffi.	easy	diffi.	easy	diffi.
Japanese (inc. length)	rel.dif.	rel.dif.			easy		

2) With consideration of lip-rounding feature

	AE vowels						
	ʉː	U	ɜː	aː	a	ɔː	ɒ
Korean	diffi.	easy	easy	easy	diffi.	easy	diffi.
Japanese	diffi.	diffi.	diffi.	easy	diffi.	easy	diffi.
Japanese (inc. length)	rel.dif.	rel.dif.			easy		

First of all, should lip-rounding feature do an important role, the AE vowel /ʉː/ will cause some problem for Korean listeners to perceive, since, although AE /ʉː/ and Korean /u/ share the feature of lip-rounding, the location of the AE vowel /ʉː/ in the vowel quadrilateral is far removed from the Korean vowel /u/, occurring systematically in the Korean vowel system. Thus, following the definition of the theory, since the AE vowel /ʉː/ is not a phone which occurs systematically on the phonetic surface of L1, Koreans will face considerable difficulty in the acquisition of this vowel. However, if lip-rounding is not an important feature, the existence of Korean /ɯ/, which is situated in the vicinity of the AE vowel /ʉː/, would put Koreans in a better position to identify the AE vowel /ʉː/.

On the other hand, the AE vowel /U/ possesses a nearly identical territory to that of the Korean back rounded vowel /u/. Thus, Korean listeners will regard the AE vowel /U/ as their L1 vowel /u/ and will not face any difficulty in perceiving the AE vowel /U/.

Both /ʉː/ and /U/ vowels in AE are equivocal to Japanese listeners in terms of vowel quality. On the vowel quadrilaterals in Figure 1, the AE vowels /ʉː/ and /U/ construct a triangle with the Japanese vowel /u/; that is to say, the two AE vowels are almost equally distant from the Japanese vowel /u/. This situation will create a fairly difficult environment for Japanese listeners to perceive the two AE vowels /ʉː/ and /U/. Considering that Japanese people can distinguish long/short difference of the phones

based on their L1 phonology, this point would positively affect their identification of the AE vowels /ʉ:/ and /U/.

The AE vowel /ɜ:/ is probably an easy acquisition target for Korean learners of English. Although the distribution areas of AE /ɜ:/ and Korean /ʌ/([ə:]) do not completely overlap, still Koreans would identify the AE vowel /ɜ:/ as their L1 vowel /ʌ/([ə:]) since no competing L1 vowel exists around the AE vowel [ɜ:] site.

To Japanese listeners, /ɜ:/ in AE would be a difficult vowel to acquire, since no vowel matching AE /ɜ:/ is found in the Japanese vowel system. Thus, the AE vowel /ɜ:/ would provide contrastive prediction of acquistion for the Korean and Japanese listeners of English.

A low central vowel /a:/ in AE will be acquired with ease by Korean and Japanese learners of English as predicted and as shown in Ingram & Park (1996, 1997), Park & Ingram (1995a) and Park (1997). On the contrary, however, the AE low central short vowel /a/ would be difficult to identify for Korean listeners. As in the case of the AE vowels /i:/ and /ɪ/, the AE vowel /a/ has a remarkably shorter length and slightly different vowel quality than the AE vowel /a:/. The Koreans, who have an equivocal phonological status of length feature in their L1, would face some difficulty in perceiving the AE vowel /a/ because there might be their confusion of the length distinction between the AE vowels /a/ and /a:/ and length of the Korean vowel /a/ might be close to AE vowel /a:/[7], even though the quality of the AE vowel /a/ would not trigger any serious difficulty to Korean listeners[8].

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[7] However, an actual measurement of the length of the Korean vowel /a/ and AE vowel /a/ must be done to confirm this assumption.

[8] One might claim that the quite similar vowel qualities of the two AE vowels /a/ and /a:/ will cause great difficulties for Korean and Japanese learners of English to distinguish them. That is to say, Korean and Japanese listeners will experience the same level of difficulty in identifying both vowels. However, this claim seems unlikely. Firstly, the AE vowel /a:/ as well as another AE vowel /i:/ is a point vowel which is the articulatory and acoustic extreme, and, as K. N. Stevens (1981) claims, is special in the sense that it appears to resist perceptual change. Secondly, the point vowels are used universally in the world's languages (Jakobson, Fant & Halle 1969). The existence of a point vowel /a/ in the Korean and the Japanese vowel inventories supports this claim. Thus, the possibility is that, when Korean and Japanese listeners listen to the AE vowel /a:/, they will identify this vowel as their vowel /a/ rather than confuse this vowel with the AE vowel /a/. On the other hand, when they face the AE vowel /a/, they may misidentify this vowel as their L1 vowel /a/. The perception result of the two AE vowels, /i:/ and /ɪ/, in Park &

If we did not consider the length factor of the AE short vowel /a/, Japanese listeners might be placed in a similar situation to that of Korean listeners. However, when the length factor is taken into account, the prediction on Japanese listeners' identification of the AE vowel /a/ changes. Japanese listeners would find it relatively easy to distinguish the AE vowel /a/ from its pair /aː/ because of the clearer status of the length factor in their L1.

The AE mid back rounded vowel /ɔː/ possesses an equivocal position in vowel space from the point of view of the Korean vowel inventory. As the case of the relation amongst the AE vowels /ʉː/ and /U/ and the Japanese vowel /u/, the AE vowel /ɔː/ constitutes a triangle along with the Korean vowels /o/ and /ʌ/([ʌ]). Without taking the lip-rounding feature into account, two possibilities for the perception of the AE vowel /ɔː/ arise. The first is that Korean listeners will categorise the AE vowel /ɔː/ as their L1 vowel /o/. In this case, Korean listeners will not have any serious problem in identifying the AE vowel /ɔː/. The second possibility is that they regard the AE vowel /ɔː/ as their L1 vowel /ʌ/([ʌ]). If the second possibility is the case, the Koreans would misperceive the AE vowel /ɔː/ as another AE vowel /ɜː/ since the AE vowel /ɜː/ is a counterpart of the Korean vowel /ʌ/ ([əː]). (Even though the qualities of the two Korean vowels [ʌ] and [əː] are remarkably different at the phonetic level, the Koreans will regard these two vowels as the vowel /ʌ/ at the phonemic level since both [ʌ] and [əː] are allophones of a single phoneme /ʌ/ in the Korean vowel system.) This environment is likely to make the identification of the AE vowel /ɔː/ difficult for Koreans. However, if we consider the lip-rounding feature of the AE vowel /ɔː/, the former prediction would be more likely.

On the other hand, the identification of the AE vowel /ɔː/ would be easy for Japanese listeners. The distribution area of the AE vowel /ɔː/ approximately accords with that of the Japanese vowel /o/. That is to say, the Japanese vowel /o/ can be a counterpart of the AE vowel /ɔː/. The existence of a counterpart over AE /ɔː/ in L1 ensures the easy identification of the AE vowel /ɔː/ by Japanese learners of English.

Finally, the low back slightly rounded short AE vowel /ɒ/ does not have any counterpart in the Korean and the Japanese vowel systems. The theory predicts that this AE vowel would provide difficulties for Korean and Japanese listeners since the AE vowel /ɒ/ is a completely novel vowel for them.

Ingram (1995a), Ingram & Park (1996, 1997) strongly supports the author's assertion.

3.2. Flege's Model

Firstly, let us consider lip-rounding as an important feature. With this assumption, the central long vowel /ʉː/ in AE is distant from the Korean /u/ in the vowel quadrilateral space. The enormous gap in terms of vowel quality between the AE vowel /ʉː/ and the Korean vowel /u/ will lead to the classification of the AE vowel /ʉː/ as a 'new' vowel by Korean listeners (see Fig. 1 and Table 4). If lip-rounding is not an important feature, the AE vowel /ʉː/ will be classified as a 'similar' vowel due to the existence of a unrounded central high vowel /ɯ/ in Korean, which is situated in the vicinity of the AE rounded central high vowel /ʉː/. On the other hand, the AE vowel /U/ is located at the high back area in the vowel quadrilateral space, the distribution area being quite close to that of the Korean vowel /u/. Therefore, the AE vowel /U/ will be classified as a 'similar' vowel by Korean learners of English.

Table 4. Prediction Based on Flege's Model: Prediction of the Classification of the Back Vowels by L2 Learners

1) Without consideration of lip-rounding feature

	AE vowels						
	ʉː	U	ɜː	ɑː	a	ɔː	ɒ
Korean	similar	similar	similar	similar	similar	similar	new
Korean (inc. length)	similar	similar	similar	similar	new	similar	new
Japanese	similar	similar	new	similar	similar	similar	new
Japanese (inc. length)	similar	similar	new	similar	similar	similar	new

2) With consideration of lip-rounding feature

	AE vowels						
	ʉː	U	ɜː	ɑː	a	ɔː	ɒ
Korean	new	similar	similar	similar	similar	similar	new
Korean (inc. length)	new	similar	similar	similar	new	similar	new
Japanese	similar	similar	new	similar	similar	similar	new
Japanese (inc. length)	similar	similar	new	similar	similar	similar	new

On the contrary, the two AE vowels /ʉː/ and /U/ might be classified as 'similar' vowels to Japaense listeners. The distribution area of the Japanese

vowel /u/ is located between the space of the AE vowels /ʉː/ and /U/. Although the Japanese vowel /u/ does not possess the quality which is quite similar to either the AE vowel /ʉː/ or /U/, but it is not distant from the distribution areas of both of them. Consequently, Japanese /u/[9] seems to be treated as a 'similar' vowel to both AE vowels /ʉː/ and /U/ by Japanese listeners.

The mid central vowel /ɜː/ in AE and the Korean vowel /ʌ/ ([əː]) are not pronounced at the exactly same point of the oral cavity. However, the absence of any other Korean vowels close to the distribution area of the AE vowel /ɜː/ seems to make the Korean vowel /ʌ/ ([əː]) as a 'similar' vowel to the AE vowel /ɜː/.

Compared to the existence of the vowel [əː] in the Korean vowel system, the Japanese vowel system does not have any counterpart to the AE vowel /ɜː/. This structure of the Japanese vowel system naturally encourages Japanese listeners to categorise the AE vowel /ɜː/ as a 'new' vowel.

In the AE vowel system, central vowels /aː/ and /a/ occupy a nearly identical space in the vowel quadrilateral so that both vowels have a counterpart /a/ in the Korean and the Japanese vowel inventories. This situation drives Korean and Japanese listeners to categorise both AE vowels /aː/ and /a/ as 'similar' vowels compared to their L1 vowel /a/. However, if length feature is considered, Korean listeners would perceive AE /a/ as a new vowel due to the remarkably short length of AE /a/ compared with the length of Korean /a/. In the case of Japanese listeners, as they have long /a/ and short /a/ in their L1, AE /a/ would still be perceived as a 'similar' vowel.

A mid back vowel /ɔː/ is situated at the mid point of the Korean vowels /o/ and /ʌ/ ([ʌ]) in the vowel quadrilateral. Therefore, the vowel /ɔː/ in AE might be perceived as either the Korean vowel /o/ or /ʌ/ ([ʌ])[10]. However,

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[9] Korean central unrounded high vowel /ɯ/ differs Japanese back rounded vowel /u/. Even though some scholars use the symbol /ɯ/ for Japanese /u/ to represent centralisation and unroundedness of this vowel, this vowel is still located at more back area with slight roundedness (or compression) in careful speech (Vance 1987: 11) than the Korean vowel /ɯ/ (See Figures 1 & 2). As a native speaker of Korean, the author can clearly feel the articulatory and acoustic difference between these two vowels. Korean /ɯ/ is more centralised with no roundedness while Japanese /u/ is located at more back area with slight roundedness.

[10] Considering lip-rounding is an influential factor in Korean phonology such as the distinction of the Korean vowels /ɯ/ and /u/ (see Best's model Section), it is more

whether the AE vowel /ɔ:/ is identified as /o/ or /ʌ/, this one will eventually be classified as a 'similar' vowel to Korean learners of English, since Korean listeners will not regard the AE vowel /ɔ:/ as a totally novel vowel.

In the Japanese vowel system, one clear counterpart, /o/, exists for the AE vowel /ɔ:/. Hence, Japanese listeners of English will naturally consider the AE vowel /ɔ:/ as a 'similar' vowel.

The vowel /ɒ/ in AE occupies a low-back area in the vowel quadrilateral space and has no matched vowel in the Korean and the Japanese vowel systems. Therefore, the AE vowel /ɒ/ will be classified as a 'new' vowel to Korean and Japanese learners of English.

3.3. Best's Model

In Section 1., the outline of Best's Perceptual Assimilation Model was described. Amongst several points proposed in that section, the author recalls two important points with regard to the present focus, namely the acquisition of AE central/back vowels by Korean and Japanese learners of English.

Firstly, Best's assimilation contrasts can be decided by the distance (discrepancy) difference of two L2 phones from a L1 phone category in the cases of CG and SC contrasts. Secondly, with regard to vowel contrasts, unlike consonant contrasts where gestural coordination of several gestures is important, the degree of lip-rounding, tongue height and tongue frontness between the two compared L2 vowels appears to be a crucial factor, since other gestures, such as velum, tongue body, tongue sides, and larynx, do not have any great change depending upon different vowels.

Given these presuppositions, establishing vowel contrasts in which two members have great quality difference seems meaningless. Therefore, in this section, seven vowel contrast pairs (/ʉ:-U/, /ɜ:-ɔ:/, /a-ɒ/, /ɔ:-U/, /ɔ:-ɒ/, /ɜ:-a:/, /a-a:/), two members of a pair appearing adjacent place each other in the vowel quadrilateral, will be considered.

Best did not consider the length feature in her experiment. However, our experiment result as to the front/central AE vowels clearly demonstrated that the length feature is also another important variable influencing L2 listeners' performance as well as the quality feature. Thus, wherever possible,

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likely that Korean listeners would regard the AE vowel /ɔ:/ as the Korean vowel /o/ rather than /ʌ/.

zzzthe length difference between the two members of a contrast will also be taken into account in addition to the prediction which purely considers the quality difference of the two vowels in a contrast (see Table 5).

Table 5. Prediction based on Best's Model

1) Without consideration of lip-rounding feature

	AE vowels pairs						
	/ʉː-U/	/ɜː-ɔː/	/a-ɒ/	/ɔː-U/	/ɔː-ɒ/	/ɜː-aː/	/a-aː/
Korean	TC	CG~SC	cross-cat.	TC	cross-cat.	TC	SC
Japanese	SC	cross-cat.	cross-cat.	TC	cross-cat.	cross-cat.	SC
Japanese (inc. length)	CG~TC	cross-cat.	cross-cat.	TC	cross-cat.	cross-cat.	TC

2) With consideration of lip-rounding feature

	AE vowels pairs						
	/ʉː-U/	/ɜː-ɔː/	/a-ɒ/	/ɔː-U/	/ɔː-ɒ/	/ɜː-aː/	/a-aː/
Korean	CG	TC	cross-cat.	TC	cross-cat.	TC	SC
Japanese	SC	cross-cat.	cross-cat.	CG	cross-cat.	cross-cat.	SC
Japanese (inc. length)	CG~TC	cross-cat.	cross-cat.	TC	cross-cat.	cross-cat.	TC

The AE vowel pair /ʉː-U/ will be classified differently by Korean and Japanese listeners since the distribution and the number of corresponding L1 vowels in Korean and Japanese clearly differ. In the Korean vowel system, there is a central/back vowel /ɯ/. This vowel does have a similarity and a discrepancy in comparison with the AE vowel /ʉː/. The similarity of the two vowels is that they occupy a nearly identical distribution area in the vowel quadrilateral. However, they are discrepant in that the Korean vowel /ɯ/ is an absolutely unrounded vowel whereas the AE vowel /ʉː/ possesses some degree of lip-rounding. If lip-rounding is not important feature to Korean listeners, the Korean vowel /ɯ/ can be a counterpart of the AE vowel /ʉː/. In this case, the AE vowel pair /ʉː-U/ might be classified as TC contrast since the AE vowel /U/ would be matched to another Korean vowel /u/ which occupies an almost identical area to that of the AE vowel /U/ in the vowel quadrilateral and be counted as a native vowel /u/ by Korean listeners.

On the other hand, if the Korean listeners are fairly sensitive to lip-rounding[11], the AE vowel /ʉː/ will lose a chance of being regarded as the

Korean vowel /ɯ/ by Korean listeners. In this case, the vowel /ʉː/ in AE might be counted as a deviant exemplar of the Korean vowel /u/ while the other AE member of the pair /U/ would be considered as a good exemplar of the vowel /u/ in Korean. For this situation, the classification of CG contrast should be allocated since both vowels /ʉː/ and /U/ in AE are counted as exemplars of the Korean vowel /u/ even though the two AE vowels' degree of deviation from the target Korean vowel /u/ is different.

Amongst the two alternatives, CG classification would be more proper since in the Korean vowel system, lip-rounding is a fairly sensitive gesture for distinguishing two neighbouring vowels, such as /u/ and /ɯ/.

For Japanese listeners, the AE vowel pair /ʉː-U/ is likely to be classified as SC contrast. As explained in Section 2.1., the Japanese vowel /u/ is distributed between the distribution areas of the AE vowels /ʉː/ and /U/ in the vowel quadrilateral and make a triangle along with the two AE vowels. If so, the two AE vowels /ʉː/ and /U/ will provide a similar degree of phonetic match to the Japanese vowel /u/, respectively, and be considered as the Japanese vowel /u/. The classification for this situation would be SC contrast. If the length difference of the AE vowel pair /ʉː-U/ and the length sensitivity of Japanese learners of English are considered, the prediction on this pair might be changed from SC to CG~TC contrast. Because, regardless of the confusion of vowel quality between the two AE vowels, Japanese listeners will benefit from the cues of length difference, which will provide different degree of Category Goodness or two different categories (/u/ vs /uu/(=/uː/) in Japanese phonology) for Japanese listeners, between the two AE vowels.

The AE mid vowel pair /ɜː-ɔː/ will also be classified differently by Korean and Japanese listeners. the Korean vowel system holds a clear counterpart /ʌ/ ([əː])[12] against the AE vowel /ɜː/ while two candidates /o/ and [ʌ] as a counterpart of the AE vowel /ɔː/ exist in the Korean vowel inventory. If the Koreans identify the AE vowel /ɔː/ with their native vowel /o/, the AE mid vowel pair /ɜː-ɔː/ will be classified as TC contrast by

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[11] Werker & Polka (1993) report that lip-rounding operates as a fairly influential factor in their L2 vowel perception experiments which measured the American English listeners' perception of German vowels.

[12] Although there is clear discrepancy of quality and length between [ɜː] and [ʌ] in phonetic level, most Koreans seem to treat these two as /ʌ/ in phonemic level and in their normal language usage, they do not seem to distinguish these two as different sounds.

Korean listeners.

On the other hand, should the Koreans regard the AE vowel /ɔ:/ as the Korean vowel [ʌ], the classification of the AE pair /ɜ:-ɔ:/ will become either CG or SC contrast. For the two different predictions, some additional account would be helpful. Phonologically, the Korean vowels [ə:] and [ʌ] belong to one phoneme /ʌ/, phonetically, however, these two vowels possess quite a different vowel quality as can be seen in the vowel quadrilateral in Figure 1. Firstly, should the Koreans evaluate the AE vowel /ɔ:/ and /ɜ:/ at the phonological level, the counterpart of them will be the identical Korean vowel /ʌ/. In this case, SC contrast is predicted. Secondly, if the Koreans judge the pair phonetically, the AE vowel /ɜ:/ will be regarded as Korean [ə:] and the other AE vowel /ɔ:/ as Korean [ʌ]. In this situation, even though the two Korean vowels belong to one phoneme category /ʌ/, the great discrepancy of the two allophones in vowel quality will set up CG contrast for Korean listeners.

On the AE pair /ɜ:-ɔ:/, since these two candidates differ in the lip-rounding feature, it is more likely that Korean listeners who are sensitive to the lip-rounding feature would perceive these two vowels as two different vowels, namely as TC contrast.

The Japanese vowel quadrilateral in Figure 1 does not display any corresponding vowel to the AE vowel /ɜ:/. However, the AE vowel /ɔ:/ holds a counterpart /o/ in the Japanese vowel system. When no corresponding vowel exists in the L1 vowel inventory against an L2 vowel, the L2 vowel should be categorised as an uncategorisable (UNC) vowel which normally falls in uncommitted phonetic space of L1. If one phone falls within a native category and the other falls in uncommitted phonetic space for an L2 pair, this pair must be classified as cross-category contrast. As the AE vowel pair /ɜ:-ɔ:/ meets this condition in terms of the Japanese vowel inventory, this pair can be classified as cross-category contrast to Japanese listeners and this contrast will guarantee excellent discrimination between the two members of the pair in terms of Best's claim (Best 1993: 296).

The low AE vowel pair /a-ɒ/ will be a contrast easy to discriminate to both Korean and Japanese listeners. The AE vowel /ɒ/ does not have any corresponding vowel in the Korean and the Japanese vowel systems. In other words, the AE vowel /ɒ/ falls in uncommited phonetic space in Korean and Japanese. On the other hand, the AE vowel /a/, which occupies a similar area to that of Korean and Japanese /a/ in the vowel quadrilateral,

can count as a native vowel by Korean and Japanese listeners. Accordingly, the AE vowel pair /a-ɒ/ will be classified as cross-category contrast by both Korean and Japanese learners of English.

The comparison of the AE vowel pair /ɔ:-U/ is not an easy task, in particular, to Japanese listeners. In the Korean vowel inventory, two vowels /o/ and /u/, which are the counterparts of the AE vowels /ɔ:/ and /U/ respectively, exist. This means that the AE vowels /ɔ:/ and /U/ will be a good exemplar of the Korean vowels /o/ and /u/, respectively. Thus the AE pair /ɔ:-U/ will be classified as TC contrast to Korean learners of English.

In the Japanese vowel inventory, the vowel /ɯ/ retains its place. This vowel can primarily become a counterpart of the AE vowel /U/ in terms of vowel quality. Also, the Japanese vowel /o/ can be a counterpart of the AE vowel /ɔ:/ since both vowels are situated at an almost identical area in the vowel quadrilateral. With this analysis, the AE vowel pair /ɔ:-U/ should be classified as TC contrast to Japanese listeners. However, the Japanese vowel /ɯ/, in normal speech, does not possess a clear lip-rounding. Thus the actual sound of this vowel seems like /ɯ̟/ (Homma 1973: 350, 352-353). If lip-rounding is a crucial feature for deciding correspondence between an L1 and an L2 vowels arising around same phonetic space, the discrepancy of lip-rounding between the AE vowel /U/ and the Japanese vowel /ɯ/ will break the counterpart relationship of the two vowels. In this case, the Japanese vowel /o/ may become a corresponding vowel to both AE vowels /ɔ:/ and /U/. However, since the difference of distance of distribution area between the Japanese vowel /o/ and the AE vowel /ɔ:/ and Japanese /o/ and AE /U/, the AE vowel /ɔ:/ will be considered as a good exemplar and the AE vowel /U/ a deviant exemplar over the Japanese vowel /o/ by Japanese listeners. Under this analysis, CG contrast should be predicted over the pair /ɔ:-U/.

If the length factor is considered for the contrast of /ɔ:-U/, due to Japanese listeners' sensitivity as to length feature and the clear difference of length between the two members of the pair /ɔ:-U/, TC contrast is predicted for Japanese listeners.

The AE vowel pair /ɔ:-ɒ/ seems to be interpreted as a cross-category contrast to Korean learners of English. If the AE vowel /ɔ:/ is regarded as a counterpart of the Korean vowel /o/ and the other AE vowel /ɒ/ is regarded a sound falling in uncommitted phonetic space of Korean, the pair /ɔ:-ɒ/ will be classified as cross-category contrast.

To Japanese listeners, the classification of the AE vowel pair /ɔ:-ɒ/

seems to be similar to that of the Koreans. The comparison of the Japanese vowel system with that of AE clearly demonstrates that the AE vowel /ɔ:/ can become a counterpart of the Japanese vowel /o/ while the AE vowel /ɒ/ falls in uncommitted phonetic space of Japanese. For this situation, cross-category contrast should be allocated.

The AE vowel pair /ɜ:-a:/ seems clear to classify the type of contrast for both Korean and Japanese listeners. In Korean phonology, two vowels /ʌ/ ([ə:]) and /a/ that can be counterparts of the AE vowels /ɜ:/ and /a:/, respectively, exist in terms of vowel distribution area. That is to say, each of the AE vowels /ɜ:/ and /a:/ can be an exemplar of /ʌ/ ([ə:]) and that of /a/ in Korean. This is a typical example of TC contrast. Thus, the AE vowel pair /ɜ:-a:/ can be classified as TC contrast to Korean listeners of English.

In the Japanese vowel inventory, there is no corresponding vowel to the AE vowel /ɜ:/ while a clear counterpart /a/ exists over the AE vowel /a:/. Thus, it can be claimed that the AE vowel /ɜ:/ falls in uncommitted phonetic space of Japanese, while the other AE vowel /a:/ is classified as a 'good' exemplar of the Japanese vowel /a/. For this state of the pair /ɜ:-a:/ with regard to Japanese listeners, the classification of cross-category contrast would be appropriate.

Finally, the AE vowels /a/ and /a:/ share an almost identical phonetic space in the vowel quadrilateral. The difference of these two vowels is discovered from the length of each vowel. While /a:/ is classified as a 'long' vowel, /a/ is categorised as a 'short' vowel. If we only take the point of quality into account, both AE vowels will be classified 'good' exemplars of a counterpart vowel /a/ in Korean and Japanese phonologies. Thus, the AE vowel pair /a-a:/ should be classified as SC contrast to both Korean and Japanese learners of English.

However, should the length factor be included to the consideration, the prediction in relation to Japanese listeners will be changed. Since Japanese listeners are sensitive to the change of length of speech sounds by the influence of L1 phonology, the AE vowels /a/ and /a:/ will be classified as different vowels and identified to the Japanese vowels /a/ and /aa/ (=/a:/), respectively. This means that the two AE vowels /a/ and /a:/ belong to different categories in Japanese phonology. Under this situation, TC contrast should be allocated to the AE vowel pair /a-a:/.

3.4. Summary of Prediction

AE /U/ is predicted as an easy vowel for Koreans to perceive in the CAH and Flege's models. However, the prediction of Japanese acquisition on the same vowel is different. While the CAH model predicts that Japanese learners will face difficulty in learning the AE vowel /U/, Flege's model predicts that Japanese learners will identify the vowel /U/ as their L1 vowel /ɯ/.

AE /ʉ:/ is quite a similar case to the AE vowel /U/. In the prediction on Japanese listeners' acquisition, the CAH model predicts that Japanese listeners will face difficulty in acquiring AE /ʉ:/. However, Flege's model predicts that the inexperienced Japanese listeners will not face difficulty to identify and produce the AE vowel /ʉ:/.

As to Korean listeners' acquisition of the AE vowel /ɔ:/, the CAH model predicts that when lip-rounding is not an important feature, as there are two different candidates /o/ and /ʌ/ as a counterpart of the AE vowel /ɔ:/, Korean listeners will face difficulty to acquire this vowel. However, Flege's model predicts that this vowel would, at any rate, be 'similar' to one of the two Korean vowels, thus the acquisition of AE /ɔ:/ would not be a difficult task. Except these three cases, the three models predict similar results of Korean and Japanese listeners' acquisition of AE back vowels.

The predictions as to the pairs comprising the AE vowel /ɜ:/ (Japanese subjects) or /ɒ/ (Korean and Japanese subjects) as a member of the pair, in terms of Best's model, fall in, with no exception, 'cross-category'. This means that the pairs containing the AE vowels /ɜ:/ and /ɒ/ (both sounds falling in uncommited phonetic space) should be discriminated quite well whether or not the other vowel, such as /ɔ:/, /a/, and /a:/, in the pair is a difficult vowel to identify in the other models. This part is quite a different point of this model from the other models. The results of the experiment will provide a clear picture on this different prediction of this model from that of the other models.

4. Experiment

4.1. The Aims of Experiment

In this section, for confirming each theory's prediction, a perception experiment was conducted.

The perception test was designed for ascertaining Korean and Japanese

learners' ability to identify one of seven AE central/back vowels in 'h--d' frame words. Through this experiment, the predictions based on the three different models could be verified.

4.2. Materials

The purpose of this perception test was to investigate the ability of Korean and Japanese learners of English to identify AE central/back vowels. Seven English central/back vowels /ʉː, U, ɜː, ɔː, a, aː, ɒ/ were the target vowels and seven English words containing each target vowel were selected for the test. The 'h--d' frame for the English test words was used so as to accommodate identical environment. The test words were 'who'd', 'hood', 'heard', 'horde', 'HUD', 'hard', and 'hod'.

The two Australians took part in this experiment. They recorded the test words for two purposes; one was making a test tape which would contain these two native AE speakers' recorded test words. The other was acoustic measurement of the test words produced by them for the comparison of target AE vowels between these two AE native speakers and Korean and Japanese learners of English at production level. They read aloud each word written in a word list three times in a sound-attenuated booth. A portable cassette recorder (Marantz model CP230) and a high condensor microphone (Sony model ECM-30) were used to record the two Australian native speakers' voices.

The recorded test items were digitised and saved as sound files. When the test tape of Perception Test were made, the sound files which contained each test item were retrieved and recorded to a cassette audio tape.

Perception Test contained a total of 28 English words (7 vowels x 2 speakers x 2 repetition). The order of test words was randomly determined. Each word was repeated twice in the test. The inter-stimulus interval was 3s, and the inter-item interval 5s.

4.3. Procedure

The test was carried out in a speech lab of the Center for Language Teaching and Research in the University of Queensland. Each test item was provided for the subjects through the headphones and the subjects could adjust the sound volume for the most appropriate sound level.

In this test, the subjects were asked to circle a word out of 7 example words given on the answer sheet for one item after listening to each test

word. The test was divided into two (preliminary and main) sessions. At the preliminary session of the test, all detailed instructions and the explanation of meanings of the test words together with the real pronunciations of an AE native speaker for each test word were given to the subjects. The presentation of a native speaker's actual pronunciation for the test words to the subjects before the main session was given for the purpose of providing a clear match between the words and their native pronunciations for the subjects, since several test words seemed to be rarely used.

After the subjects understood thoroughly how to answer over the test items, the main session of the test commenced. A total of elapsed time for the completion of this test was approximately 30 minutes.

4.4. The Subjects and Analysis

A total of twenty subjects participated in this test. The subjects were divided into four different groups; Korean Experienced (KE), Korean Inexperienced (KI), Japanese Experienced (JE), Japanese Inexperienced (JI). Each group consisted of five members, respectively. The criterion of the experienced and inexperienced subjects was the subjects' staying period (5 years) in Australia.

The 20 answer sheets of this test were marked by the author. Afterwards, the results of all subjects were typed in and saved in the form of computer ASC II files. These computer files were later converted to files suitable for statistical programs and analysed by the statistical analysis programs, Statview and S-plus.

4.5. Results

The results of the subjects in the Perception Test were analysed and presented in the form of confusion matrices. It was possible to check the subjects' response range on each of the AE central/back vowels by making matrix tables. In a matrix, seven vowels belonging to rows represent the target vowels which must be identified by the subjects and another seven vowels in columns present the actual vowels which were replied by the subjects. Thus, the correct answers must be on the diagonal line in the matrix. The answers which are out of the diagonal line are deviated ones.

◉ Korean Subjects

Table 6. Confusion Matrix of Korean Subjects
(a sum of two groups' results)

		ɜ:	a:	a	ɔ:	ɒ	ʉ:	U	(R)
	ɜ:	40							
	a:		40						KE=20
	a		6	31		3			KI=20
(T)	ɔ:				32	8			
	ɒ	2	5	17		16			
	ʉ:						30	10	
	U			1			1	38	

The combined results of the two Korean groups (KE, KI) are shown in Table 6. Korean subjects identified AE /ɜ:/ and /a:/ perfectly and /U/ highly accurately (38 times out of 40) (see Table 8 for the statistical analysis).

However, with respect to the other four AE vowels /a, ɔ:, ɒ, ʉ:/, the Korean subjects did not make highly accurate perception (/a/ : 31/40, /ɔ:/ : 32/40, /ɒ/ : 16/40, /ʉ:/ : 30/40). In particular, the identification of the vowel /ɒ/ was problematical.

The high percentage of accuracy in perception of /ɜ:/, /a:/, /U/ seems to be attributable to the existence of Korean counterparts /ʌ/ ([ə:]), /a/, and /u/ respectively.

◉ Japanese Subjects

The combined results of the two Japanese groups (JE, JI) are shown in Table 7. Unlike the Korean subjects' results, the Japanese subjects showed almost perfect perception with only one AE vowel /a/ (39 times out of 40). The AE vowels /a:/ and /ɜ:/, with which Korean subjects made a perfect perception, were not perceived with the perfect accuracy (/ɜ:/ : 37/40, /a:/ : 36/40). The Japanese subjects did not make a good perception of /U/ (29/40), with which Korean subjects made more accurate perception (38/40).

Table 7. Confusion Matrix of Japanese Subjects
(a sum of two groups' results)

		ɜ:	a:	a	ɔ:	ɒ	ʉ:	U	(R)
	ɜ:	37	3						
	a:	4	36						JE=20
	a			39	1				JI=20
(T)	ɔ:				32	2	4	2	
	ɒ	1		17		21		1	
	ʉ:						31	9	
	U			1		3	7	29	

With respect to the other three AE vowels (/ɔ:/, /ɒ/, /ʉ:/), Japanese subjects did not make a sharp identification (/ɔ:/ : 32/40, /ɒ/ : 21/40, /ʉ:/ : 31/40) as the cases of Korean subjects. High accuracy of the Japanese subjects' perception on the AE vowel /a/ seems to reveal Japanese subjects' high degree of phonological ability in distinguishing the length of vowels.

◉ Statistical Comparison

Table 8. Summary ANOVAS
Vowel identification concerning different L1 background

Independent Variables	Dependent Variables	Degrees of freedom	Sum of Sq	Mean Sq	F Value	Pr	Comparisons
La (Korean, Japanese)	Total Errors	1	0.2	0.2	0.01	0.917	
Residuals		18	328.6	18.26			
La (Korean, Japanese)	Errors on /ɜ:/	1	0.45	0.45	1.98	0.176	
Residuals		18	4.1	0.23			
La (Korean, Japanese)	Errors on /a:/	1	0.8	0.8	3.27	0.087	Kor > Jap
Residuals		18	4.4	0.24			
La (Korean, Japanese)	Errors on /a/	1	3.2	3.2	3.65	0.072	Jap > Kor
Residuals		18	15.8	0.88			
La (Korean, Japanese)	Errors on /ɔ:/	1	0	0	0	1	
Residuals		18	31.2	1.73			
La (Korean, Japanese)	Errors on /ɒ/	1	1.25	1.25	1.3	0.269	
Residuals		18	17.3	0.96			
La (Korean, Japanese)	Errors on /u:/	1	0.05	0.05	0.04	0.851	
Residuals		18	24.9	1.38			
La (Korean, Japanese)	Errors on /U/	1	4.05	4.05	4.42	0.049	Kor > Jap
Residuals		18	16.5	0.916			

Table 8 shows the one way ANOVA table as to the Korean and the Japanese subjects' difference in the perception of AE central/back vowels. Owing to the small number of perception data on each vowel, the difference of p-level between different groups (Korean vs Japanese) on each AE central/back vowel was not quite clear[13].

At the comparison of the perception data of the subjects having Korean and Japanese backgrounds, just one vowel's (AE /U/) p-level ($p<.05$) was significant. The AE vowels /a:/ and /a/'s p-levels were marginally significant (/a:/ : $p = 0.087$, /a/ : $p = 0.072$).

The significant difference of /U/ identification between the Korean and the Japanese subjects might be interpreted that the existence of a clear counterpart /u/ in the Korean vowel system gave the Korean subjects better opportunity to identify the AE vowel /U/ while the Japanese subjects did not have chances as good as the Korean subjects due to the absence of a clear counterparts on the AE vowel /U/.

The case of the AE vowel /a:/ has quite a similar story. The Japanese subjects confused the AE vowel /a:/ with /ɜ:/, since the counterpart of /ɜ:/ in AE does not exist in the Japanese vowel system.

With respect to /a/ vowel in AE, the Japanese subjects perceived better (39/40) than Korean subjects (31/40). The Japanese subjects' highly accurate identification seems to be related to the phonologically clear status of length distinction in Japanese phonology. This fact is supported by the Korean subjects' incorrect identification of this vowel as /a:/ (6 times out of 9 incorrect answers).

◉ Each Korean Group

Respective Korean groups' result matrices are provided in Table 9 and the ANOVAs and t-tests as post-hoc analyses of the Korean and Japanese groups on the basis of different L1 backgrounds and L2 experience are presented in Table 11.

[13] The level of significance was .05 due to the small sample sizes.

Table 9. Confusion Matrices of Respective Korean Groups

Korean Experienced

		ɜː	aː	a	ɔː	ɒ	ɞː	U	(R)
	ɜː	20							
	aː		20						
	a			20					
(T)	ɔː				18	2			
	ɒ		1	8		11			
	ɞː						18	2	
	U						1	19	
(Total)		20	21	28	18	13	19	21	

Korean Inexperienced

		ɜː	aː	a	ɔː	ɒ	ɞː	U	(R)
	ɜː	20							
	aː		20						
	a		6	11		3			
(T)	ɔː				14	6			
	ɒ	2	4	9		5			
	ɞː						12	8	
	U			1				19	
(Total)		22	30	21	14	14	12	27	

◉ Korean Inexperienced Group

The subjects belonging to this group made relatively many perception errors with regard to the AE vowels /a/ (9 mistakes out of 20), /ɔː/ (6 mistakes out of 20), /ɒ/ (15 mistakes out of 20), and /ɞː/ (8 mistakes out of 20). The listeners, however, performed well over the other central/back AE vowels /ɜː/ (20/20), /aː/ (20/20), and /U/ (19/20).

In the case of the AE vowel /a/, the subjects made mistakes in both factors of quality (/ɒ/) and length (/aː/). The vowel /aː/ possesses nearly overlapping distribution area with that of the AE vowel /a/ in the vowel quadrilateral, however these two vowels are discrepant in vowel length.

Thus, six cases of misperception of the vowel /a/ as /aː/ by the listeners might be classified as the misperception of the length. On the other hand, the three cases of misperception of vowel /a/ as /ɒ/ by the subjects might be categorised as the misperception of the quality. Since, although these two vowels share the short length, they are situated at different areas in the vowel quadrilateral (see Figure 1).

The aspect of performance of the subjects over the AE vowel /ɒ/ is more complex. The misperception cases range from quality mistakes (/a/: 9 cases) to quality plus length mistakes (/aː/: four times; /ɜː/: twice).

The AE vowel /ɔː/ was misperceived as /ɒ/ for six times. This misperception should be classified as the length plus quality mistake. However, considering the fact that they are the members of a lax-tense pair and the difference of these two vowels is more remarkable in the length feature, this misperception of the subjects can be dealt with as the length distinction mistake. Finally, the AE vowel /ʉː/ was misperceived as /U/ for 8 times. This result can be regarded as the length misperception, considering the two vowels are the members of a lax-tense pair.

Overall, the nature of misperception of the KI subjects was mainly based on length mismeasurement.

◉ Korean Experienced Group

Overall the performance of the Korean experienced subjects was fairly good. They marked perfect scores for the AE vowels /ɜː, aː, a/ and performed well with regard to other AE vowels /ɔː/ (18/20), /ʉː/ (18/20), and /U/ (19/20). Only one AE vowel /ɒ/ caused perceptual problem to the Korean listeners belonging to this group (11/20).

The comparison of the results between the KE and KI groups clearly demonstrates that remarkable improvements of the KE group's result compared to that of the KI group are observable with regard to the length feature misperception (/ɔː/: 14/20 → 18/20, /a/: 11/20 → 20/20, /ʉː/: 12/20 → 18/20). However, the mistakes with regard to the pure quality feature (/ɒ/ → /a/: KI: 9 times, KE: 8 times) did not significantly decrease[14]. Nevertheless,

[14] There was one exeption of the clear improvement of pure quality misperception (/a/ → /ɒ/: KI: 3 times, KE: 0). However, if we consider the fact that the AE vowel /a/ has a qualitative counterpart /a/ in Korean, this situation might be understandable in association with the subjects' L1 (Korean) phonology. Also the first encounter of

a clear improvement of the perception of the AE vowel /ɒ/ with regard to the length feature (/ɒ/ → /aː/: KI: 4 times, KE: once; /ɒ/ → /ɜː/: KI: twice, KE:0) also arose. The result seems to indicate that the improvement of the quality confusion in L2 perception may be more difficult than that of the length confusion.

◉ Each Japanese Group

Respective Japanese groups' result matrices are provided in Table 10 and The ANOVAs and t-tests as post-hoc analyses of the Korean and Japanese groups on the basis of different L1 backgrounds and L2 experience are presented in Table 11.

Table 10. Confusion Matrices of Respective Japanese Groups

Japanese Experienced

		ɜː	aː	a	ɔː	ɒ	ʉː	U	(R)
	ɜː	20							
	aː	2	18						
	a			20					
(T)	ɔː				17		3		
	ɒ	1		5		14			
	ʉː						16	4	
	U					1	3	16	
(Total)		23	18	25	17	15	22	20	

Japanese Inexperienced

		ɜː	aː	a	ɔː	ɒ	ʉː	U	(R)
	ɜː	17	3						
	aː	2	18						
	a			19	1				
(T)	ɔː				15	2	1	2	
	ɒ			12		7		1	
	ʉː						15	5	
	U			1		2	4	13	
(Total)		19	21	32	16	11	20	21	

the AE vowel /a/ by Korean listeners might have caused their misperception of this vowel.

◉ Japanese Inexperienced Group

Comparing the Korean groups' results which mostly included length-related errors, the JI group's performances contained more quality-related errors than those of the Korean subjects. The following are pure quality distinction errors: /ɜ:/ → /a:/ (3 times), /a:/ → /ɜ:/ (twice), /ɔ:/ → /ʉ:/ (once), /ɒ/ → /a/ (12 times), /ɒ/ → /U/ (once), /U/ → /a/ (once), /U/ → /ɒ/ (twice). Another characteristic of the JI group's perceptual performance was that the range of perception over the AE vowels was more expanded than that of the Korean listeners. The instances are as follows: /ɜ:/ → /ɜ:/, /a:/; /a:/ → /a:/, /3:/; /ɔ:/ → /ɔ:/, /ɒ/, /ʉ:/, /U/; /ɒ/ → /ɒ/, /a/, /U/; /ʉ:/ → /ʉ:/, /U/; /U/ → /U/, /ʉ:/, /ɒ/, /a/.

The two attributes of the JI group's perceptual performance might be accounted for from the two facts. Firstly, Japanese listeners possess a more sensitive ability to distinguish long/short vowels than that of Koreans, based on the systematic support of Japanese phonology. Secondly, the Japanese vowel system has the only three vowels /a, o, u/ in the central/back area. This might result in Japanese listeners' expansion of the perceptual range over the AE central/back vowels.

◉ Japanese Experienced Group

Overall, as the relationship between the KE and KI groups, the improvement of the JE group's performance in comparison with that of the JI group was observable. However, the extent of the JE group's improvement was smaller than that of the Korean experienced group. The close observation of the result of the JE group indicated that the less improvement of the JE group's perception was mostly related to the pure quality errors. The examples of this situation are as follows: /a:/ → /ɜ:/ (JI: twice, JE: twice), /ɔ:/ → /ʉ:/ (JI: once, JE: 3 times), /ɒ/ → /a/ (JI: 12 times, JE: 5 times). This phenomenon seems to reveal that improving the confusion of pure quality is more difficult than that of the length-related confusion.

◉ Statistical Comparison

Table 11. Summary ANOVAS

Vowel identification concerning different L1 background and L2 experience

Independent Variables	Dependent Variables	Degrees of freedom	Sum of Sq	Mean Sq	F Value	Pr	Comparisons (t-test)
Gr (KE, KI, JE, JI)	Total Errors	3	91.6	30.53	2.06	0.146	
Residuals		16	237.2	14.83			
Gr (KE, KI, JE, JI)	Errors on /ɜ:/	3	1.35	0.45	2.25	0.121	
Residuals		16	3.2	0.2			
Gr (KE, KI, JE, JI)	Errors on /a:/	3	0.8	0.27	0.97	0.431	
Residuals		16	4.4	0.28			
Gr (KE, KI, JE, JI)	Errors on /a/	3	11.4	3.8	8	0.001	KE>KI (t=-3.09, df=8, p=0.015)
Residuals		16	7.6	0.475			JE>KI (t=-3.09, df=8, p=0.015)
							JI>KI (t=-2.60, df=8, p=0.0318)
Gr (KE, KI, JE, JI)	Errors on /ɔ:/	3	2	0.67	0.37	0.778	
Residuals		16	29.2	1.83			
Gr (KE, KI, JE, JI)	Errors on /ɒ/	3	9.75	3.25	5.91	0.006	JE>JI (t=-4.43, df=8, p=0.0022)
Residuals		16	8.8	0.55			JE>KI (t=-3.67, df=8, p=0.0063)
							KE>KI (t=-2.06, df=8, p=0.0736) (marg.)
Gr (KE, KI, JE, JI)	Errors on /u:/	3	3.75	1.25	0.94	0.443	
Residuals		16	21.2	1.33			
Gr (KE, KI, JE, JI)	Errors on /U/	3	4.95	1.65	1.69	0.208	
Residuals		16	15.6	0.975			

Table 11 represents one way ANOVA table of the KE, KI, JE, and JI groups' perception of the AE central/back vowels. At the comparison of the perception of the four groups, the AE vowels /a/ and /ɒ/ were statistically significant ($p < 0.01$).

With respect to the AE vowel /a/, the KE (20/20), JE (20/20), and JI (19/20) groups showed quite an accurate perception but the subjects of the KI group (11/20) just identified 55% of the whole tokens. Considering that 6 out of 9 misperceptions by the KI subjects are /a/ → /a:/ cases where the two AE vowels have almost identical quality but differ in their length and that no misperception for the AE vowel /a/ is recorded in the performance of the KE group, L2 learners' fast improvement of ability of the vowel length distinction seems to be eminent after the considerable period of their exposure to an L2 speaking environment. The JI group's highly accurate perception seems to show that the support of L1 phonological system (phonological length distinction of vowels) acts as a positive factor in L2

learners' L2 sound acquisition.

The other statistically significant vowel is /ɒ/. The JE (14/20) and KE (11/20) groups better perceived this vowel than the JI (7/20) and KI (5/20) groups, respectively. One point which should be emphasised is that even the JE and KE subjects, whose experience in L2 speaking environment was more than 5 years, could not achieve highly accurate perception rate. All four group members mainly misperceived /ɒ/ as /a/. Thus, it can be said that overcoming of the quality confusion in L2 vowel perception is quite difficult. This fact is noticeable in relation to the rapid improvement of the KE subjects' distinction (20/20) of the vowel length compared to the low accuracy (11/20) of the KI subjects for the AE vowel /a/.

5. Discussion

A great difference of performance between the Korean and Japanese listeners was the nature of deviant answers. The deviant answers of the Korean inexperienced subjects were mostly related to length and examples of this kind of misperception were rarely found in the answers of the Korean experienced subjects. On the other hand, the deviant answers of the Japanese inexperienced listeners were mainly related to the pure quality feature. Unlike the Korean experienced subjects' great improvement over the length related deviant forms made by the KI subjects, the members of the JE group did not show any remarkable improvement from the performance of the JI group with regard to the pure quality related deviant forms.

The difference of the nature of deviant forms of Korean and Japanese groups seems explicable from the different degree of length sensitivity of the two language subjects based on the status of length in their L1 phonology. Also, the JE group's immaterial improvement of quality-related deviant forms made by the JI group seems to indicate that the quality factor is much harder to improve than the length factor in L2 vowel acquisition.

The other point to make mention of is that the Japanese subjects' responses cover a wider range of the area in the vowel quadrilateral over their respective AE target vowels than as those of the Korean subjects[15]. The examples are as follows: /ɜ:/ → /ɜ:/, /a:/ (JI); /a:/ → /a:/, /ɜ:/ (JE, JI); /ɔ:/ →

[15] Korean subjects' reply was mainly restricted to the AE lax-tense vowel pair (except the AE vowel /ɒ/) which contains the target vowel.

/ɔ:/, /ɒ/, /ʉ:/, /U/ (JI); /ɔ:/ → /ɔ:/, /ʉ:/ (JE); /ɒ/ → /ɒ/, /a/, /U/ (JI); /ɒ/ → /ɒ/, /a/, /ɜ:/ (JE); /U/ → /U/, /ʉ:/, /ɒ/ (JE); /U/ → /U/, /ʉ:/, /ɒ/, /a/ (JI). This result should be attributable to the small number of the Japanese vowels (/a, o, u/) arising in this area.

Finally, the existence of a clear L1 counterpart provided a good standard to distinguish L2 vowels arising in the vicinity of the distribution area of the L1 counterpart in the vowel quadrilateral space for L2 learners. Below are several instances given. Korean listeners have clear counterparts /ʌ/ ([ə:]) and /a/ against the AE vowels /ɜ:/ and /a:/ respectively. This situation provided a comfortable condition for Korean listeners (KE & KI groups) so that they made no perceptual mistakes over the AE vowels /ɜ:/ and /a:/. On the other hand, Japanese does not retain any counterpart against the AE vowel /ɜ:/, while there is a clear counterpart /a/ over the AE vowel /a:/. This situation might have provided some confusion between these two AE vowels for Japanese listeners belonging either to the JE or to the JI group. This phenomenon might have happened by the **expansion** of the territory of the Japanese vowel /a/ including part of the territory of the AE vowel /ɜ:/ due to the lack of corresponding vowel against the AE vowel /ɜ:/ in the Japanese vowel system.

Along with the sensitivity of length in terms of vowels, it could be said that Japanese listeners possess two clear L1 counterparts /aa/[16] and /a/ against the AE vowels /a:/ and /a/, respectively. The outstanding performance of the JI and JE groups over AE /a/ (JI: 19/20, JE: 20/20) clearly demonstrated the importance of the existence of an L1 counterpart. On the contrary, Korean inexperienced subjects did show quite a different performance on the AE vowel /a/. Since the Korean inexperienced subjects were less sensitive with length distinction, they might have regarded the AE vowel /a/, which has quite close quality to that of the Korean /a/, as a counterpart of the Korean vowel /a/ likewise the AE vowel /a:/. Thus, there might have been a confusion for distinguishing the AE vowels /a:/ and /a/ in the KI subjects' minds[17]. The outcome of the KI subjects'

[16] /aa/ means long /a/. In Japanese phonology, many scholars select /aa/ notation rather than /a:/ for representing the long vowel /a/.

[17] Most of Koreans learn American English in Korea. In American English, the quality of the equivalent vowel of the AE vowel /a/ (=/ʌ/ in general transcription) is differing. Thus, when Korean listeners face this sound they might treat this vowel as AE vowel /a:/ which has almost identical quality to the AE vowel /a/.

performance against the AE vowel /a/ clearly proved this situation[18]. However, the KE subjects performed perfectly on the vowel /a/. This remarkable improvement appears to prove the fact that the length confusion can be resolvable along with the accumulation of L2 experience of L2 learners.

Korean has a phonemic contrast (/ɯ/-/u/) which has a correspondence in the AE vowel quality contrast (/ʉː-U/). The Korean vowel /u/ is quite close to the AE vowel /U/ in terms of quality (F1 and F2). This environment seems to have led the Korean listeners to hear AE /U/ as Korean /u/. As a result of this, the listeners belonging to the two Korean groups recorded almost perfect scores (19/20: KI, KE). However, the KI subjects' less sensitive ability to distinguish length difference between qualitatively similar vowels drove them into poor performance over the AE vowel /ʉː/ (12/20). Also, if so, lip rounding feature must have influenced the Korean inexperienced listeners' perception because, regardless of the existence of Korean /ɯ/ which is acoustically quite close to the AE vowel /ʉː/, Korean inexperienced listeners could not perceive AE /ʉː/ satisfactorily. The low score of the KI group was, however, improved at the performance of the KE group (18/20) over the AE vowel /ʉː/. This instance once again positively supports the recoverability of length confusion along with the gaining of L2 experience.

On the other hand, the Japanese vowel system does not hold any clear counterpart over the AE vowels /ʉː/ and /U/. Although vowel /u/ exists in the Japanese vowel inventory, the distribution area of this vowel is located between the AE vowels /ʉː/ and /U/. This situation is analogous to the relationship amongst Korean merged vowel /e~ɛ/ and the AE vowels /e/ and /æ/. Thus, the Japanese vowel /u/ either can become a counterpart of both AE vowels /ʉː/ and /U/ or can not become a counterpart of either the AE vowel /ʉː/ or /U/. This ambiguous situation might have made the Japanese subjects perform unsatisfactorily over both AE vowels /ʉː/ and /U/ (JI: /ʉː/ (15/20), /U/ (13/20); JE: /ʉː/ (16/20), /U/ (16/20)). The small difference of performance between the two Japanese groups appears to indicate that the overcoming of a pure quality confusion in L2 vowel

[18] The three occasions of misperception of AE /a/ as /ɒ/ might be accounted for by the subjects' instability over and confusion with the novel vowel /a/. This means that the subjects might have felt the shorter length from the vowel /a/ at the phonetic level and identified this vowel as AE /ɒ/, confusing the quality factor of AE /a/.

perception is not an easy task for L2 learners even after lengthy exposure to the L2 speaking environment. If Japanese listeners had not possessed the sensitive ability to distinguish the length feature, their performance over the AE vowels /ʉː/ and /U/ might have been worse. After all, the outcome seems to indicate that the more important factor is quality and the less important one is length in L2 vowel perception, since without the exact capture of the L2 vowel quality, the L2 learners did not achieve any remarkable improvement of L2 vowel acquisition after lengthy exposure to the L2 speaking environment.

The Korean vowel system has a vowel /o/. Even though this vowel does not exactly match the AE vowel /ɔː/ qualitatively, they can be categorised as counterparts reciprocally. The outcome of the experiment supports this situation. The confusion between the AE vowels /ɔː/ and /ɒ/ seems attributable to the weak ability of Korean listeners to distinguish the length feature of the AE vowels.

On the other hand, the Japanese vowel system retains a vowel /o/. This can be a counterpart of the AE vowel /ɔː/. Thus, the Japanese listeners seemed to perceive the AE vowel /ɔː/ quite well. Strange to say, however, the result of Japanese groups did show that the reply of Japanese listeners over the AE vowel /ɔː/ was expanded to the AE vowels /ʉː/ and /U/, unlike the initial prediction. In Japanese phonology, there is a vowel /ɯ/. However, this vowel does not keep clear lip-rounding in normal speech as well as possessing the discrepancy of quality with the AE vowels /ʉː/ and /U/. These factors seemed to lessen the influence of the Japanese vowel /ɯ/ as a counterpart of the AE vowels /ʉː/ and /U/. The Japanese vowel /o/ possesses the lip-rounding feature, as do the three AE vowels /ɔː/, /ʉː/ and /U/. This situation must have made Japanese listeners expand the range of perception of AE /ɔː/ to the AE vowels /ʉː/ and /U/. If there had been a clear counterpart /ɯ/ with retention of a clear lip-rounding feature over the AE vowels /ʉː/ and /U/ in the Japanese vowel inventory, the **expansion** of the range of responded vowel(s) over the target AE vowel /ɔː/ would not have arisen.

Through several examples accounted for above, the importance of the existence of the solid L1 counterpart over L2 vowels is clearly proved.

The remainder of this Discussion section examines separately the predictions which were established on the basis of four different models, from traditional CA theory to Best's model, with the result of Perception Test. After the detailed examination of each theory, a deeper discussion of L2

vowel perception follows.

The traditional CA model predicted that the AE vowel /ɜ:/ would be difficult to identify for Japanese listeners, since a corresponding vowel to AE /ɜ:/ does not exist in the Japanese vowel system. However, the two Japanese groups performed either perfectly or relatively well (JI: 17/20, JE: 20/20) with respect to this vowel. Rather, the two Japanese groups misperceived the AE vowel /a:/, which was predicted to be perceived well because of the existence of a counterpart vowel /a/ in Japanese phonology, twice out of twenty cases, respectively (JI: 18/20, JE: 18/20). This outcome seems to demonstrate the importance of the consideration of the relationship amongst neighbouring L2 vowels (/ɜ:/ and /a:/ in AE) and L1 counterpart(s) (/a/ in Japanese) rather than considering the one to one relationship between L1 and L2 sounds (AE /ɜ:/ to nothing in Japanese, and AE /a:/ to Japanese /a/).

The Japanese vowel system retains a vowel /o/ which is counted as a counterpart of the AE vowel /ɔ:/. Along with this fact, the prediction on the AE vowel /ɔ:/ was that Japanese listeners would perceive this vowel satisfactorily. However, the performance of the two Japanese groups (JE: 17/20, JI: 15/20) did not reveal an excellent result over this vowel.

The test results of Japanese listeners over the AE vowels /ɜ:/ and /ɔ:/ seem to indicate that whether or not the counterpart over L2 vowels in question exists is not an entirely important factor to determine the L2 listeners' perceptual performance on L2 vowels in question. Rather, respective factors of lip-rounding, formant structure (acoustic factor), and length of the L2 vowels seem to be influential.

Flege's Speech Learning Model (with consideration of lip-rounding feature) classified the AE vowel /ʉ:/ as a 'new' vowel to Korean listeners. Following Flege's theory, after L2 learners' lengthy exposure, the vowels which were classified as 'new' vowels must be perceived accurately since L2 listeners must have set up novel categories for 'new' vowels without the inhibition of 'Equivalence Classification'. The performance of KE subjects on AE /ʉ:/ did record almost perfect scores (KE: /ʉ:/ (18/20)). On the other hand, the AE vowel /a/ was classified as a 'similar' vowel (without considering length), since this vowel has a counterpart /a/ in the Korean vowel system. According to Flege, the 'similar' vowel will not elicit a perfect result after L2 learners' lengthy exposure to the L2 speaking environment since the process of 'Equivalence Classification' will block L2 learners' constituting a new category for a 'new' vowel. However, this predic-

tion was broken by the KE group's perfect performance (20/20) on this vowel. With the prediction of a 'new' vowel for the AE /a/ with considering length feature, the KE group's performance can be accounted for perfectly.

The two instances indicate that the prediction in terms of Flege's model based purely on vowel formant quality (F1 and F2) is not effective at all, and that the features of vowel length and lip-rounding should be considered for more accurate prediction.

The example of the AE vowel /ɒ/ is extraordinary. Since this vowel does not have any counterpart in the Korean and the Japanese vowel inventories, this vowel is classified as a 'new' vowel to both Korean and Japanese listeners. Following Flege's theory, since this is a 'new' vowel, L2 learners should perceive and produce this vowel accurately after lengthy exposure to the L2 speaking environment. Surprisingly, both Korean and Japanese experienced subjects recorded the worst perception performance on this vowel (KE: 11/20, JE: 14/20) out of the seven central/back AE vowels. This result collides with the prediction based on Flege's model. These counter examples against the prediction based on Flege's model strongly challenge the effectiveness of Flege's model.

Under the application of Best's model, the AE pairs /a-ɒ/ and /ɔ:-ɒ/ were classified as cross-category contrasts for both Korean and Japanese learners of English, and /ɜ:-ɔ:/ and /ɜ:-a:/ for Japanese learners. If Best's claim is right, all the pairs which were classfied as 'cross-category' contrast must have been discriminated clearly. However, except for the /ɜ:-ɔ:/ contrast for Japanese listeners, all other 'cross-category' contrast pairs did not elicit a good performance from any of the Korean and Japanese groups.

The result of the experiment seems to indicate that the categorisation of the AE vowel /ɒ/ as a sound which falls in uncommitted phonetic space in Korean and Japanese and of another AE vowel /ɜ:/ as a sound which falls in uncommitted space in Japanese was not appropriate. Nevertheless, that the AE vowels /ɒ/ (to Korean and Japanese) and /ɜ:/ (to Japanese) can not be a counterpart or a sound which falls within native phonetic category, whether it is a native or deviant exemplar in the Korean and the Japanese vowel systems, is clear. If so, the AE vowels /ɒ/ and /ɜ:/ must be classified as the sounds falling in uncommitted phonetic space of the L2 learners' native language. Under this situation, Best's model is seriously challenged, especially with regard to L2 vowel perception.

Best depended upon Gestural Phonology which put the emphasis on the gestures of a sound as the basis of her model. Consequently, her model

could not but put the emphasis on the gestural coordination of several gestures for producing a sound. In the cases of consonants, two sounds which consist of a pair could be classified clearly by considering several gestures, such as velum, tongue body, tongue sides, larynx. However, in the case of vowels, since there is no contacting point in the oral cavity and most gestures do not have any remarkable difference on different vowels, the application of her criteria to classifying two L2 vowels does not seem quite suitable. Thus, the application of Best's model to predict L2 vowel perception by L2 learners should be cautious.

Close comparison of the outcome of the Perception test with the predictions based on Traditional CA, Best's and Flege's models revealed weak points in each theory. This means that no theory out of these three was perfectly appropriate to predict and account for the L2 learners' perception of L2 (AE) central/back vowels, in particular with the consideration of only a feature. The rest of this section analyses the results of the experiment from a variety of angles.

In the previous section, the importance of length as well as the spectral feature (F1 and F2)[19] was thoroughly discussed and proved. This conclusion was also supported by the result of the Perception test. Then, what is the relationship between these two factors?

In Australian English, the vowels /ʉ:/ and /U/ and /a:/ and /a/ make a tense-lax pair, respectively. These two vowel pairs share a common feature that, out of two members of a pair, one is a short and the other a long vowel. However, these two vowel pairs differ in the gap of the quality of the paired vowels; /a:/ and /a/ arise at nearly identical areas in the vowel quadrilateral while /ʉ:/ and /U/ have a great gap in arising places. Thus, while the /a:/-/a/ pair has a length difference, the /ʉ:/-/U/ pair holds both length and quality differences.

The author has already commented that Japanese listeners are sensitive to the difference of length of L2 sounds and there is a clear counterpart /a/ in the Japanese vowel system. Along with this background, Japanese listeners would distinguish quite well the AE vowel pair /a:/-/a/ since the members of this pair differ only in length. The outcome of the test revealed that the prediction was correct (JE:20/20, JI:19/20); the inexperienced subjects even identified these two vowels almost perfectly.

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[19] This feature is described as 'quality' or 'acoustic feature' in this paper.

Then, what was the perceptual outcome of Japanese subjects for the other pair /ʉ:-U/? In the Japanese vowel system, there is a vowel /u/ which can be a counterpart of both AE vowels /ʉ:/ and /U/, but the distribution areas of the three vowels do not overlap. Two predictions on the perception of this pair by Japanese listeners might be established based on the explanation for the relationship between the AE vowel pair /ʉ:-U/ and the Japanese vowel /u/.

Firstly, if the length factor is more influential factor than the quality factor, Japanese listeners might perform satisfactorily (CG~TC in Best's model) regardless of the confusion of quality between the two AE vowels /ʉ:/ and /U/. Secondly, should quality be more powerful than length, Japanese listeners will not achieve the satisfactory perceptual result (SC in Best's model) in spite of the advantage of length difference between the two AE vowels in question.

The outcome of the test demonstrated that both groups (JI, JE) of Japanese listeners did not overcome the confusion of quality difference between AE /ʉ:/ and /U/ (JI: /ʉ:/ (15/20), /U/ (13/20); JE /ʉ:/ (16/20), /U/ (16/20)). Therefore, this result seems to exemplify that the quality feature is harder to overcome than the length feature in L2 vowel perception. Also, the result of Japanese listeners' perception for the /a:/-/a/ pair is likely to be interpreted that, if there is a reliable common counterpart in the L1 to the L2 vowels in question, then the length difference of those L2 vowels can be used as a good cue to distinguish them by foreign listeners who are sensitive to the length difference of L2 sounds.

In the previous paragraph, the author dealt with the relationship between quality and length factors. In the following several paragraphs, the author will treat the extent of improvement of the two factors along with the gaining of L2 experience (refer to Tables 9 and 10).

The results of the Korean groups (KE, KI) reveal a great gap in the number of correct answers for the target vowel between the two different groups. This outcome might be interpreted as the KE group having improved the misperception of the AE vowels in question. Considering the wrong answers of each of the AE vowels, it is found that they are discrepant from the target vowel mainly in length. Also, except for the KI group's reply as /ɒ/ (3 times) for the target vowel /a/, the incorrect answers and target vowels for the Korean groups are in the relationship of tense-lax vowel pairs. This means that Korean listeners' misperception is mainly related to the confusion of vowel length. If so, it can be said that

the confusion with regard to the length feature can be overcome along with the accumulation of L2 experience.

On the other hand, the gap of the number of correct answers for the target AE vowels between the two Japanese groups (JE, JI) is not as much as that of the results of the two Korean groups. As well, either the wrong answers were discrepant in quality (/ɜ:/ vs /a:/) or the range of incorrect answers was wider (/ɒ, ʉ:, U, ɔ:/ for /ɔ:/ and /ɒ, a, ʉ:, U/ for /U/)[20]. This result might be interpreted as the Japanese groups' wrong answers being mainly related to the failure of a quality distinction. The small gap in the performance over the AE vowels /ɜ:, a:, ɔ:, ʉ:, U/ between the two Japanese groups and the characteristics of their wrong answers mainly related to vowel quality confusion seem to indicate that overcoming the confusion of vowel quality is not an easy task, unlike the case of vowel length, even after lengthy exposure to the L2 speaking environment.

Overall, it might be argued that the length feature of the L2 vowels is the one which can be acquired after the accumulation of L2 experience while the quality feature of them is hard to acquire even after considerable experience of L2[21].

From the results presented in Tables 9 and 10, the author also found a great difference in the range of deviated answers produced by Korean and Japanese groups. The Korean groups' wrong answers are limited either to a member of the tense-lax pair to which the target vowel belongs or to just an adjacent vowel (e.g., the deviated answer /ɒ/ for the target vowel /a/ in the case of the KI group) in the vowel quadrilateral space. On the other hand, the Japanese groups' deviant forms have a wider range than those of Korean groups. This outcome seems to be related to the Korean and the Japanese vowel systems' internal structure.

Figure 3 represents the range of actual answers on AE target vowels and the L1 vowels corresponding to the target vowels. In the case of Korean listeners' performance, no overlap is discovered over different L1 vowels.

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[20] The pair /ʉ:-U/, even though the members of this pair have both length and quality difference, might be classified as the one possessing quality difference to Japanese listeners, as explained in the previous paragraph.

[21] The remarkable accuracy of the perception by the KE group in terms of length is well supported by the fact that Korean listeners kept the ability to distinguish length at the phonetic level although Korean phonology does not provide any phonological support to distinguish length, as found in Chapter 3, Park (1997).

This appears to indicate that the dense distribution of their L1 vowels prevented Korean listeners from expanding the perceptual scope of AE target vowels. On the contrary, Japanese listeners' perceptual result did show not only the expanded perceptual areas for the respective Japanese vowels but also a clear overlap of the perceptual areas (in the cases of the Japanese vowels /u/ and /o/).

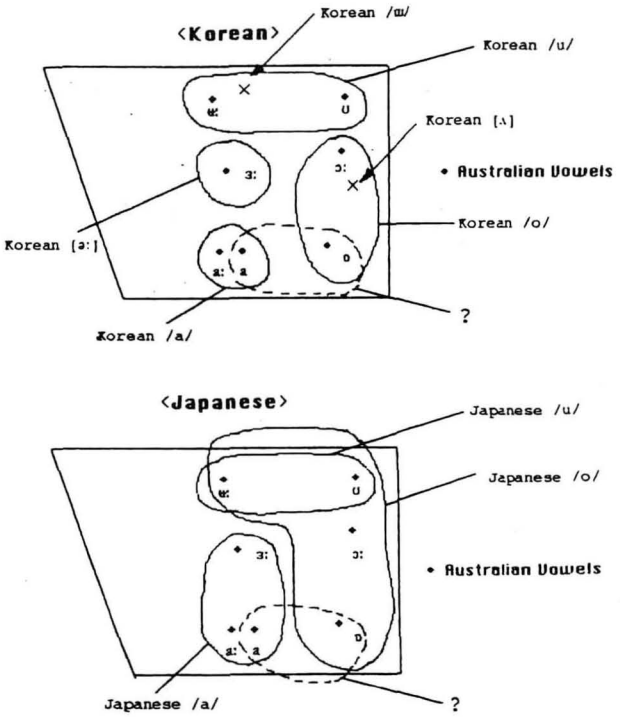

Figure 3. The Range of L2 Vowel Perception by Korean and Japanese Listeners: Perceptual Ranges of Korean and Japanese Listeners on the L2 Target Vowels and the Location of L1 Vowel(s) Corresponding to Them

As a whole, the density of an L1 vowel system seems to influence crucially L2 learners' setting up of perceptual scope over respective L2 target vowels. This means that if there exist many L1 vowels which result in densely occupied space in the vowel quadrilateral, the L2 learners who possess the dense L1 vowel system will make an accurate perceptual target

range for respective L2 vowels under the influence of the L1 vowel distribution. On the other hand, if an L1 vowel system is only sparse and has fewer vowels than the L2, the L2 learners possessing the sparse L1 vowel system will set up a more expanded target range for respective L2 vowels since the sparsity of the L1 vowel system, unlike the dense L1 vowel system, will not interfere with the establishment of a more expanded perceptual target range for L2 vowels[22]. This will eventually result in inaccurate L2 vowel perception in particular with regard to vowel quality.

The KI subjects confused the AE vowels /ɚ:/ and /ɔ:/ as /U/ and /ɒ/, respectively. In the Korean vowel system, /ɯ/ and /ʌ/ ([ʌ]) exist and both vowels are situated closely to the AE vowels /ɚ:/ and /ɔ:/, respectively. However, the Korean vowels /ɯ/ and [ʌ] are unrounded while /ɚ:/, /ɔ:/, /U/ and /ɒ/ belong to the category of rounded vowels. If the quality factor was more influential than the lip-rounding feature, the Korean vowels /ɯ/ and [ʌ] might be a counterpart of the AE vowel /ɚ:/ and /ɒ/[23], respectively and the confusion of the KI subjects between the AE vowels /ɚ:/ and /U/ and /ɔ:/ and /ɒ/ would not have happened. However, the outcome clearly demonstrated that the KI group members misperceived /ɚ:/ as /U/ and /ɔ:/ as /ɒ/. Thus, the lip-rounding feature seems a more influential factor than the vowel quality feature (F1 and F2).

This kind of situation is also discovered in the JI and JE groups' performance. The AE vowels /ɚ:/ and /U/ are acoustically close to the Japanese vowel /ɯ/. Thus, the Japanese vowel /ɯ/ might be counted as a counterpart of the AE vowels /ɚ:/ and /U/. However, the discrepancy of lip-rounding is discovered amongst these vowels. While both AE vowels possess the lip-rounding feature, the Japanese vowel /ɯ/ is normally pronounced without lip-rounding in casual speech. Thus, some scholars depict this vowel as [ɯ] at the phonetic level (Homma 1973; Vance 1987).

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[22] This claim is, after all, the opposite opinion to the theory of Flege in that the author's claim predicts the poor performance (perception and production) of L2 learners over 'new' L2 vowels while Flege predicts the better performance of L2 learners against 'new' L2 vowels.

[23] Since the qualitative distance between the AE vowel /ɚ:/ and the Korean vowel /ɯ/ is so close, they can surely be counterparts for each other. However, although [ʌ] is the closest vowel in the Korean vowel inventory to the AE vowel /ɒ/, the distance between these two vowels is not close as compared to that between AE /ɚ:/ and Korean /ɯ/ (see Fig. 3). Consequently, the possibility of these two being counterparts is less likely.

Regardless of the existence of a counterpart /u/ over the AE vowels /ʉ:/ and /U/ in the Japanese vowel system, the members of the JI and JE groups misperceived the AE vowel /ɔ:/ (the Japanese counterpart of this vowel is the rounded vowel /o/) as /ʉ:/ (JI and JE) and /U/ (JI). Once again, if the quality feature were superior to the lip-rounding feature, this result might not have arisen.

The results of the Japanese groups as well as the outcome of the KI group's perception of the AE vowels /ʉ:/ and /ɔ:/ strongly support the fact that the feature of lip-rounding is more influential than the feature of vowel quality (acoustic feature) in L2 vowel perception. Along with the earlier discussion for the relationship between length and quality features, we might eventually establish the hierarchy amongst the three features, namely lip-rounding, quality, and length in L2 vowel perception[24] (see Table 12). However, it is necessary that this tentative hierarchy should be examined through other various L2 vowel perception experiments.

Table 12. The Hierarchy of the Three Factors in L2 Vowel Perception

lip-rounding > quality (acoustic feature) > length

Earlier in this section, we raised the question of whether AE /ɒ/ belongs to a sound which falls in uncommitted phonetic space of L1 (Korean to Korean listeners or Japanese to Japanese listeners) in terms of Best's model. According to Best, since this vowel does not belong to one out of three categories (native, good, or deviant exemplar) of any L1 vowel, this one must be classified as a vowel which falls in uncommitted phonetic space of L1.

Table 13. The Perceptual Performance of the Four Groups (KE, KI, JE, JI) on the AE Vowel /ɒ/

	/ɜ:/	/a:/	/a/	/U/	/ɒ/	(R)
(T) /ɒ/		1	8		11	KE
	2	4	9		5	KI
	1		5		14	JE
			12	1	7	JI

[24] The superiority of lip-rounding is also discussed in Flege & Hillenbrand (1984) and Polka & Werker (1994).

To the point that the AE vowel /ɒ/ caused an extreme difficulty (see Table 13) to Korean and Japanese listeners[25], her theory might be appropriate. However, if this vowel is a vowel falling in uncommitted phonetic space for Korean and Japanese, the comparison of this vowel with the other L2 vowels in vowel pairs, such as /ɒ-a/ (cross-category) and /ɔː-ɒ/ (cross-category), should have recorded a good score. The actual result is, however, exactly opposite from the prediction based on Best's model. This outcome strongly challenges Best's Perceptual Assimilation model and raises the question of whether or not Best's model is effective in relation to L2 vowel perception as opposed to L2 consonant perception. This question also deserves to be studied more in the future[26].

Finally, in the previous section 3.3., we set up two different predictions on the Korean vowel /ʌ/ and two allophones [ʌ] and [əː], both of which have quite a different vowel quality. If the phonological level is applied in Korean listeners' AE vowel perception, two allophones [ʌ] and [əː] would be regarded as one phoneme /ʌ/. On the other hand, should phonetic level be active, each allophone will play a role like other phonemic vowels. The performance demonstrated that these two allophones behaved independently of each other. While [əː] played a clear role as a counterpart of the AE vowel /ɜː/, [ʌ] did not play any clear role (see Figure 3). Thus, it can be noted that the phonetic level seems to be activated if the condition meets although the phonological level is normally activated (refer to Werker (1993, 1994)). This result accords with the claim of Werker (1994) that while the phonological (phonemic) level is activated normally, the phonetic level, if the condition meets, can be activated. An analogous case is also discovered from /l-r/ perception of Korean listeners (Park (1997), Park & Ingram (1995b), Ingram & Park (1998)).

6. Conclusions

In this paper the three models were examined in relation to the perception

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[25] It is uncertain why Korean and Japanese subjects could not perceive the AE vowel /ɒ/ well. Assumably, L2 listeners' perceptual difficulty for the vowel /ɒ/ appears to lie in the short length and rarely arising place of this vowel, in particular, with lip-rounding.

[26] More expanded experiments are now underway to check this issue.

of AE back vowels by Korean and Japanese learners. Our experiment result showed that neither of the models could not predict the result perfectly.

The traditional model is based upon phonemic classification and comparison between the L1 and L2 vowels. The outcome of our experiment, however, showed that the listeners can activate their perceptual ability at phonetic level. On the other hand, while Flege's model is based upon acoustic consideration, Best's model departs from the consideration of articulatory gestures (features). The result in this paper seems to support articulatory consideration by showing the stronger influence of the lip-rounding feature than that of the pure acoustic signal (F1, F2). Nevertheless, Best's model revealed its weak point with the prediction of perception of the AE vowel /ɒ/ [27].

From the result of the experiment, it can be claimed that a novel model, which takes all influential factors into account, should be established to make more accurate predictions of L2 vowel perception.

The outcome of the experiment derived from relatively small amount of data. Therefore, the author is conducting successive experiments on AE back vowel perception in order to ascertain and expand the results of the experiment described in this paper.

References

Bernard, J. R. (1989) 'Quantitative Aspects of the Sounds of Australian English,' in P. Collins & D. Blair (eds.), *Australian English, The Language of a New Society*, Brisbane: The University of Queensland Press.

Best, C. T. and Strange, W. (1992) 'Effects of Phonological and Phonetic Factors on Cross-language Perception of Approximants,' *Journal of Phonetics* 20, 305-330.

_____, McRoberts, G. W., and Sithole, N. N. (1988) 'The Phonological Basis of Perceptual Loss for Nonnative Contrasts: Maintenance of Discrimination Among Zulu Clicks by English-speaking Adults and Infants,' *Journal of Experimental Psychology: Human Perception and*

[27] This problem might be accounted for with the consideration of language-universal factors (refer to Park (1997)).

Performance 14, 345-360.

Best, C. T. (1990) 'Adult Perception of Nonnative Contrasts Differing in Assimilation to Native Phonological Categories,' *Journal of the Acoustical Society of America* 88, S177.

_____ (1993) 'Language-specific Developmental Changes in Non-native Speech Perception: A Window on Early Phonological Development,' in B. de Boysson-Bardies et al. (eds.), *Developmental Neurocognition: Speech and Face Processing in the First Year of Life,* Dordrecht: Kluwer.

_____ (1994) 'The Emergence of Native-language Phonological Influences in Infants: A Perceptual Assimilation Model,' in H. C. Nusbaum and J. Goodman (eds.), *The Development of Speech Perception: The Transition from Speech Sounds to Spoken Words,* Cambridge: MIT.

Bohn, O-S. and Flege, J. E. (1992) 'The Production of New and Similar Vowels by Adult German Learners of English,' *Studies in Second Language Acquisition* 14-2, 131-158.

Clark, J. and Yallop, C. (1990) *An Introduction to Phonetics and Phonology,* Oxford: Basil Blackwell.

Flege, J. and Hillenbrand, J. (1984) 'Limits on Phonetic Accuracy in Foreign Language Speech Production,' *Journal of the Acoustical Society of America* 76-3, 708-721.

Flege, J. E. (1987a) 'The Production of 'New' and 'Similar' Phones in a Foreign Language: Evidence for the Effect of Equivalence Classification,' *Journal of Phonetics* 15-1, 47-65.

_____ (1987b) 'Effects of Equivalence Classification on the Production of Foreign Language Speech Sounds,' in A. James and J. Leather (eds.), *Sound Patterns in Second Language Acquisition,* Dordrecht: Foris.

_____ (1995) 'Second Language Speech Learning: Theory, Findings and Problems,' in W. Strange (ed.), *Speech Perception and Linguistic Experience: Issues in Cross-Language Research,* Baltimore: York Press.

Homma, Y. (1973) 'An Acoustic Study of Japanese Vowels,' *Onsei no Kenkyu* 16, 347-368.

Huh, W. (1983) *Onohak Kaeron, Kochinphan (An Introduction to Linguistics,*

2nd Edition), Seoul: Saemmunhwasa.

Imai, K. (1989) *Nichiei Hikakokouza*, Tokyo: Taishukan.

Ingram, J. and Park, S-G. (1996) 'Inter-language Vowel Perception and Production by Korean and Japanese Listeners,' *Proceedings of 1996 Interantional Conference on Spoken Language Processing* (ICSLP 96).

_____ (1997) 'Cross-language Vowel Perception and Production by Japanese and Korean Learners of English,' *Journal of Phonetics* 25-3.

_____ (1998) 'Language, Context and Speaker Effects in the Identification and Discrimination of English /r/ and /l/ by Japanese and Korean Listeners,' *The Journal of the Acoustical Society of America* 103-2.

Jakobson, R., Fant, C. G., and Halle, M. (1969) *Preliminaries to Speech Analysis: The Distinctive Features and Their Correlates*, Cambridge, MA.: MIT Press.

Keating, P. A. and Huffman, M. K. (1984) 'Vowel Variation in Japanese,' *Phonetica* 41, 191-207.

Lee, H-B. (1987) 'Korean Prosody: Speech Rhythm and Intonation,' *Korea Journal* 27-2, 42-70.

_____ (1989a) *Korean Grammar*, New York: Oxford University Press.

_____ (1989b) *Hankukoe Pyojun Pareum (The Standard Pronunciation of Korean)*, Seoul: Kyoyukkwahaksa.

Lee, K-M., Kim, C-W., and Lee, S-O. (1984) *Kugo Eumullon (Korean Phonology)*, Seoul: Hagyonsa.

Park, S-G. and Ingram, J. (1995a) 'English Vowel Production and Perception by Adult Korean and Japanese Speakers of English,' Presented at the Conference of Australian Linguistics Society held in Australian National University in Canberra in September, 1995.

_____ (1995b) '/l/ and /r/ Perception by Korean and Japanese Speakers Learning English: The Relative Importance of L1 Transfer Effects and Universal Acoustic Factors,' *Korean Journal of Linguistics* 20-4, 87-109.

Park, S-G. (1997) *Australian English Pronunciation Acquisition by Korean and Japanese Learners of English*, Ph.D. Dissertation, The University of Queensland.

Polka, L. and Werker, J. F. (1994) 'Developmental Changes in Perception of Nonnative Vowel Contrasts,' *Journal of Experimental Psychology: Human Perception and Performance* 20-2, 421-435.

Polka, L. (1995) 'Linguistic Influences in Adult Perception of Non-native Vowel Contrasts,' *Journal of the Acoustical Society of America* 97-2, 1286-1296.

Stevens, K. N. (1981) 'Constraints Imposed by the Auditory System on the Properties Used to Classify Speech Sounds: Data from Phonology, Acoustics and Psychoacoustics,' in T. F. Myers, J. Laver, and J. Anderson (eds.), *The Cognitive Representation of Speech* 61-74. Amsterdam: North Holland.

Vance, T. (1987) *An Introduction to Japanese Phonology*, Albany: State University of New York Press.

Werker, J. and Polka, L. (1993) 'The Ontogeny and Developmental Significance of Language-specific Phonetic Perception,' in B. de Boysson-Bardies et al. (eds.), *Developmental Neurocognition: Speech and Face Processing in the First Year of Life*, Dordrecht: Kluwer.

Werker, J. (1993) 'Developmental Changes in Cross-language Speech Perception: Implications for Cognitive Models of Speech Processing,' in G. T. Altmann and R. Shillcock (eds.), *Cognitive Models of Speech Processing: The Second Sperlonga Workshop*, Essex: Lawrence Erlbaum Associates.

_____ (1994) 'Cross-language Speech Perception: Development Change does not Involve Loss,' in H. C. Nusbaum and J. Goodman (eds.), *The Development of Speech Perception: The Transition from Speech Sounds to Spoken Words*, Cambridge: MIT.

Yang, B-G. (1990) *Development of Vowel Normalisation Procedures: English and Korean*, Seoul: Hanshin Publishing.

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