The role of perceived similarity and contrast: English loanwords into Korean and Japanese

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Abstract

This study explores a pattern of speech perception in Korean and Japanese with special attention to American English vowel /æ/. Two identification tests reveal that Korean speakers pay more attention to the second Formant (F2) signaling the backness of a vowel, whereas Japanese speakers are more sensitive to the first Formant (F1) signaling the height of a vowel. The distinct sensitivity to different acoustic cues in the languages discussed here is accounted for by two language-specific factors: Different L1 vowel systems and language-specific variations.

Key words:
Perceived similarity, language-specificity, native phonology, language experience, Korean, Japanese

1. Introduction

Loanword adaptation involves multiple factors, including speech perception, the phonological grammar of a recipient language, orthography, and other socio-linguistic factors. In particular, there is ample evidence for the role of perception in loanword phonology (Silverman, 1992; Dupoux et al., 1999; Peperkamp and Dupoux,
2003; Peperkamp, 2005; Peperkamp et al., 2008). It is possible that auditory capacity and perceptual mapping are fundamentally language-universal. However, it is widely acknowledged that perception is constrained by language-specific experience (Kuhl, et al., 1992; Best, 1995; Flege, 1995; Johnson, 2004). Thus, the perception pattern of non-native sounds observed in loanword adaptation provides much insight into language-specific aspects of the native phonology of a recipient language. In exploring the influence of language-specificity on perception, it is important to compare directly languages bearing distinct sound systems.

This study is concerned with the adaptation of American English [æ] in Korean and Japanese. Neither the vowel inventories of Japanese nor Korean include /æ/. At the same time, this vowel is adapted in a different way in each language. Let us consider the data in (1), where English [æ] takes on distinct forms in Korean and Japanese:

<table>
<thead>
<tr>
<th></th>
<th>English</th>
<th>Korean</th>
<th>Japanese</th>
</tr>
</thead>
<tbody>
<tr>
<td>iPad</td>
<td>[ai pʰedi]</td>
<td>[ai paddo]</td>
<td></td>
</tr>
<tr>
<td>tab</td>
<td>[tʰeɡ]</td>
<td>[tabu]</td>
<td></td>
</tr>
<tr>
<td>gag</td>
<td>[kegi]</td>
<td>[gjagu]</td>
<td></td>
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</tbody>
</table>

Commonly, /æ/ is adapted as /e/ in Korean\(^1\), while it is generally adapted as /a/ in Japanese. Since it is extensively documented that Korean speakers fail to discriminate the English /e/~/æ/ contrast (Flege et al., 1997; Ingram and Park, 1997; Kim, 2010; Tsukada

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\(^1\) Some variations are observed in the adaptation of [æ] in Korean, probably due to the orthographic effects, or the way in which loanwords are introduced and borrowed into the language.
et al., 2005; among others), this observed adaptation pattern in Korean seems to be attributable to the influence of perception. In contrast, the role of perceptual similarity in the Japanese loanword adaptation is questionable, given an apparent influence from orthography. However, it has been reported that Japanese speakers frequently misperceive /æ/ as /a/ (Ingram and Park, 1997; Hisagi, 2007; Strange et al., 2001). It will furthermore be shown that the perceptual mapping supports these distinct repair strategies in adopting the low front vowel [æ] in American English into Korean and Japanese.

This study investigates patterns of speech perception in Korean and Japanese. The distinct perception patterns in each language discussed here are accounted for by different L1 phonological systems and language-specific variations/sound change in progress.

*Vowel inventory of Korean and Japanese.* Standard Japanese has five short vowels. Figure 1 shows average values for the first formant (F1) and second formant (F2) of each short vowel (Vance, 2008). While slight differences are observed between reading word lists and prose passages, /e/ and /a/ are well apart from each other both in F1 and F2 dimensions.

![Figure 1. Average F1 and F2 of Japanese short vowels produced by Japanese speakers reading word lists (●) and prose passages (○) (Vance, 2008)](image-url)
Turning to Korean, Standard Korean includes seven contrastive monophthongal vowels: /a, e, i, o, u, ɨ, ʌ/ (Ahn, 1998; Kim, 1999; Kang, 2013). The vowel space of Korean is shown in Figure 2.

![Figure 2](image)

Figure 2. Korean vowel space in an /hV/ context: the center of each ellipse represents the mean F1/F2 frequency, while the solid and dashed ellipses represent one and two standard deviations, respectively (Mitsuya, 2010).

It should be noted that Korean previously exhibited an /e/-/ɛ/ contrast, and this is still reflected in the Korean writing system: /e/ by “ㅔ” and /ɛ/ by “ㅐ”. A recent corpus study (Kang, 2013) finds that the merger of /e/ and /ɛ/ is nearly completed via the raising of /ɛ/. As a result, both letters “ㅔ” and “ㅐ” are realized as /e/, and this symbol is used for the non-high front vowel in Korean throughout this paper. Still, (Kang, 2013) reports that older male speakers marginally retain this vowel distinction, suggesting the possibility that younger speakers experience this contrast even if they do not distinguish the two vowels.

By comparing the vowel systems in Korean and Japanese, it seems that the vowel spaces of the non-high, non-back area are quite similar in terms of density and average F1 and F2 values. Thus we need first to consider if the divergent adaptation patterns of /æ/ between the two languages involves different perception patterns. In order to examine
this question, I conducted identification tests with two different sets of stimuli, each discussed in the following sections.

2. Experiment

2.1 Identification of non-native vowels using natural stimuli

2.1.1 Method

Material and recording. English nonsense words of the form CVs were created. All the items contained one of the three vowels /æ, e, a/ preceded by either /h/ or /f/. Testing nonsense words, allowed us to obviate the influence of existing loans or frequency effect. An onset was added to the vowels, as a CV syllable makes the possible responses less likely to be existing words than a simple V syllable. Note that a stop-V sequence results in more existing words compared to a fricative-V sequence. The onset fricatives, particularly /h/, were chosen in order to minimize possible effects of a consonant on the acoustic characteristics of a following vowel. Most of the possible responses for the CV combinations tested in the current study were nonce words both in Korean and Japanese.

Figure 3. F1 and F2 of the three English vowels produced by the American English
One male speaker of American English read the list containing the six target items together with twelve fillers. The recording was made in a sound-attenuated booth at National Institute for Japanese Language and Linguistics. The mean formant frequencies of the speaker are presented in Figure 3.

Participants and task. Thirty four standard Korean, and twenty eight standard Japanese monolingual speakers participated in a forced-choice vowel identification task. Participants ranged in age from 18 to 39 years at the time of the test. All were born and grew up in the respective linguistic target areas and had no history of speech or hearing impairment.

The target items and fillers were shuffled and presented in a random order. Participants were instructed to choose the closest sequences that they heard among given choices, after listening to each token three times. Choices were provided in Korean (Hangul) or Japanese orthography (Katakana).

2.1.2 Results

The mean percentages of /e/ perception are illustrated in Figure 4. In both languages, the control vowels /a/ and /ɛ/ are quite consistently mapped to /a/ and /e/, respectively; only one Korean speaker chose /e/ for English /a/ preceded by /h/, and three Japanese speakers chose /a/ for English /ɛ/ preceded by /f/. In contrast, the perception of /æ/ exhibits substantial differences between Korean and Japanese: for English vowel /æ/, Koreans speakers tend to perceive /e/ while Japanese speakers tend to perceive /a/, indicating that perception also supports the observed adaptation pattern in the languages discussed here.
It should be noted that the non-/e/ responses for English /æ/ were /a/ without exception.

Figure 4. Percentages of /e/ responses for natural stimuli in Korean (left) and Japanese (right)

The vowel identification patterns discussed above seem to show that the vowel quality of /æ/ guides Korean and Japanese speakers to perceive different vowels. However, natural stimuli involve not only the vowel quality but also other perceptual cues, such as pitch or duration. In order to circumvent the problem of natural stimuli, another set of sounds was further tested.

2.2 Identification of synthesized stimuli

2.2.1 Method

Two sets of synthesized sounds for each onset consonant were created, by varying the F1 and F2 of the English vowel /æ/ as obtained in the recording session (i.e. an F1 continuum and F2 continuum respectively). In manipulating formant frequencies, the tool “source-filter synthesis using existing sounds” in Praat was used. Specifically, F1 of the vowel was lowered by 30 Hz steps (ranging from 800 Hz to 620 Hz), and F2 by 60 Hz
steps (ranging from 1540 Hz to 1180 Hz), yielding 7 stimuli for each continuum. As a reference for the range of formant continua, the F1 and F2 values of [a] and [ɛ] recorded were used, which is given in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>F1 (Hz)</th>
<th>F2 (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Æ</td>
<td>787</td>
<td>1600</td>
</tr>
<tr>
<td>Ɛ</td>
<td>641</td>
<td>1650</td>
</tr>
<tr>
<td>a</td>
<td>788</td>
<td>1176</td>
</tr>
</tbody>
</table>

It is worth noting that the duration of stimuli was carefully controlled, since it is widely acknowledged that duration can be a critical cue for vowel contrast. The duration of all the manipulated stimuli in this study was 85 ms, which was the average duration of [a] and [ɛ] for the speaker.

The stimuli were presented to the same participants who identified the natural stimuli. The equivalent procedure of the previous task was performed for this set of stimuli.

### 2.2.2 Results

Figure 5 presents the percentages of /e/ responses in Korean. For the F1 continuum ([æ] to [ɛ]), no appreciable change of vowel perception is observed, indicating that the stimuli were invariably perceived as /e/. Sounds on the F2 continuum ([æ] to [a]), on the other hand, exhibit a gradual decrease of /e/ responses, suggesting that speakers are sensitive to the backness of a vowel, as signaled by F2. Interestingly, the two onset consonants yield fairly different perception patterns: the percentages of /e/ perception declines more
rapidly with /f/ onset than with /h/ onset. This difference associated with onset consonants cannot be attributed to the influence of formant transition, since both F1 and F2 were manipulated to be constant throughout the entire vowel portion, thus bearing no transition from the preceding consonant. Rather it is conceivable that the formant structure of the original vowel [æ] contained in /h/—F2 in particular—is responsible for the prevalent /e/ responses involving the /h/ onset. At the same time, these results suggest that Korean speakers are relatively insensitive to varying F1, and perceive /e/ as long as the F2 of a vowel is high enough to signal a front vowel. This consonant is less likely to affect the following vowel, but is itself quite heavily affected by the vowel, and furthermore, cues present in the consonant caused by the vowel seem to play some role in vowel identification.

Figure 5. Percentages of /e/ responses for manipulated stimuli in Korean

Turning to Japanese, quite different responses are observed, as shown in Figure 6. Unlike Korean speakers, sounds on the F1 continuum ([æ] to [ɛ]) are negatively correlated with the percentage of /e/ responses, suggesting that Japanese speakers are sensitive to vowel height as signaled by F1. With respect to varying F2, no noticeable
change in vowel perception was observed. The observed difference between Korean and Japanese is instructive because it reveals that the specific perceptual boundary between /e/ and /a/ differs across the languages, even though the average F1 and F2 frequencies of the vowels are comparable.

![Figure 6. Percentages of /e/ responses for manipulated stimuli in Japanese](image)

In summary, the results reveal that the perception pattern supports the adaptation patterns not only for Korean but for Japanese as well. Moreover, the results of synthetic stimuli show that Korean speakers perceive /e/ as long as F2 is high (signaling a front vowel) whereas Japanese speakers perceive /a/ as long as F1 is high (signaling a low vowel).

3. Discussion

Korean speakers attend more to F2, whereas Japanese speakers attend more to F1 in identifying non-high, non-back vowels. Given the fact that the identical acoustic cues regarding vowel quality are equivalently available for use in both languages, and that the non-back, non-high parts of the vowel space are extremely similar in Japanese and
Korean, it is not obvious why distinct perception patterns are observed in these languages.

However, it is widely accepted that perception is influenced by language-specificity (Kuhl, et al., 1992; Best, 1995; Flege, 1995; Johnson, 2004). In particular, two possible language-specific factors may have affected the divergent response patterns observed here. One possibility involves the phonology/phonetics of L1. Specifically, differences in the constitution of the vowel inventory across the languages might have affected the perception pattern by directing native speakers’ attention to different acoustic cues. This possibility implies that it is necessary to look beyond the merely lower front portion of the vowel spaces, and to the overall vowel system in order to understand the relevant perception patterns. If we consider the entire vowel system of the languages under investigation, it is clear that two more contrastive vowels are present in Korean: a high mid unrounded vowel /ɨ/ and mid back unrounded /ʌ/. It may be the case that the presence of mid back unrounded /ʌ/ vowel leads listeners to be sensitive to the backness of a vowel, in non-high vowels as well. Also, the mid back unrounded vowel /ʌ/ yields greater competition among vowels of mid height, i.e. /e, o, ʌ/. Unlike /o/, which is characterized by roundness, /e/ and /ʌ/ contrast only in backness, and this may result in speakers’ enhanced attention to F2 in the identification mid vowels. In contrast, for Japanese speakers, perception of non-native sounds involving different F2 values may be more challenging than perceiving contrasts involving F1 differences, since the Japanese vowel inventory includes only /e/ and /o/ (which contrast not only in backness but also in roundness).

Still, the differences in L1 phonology/phonetics alone do not sufficiently account for the observation that Korean speakers are more insensitive to F1 than Japanese
speakers. The other language-specific factor that may have contributed to these response patterns is the merger of /e/ and /ɛ/ in Korean. Recall that the merger of the two vowels has nearly reached completion, and only older speakers retain the contrast (Kang, 2013). A recent corpus study (Yoon et al., 2015) reports the vowel contrast of older speakers in many varieties of Korean, including standard Korean. The vowel system of standard Korean that Yoon et al. (2015) present is shown in Figure 7. The study relied on spontaneous conversational speech collected in 2011, and the speaker was 81 years old at the time of recording. As illustrated in Figure 7, this speaker still retain the /e/-/ɛ/ distinction. It is not implausible to think that this distinction is simply recognized as greater phonetic variation by younger speakers who do not maintain this contrast, and that this “variation” in F1 dimension might have contributed to the development of insensitivity with regard to varying F1.

![Vowel Inventory of Standard Korean](image)

**Figure 7.** The vowel inventory of standard Korean produced by an older speaker (Yoon et al., 2015)

Further investigation into other languages may provide yet more direct evidence as to whether the presence or absence of this contrast indeed influences sensitivity to specific
acoustic cues, as seems indicated here in the Korean and Japanese cases.

4. Conclusions

In this paper I have addressed distinct adaptation patterns in Korean and Japanese, focusing on American English vowel /æ/. Specifically, the role of perceptual similarity modified by language-specific contrasts in L1 phonology and phonetic details, was explored in accounting for observed adaptation patterns.

I have provided the data of an identification task where two sets of stimuli were tested: natural utterances of nonsense words and formant-manipulated stimuli. The results reveal that speakers of the languages investigated perceive the input vowel [æ] in distinct ways: while [æ] was perceived consistently as [e] by Korean speakers, it was identified as [a] by Japanese speakers. This result provides support for the role of perceived similarity in loanword adaptation. Furthermore, distinct sensitivity to different acoustic cues was found: Korean speakers tend to pay more attention to F2 (signaling the backness of a vowel), whereas Japanese speakers appear to be more sensitive to F1 (signaling the height of a vowel). By utilizing synthetic stimuli, it was shown that the perceptual boundary between /e/ and /a/ differs across the languages, even though the average F1 and F2 frequencies of the vowels are comparable between Korean and Japanese.

This paper has also discussed why Japanese and Korean speakers exhibit distinct sensitivity to identical acoustic cues even regarding the same relative vowel space (i.e. the non-high, non-back region). The distinct perception patterns are ascribed to language-specific experiences. By taking differences in L1 phonology, as well as phonetic variations into account, this study has highlighted the manner in which language
specificity shapes different perceptual sensitivity.

Testing more varieties of dialects and languages as a recipient and also as a donor language is a promising direction for future research. Recently, a perception study demonstrated that Polish speakers exhibit distinct perception pattern of /æ/ in British English and American English (Szpyra-Kozłowska and Radomski, 2015). Incorporating more recipient languages having different phonetics and phonology would help us better understand how language-specific experiences constrain perception patterns of speakers in the adaptation of loanwords.

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References


