

Perception of syllable-initial and syllable-final nasals in English by Korean and Japanese speakers

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In both Korean and English, /m/ and /n/ contrast syllable-initially and /m/, /n/ and /ŋ/ contrast syllable-finally. In Japanese, /m/ and /n/ contrast syllable-initially while nasals do not contrast syllable-finally. Experiment 1 of this study investigated Korean and Japanese speakers' perception of English nasals to examine how learners' L1 influences the perception of L2 segments. The Japanese speakers had considerable difficulty distinguishing /ŋ/ from /n/ syllable-finally. Final /m/-/ŋ/ and /m/-/n/ were not particularly problematic for the Japanese speakers, although these contrasts do not exist in their L1. Experiment 2 examined the perceived relation between English /m/, /n/ and /ŋ/ and Japanese categories to investigate why final /n/-/ŋ/ was especially difficult for the Japanese speakers. In order to examine which Japanese categories are used to represent final nasals in English, Japanese speakers were asked to write English words used in Experiment 1 with the Katakana orthography. It was found that syllable-final /m/ was assimilated to one Japanese category, ろ /muw/, whereas two or more categories were used to classify /n/ and /ŋ/. There was a relatively high degree of overlap in classification between /n/ and /ŋ/ since both /n/ and /ŋ/ were classified with ん /N/ and んぐ /Ngw/. The three final contrasts, /n/-/ŋ/, /m/-/ŋ/ and /m/-/n/ were classified as one of the assimilation types of the Perceptual Assimilation Model (PAM), based on the results from Experiment 2. The syllable-final /m/-/ŋ/ and /m/-/n/ contrasts were classified as Uncategorized–Categorized (UC), and the syllable-final /n/-/ŋ/ contrast was classified as Both Uncategorizable (UU). PAM expects discrimination to be very good for UC, but poor for UU if the two non-native categories are relatively similar to each other. The results from Experiment 1 for the Japanese speakers were consistent with the PAM prediction.

I Introduction

Knowledge of first language is considered to be one of many factors affecting foreign accent, such as age, length of residence, gender,

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motivation and instruction (Major, 1987; Flege, 1995; for a review, see Piske *et al.*, 2001). Pronunciation problems cannot be simply predicted on the basis of comparison between the first language (L1) and second language (L2) (Major, 1987: 188–89; Eckman & Iverson, 1994: 263); for example, Eckman and Iverson (1994) reported cases in which L2 learners found some segment types more difficult than others, even though both exist in their L1. It was also found that learners had no difficulty in producing some segments in the coda although they do not appear in the coda in L1 (Eckman and Iverson, 1994).

Some models of cross-language and L2 speech perception posit that the perceived relationships between categories in L1 and L2 play an important role in how accurately L2 segments are perceived or produced (Best, 1995; Flege, 1995). The Speech Learning Model (SLM; Flege, 1995) hypothesized that L1 and L2 sounds are perceptually related to one another at a position-sensitive allophonic level, and acquisition of L2 sounds depends on the perceived dissimilarity between L1 and L2 sounds. The Perceptual Assimilation Model (PAM; Best, 1995) predicts discriminability for non-native contrasts from the assimilation of each of the contrasting non-native segments. For example, if two non-native categories are assimilated to two different native categories, discrimination is expected to be excellent. On the other hand, if two non-native categories are assimilated to a single native category, discrimination is expected to be poor (Best, 1995: 195).

This study consists of two experiments. Experiment 1 investigated how learners' perception of L2 segments is affected by their L1, by examining native Korean and Japanese speakers' perception of nasal segments in English. Experiment 2 examined the perceived relationship between English syllable-final nasals and Japanese categories in order to provide insight into why one of the contrasts was particularly difficult for the Japanese speakers.

II Background

Nasal segments [m], [n] and [ŋ] all appear in English, Korean and Japanese, but their phonemic status and distributions differ. In English, /m/ and /n/ contrast both syllable-initially and syllable-finally. The velar nasal /ŋ/ contrasts with the other two nasals only syllable-finally. In Korean, /m/ and /n/ contrast syllable-initially and /m/, /n/ and /ŋ/ contrast syllable-finally, as in English (Lee, 1973: 160). In Japanese, on the other hand, /m/ and /n/ contrast only syllable-initially and there are no contrasts in nasals syllable-finally (Amanuma *et al.*, 1983; Vance, 1987). Nasal segments do appear

syllable-finally; however, all nasal segments are generally treated as allophones of the so-called mora nasal, /N/ (Vance, 1987).¹ Phonetically, /N/ is a uvular nasal [ŋ] before a pause, and many allophones, including [m], [n] and [ŋ], appear in complementary distribution due to regressive assimilation (Amanuma *et al.*, 1983; Vance, 1987; Nakajo, 1990). For instance, /N/ is phonetically realized as [n] in *hon-da* 'is book' but as [ŋ] in *hon-ka* 'book?' (from Vance, 1987: 35). /N/ is written with the same letter (ん in Hiragana, ヌ in Katakana) in the Japanese orthography (or Kana orthography), despite the fact that a wide variety of segments appear as allophones. In Japanese romanization, it is written as *n*. The letter *m* may also be used occasionally when it is phonetically [m] (e.g. *namba* for /naNba/ 'a name of a place in Osaka', but *ng* is not used for [ŋ]).

In addition, it has been argued whether or not [ŋ] is a phoneme in Japanese (Goodman, 1968; Vance, 1987; Makajo, 1990). Some have analysed [ŋ] as a separate phoneme (e.g., Amanuma *et al.*, 1983) because some minimal pairs exist (/daigo/ *fifth*, /daiŋo/ *an emperor's name*, from Nakajo, 1990: 77). However, it is generally agreed that syllable-initial [ŋ] is an allophone of /g/ (Kohmoto, 1969; Vance, 1987; Hibiya, 1995).

As one might expect, English words with syllable-final nasals are borrowed differently in Korean and Japanese. Syllable-final /m/, /n/, /ŋ/ in English borrowings are pronounced as [m], [n], [ŋ] in Korean.² Words such as *team*, *game*, *room* are borrowed with a final /m/. *King Kong*, *Hong Kong* are borrowed with a final /ŋ/, and *chicken* is borrowed with a final /n/. In Japanese, foreign borrowings with syllable-final nasals are pronounced either with vowel insertion, or borrowed with the coda nasal, which is pronounced as uvular nasal [ŋ] utterance-finally. The final /m/ is pronounced as [mu] with vowel insertion (e.g., *game* ㄱ-ム /ge:mu/, *room* /ㄴ-ム /ru:mu/). The final /n/ is borrowed as the coda nasal, /N/ (e.g., *chicken* ㄷ키ㄴ/tjikiN/). The final /ŋ/ is sometimes borrowed as /Ngu/, the coda nasal followed by /gu/ (e.g., *King Kong* キㄴㄱㄴㄱ/kiNgu koNgu/). It is also borrowed as the coda nasal (e.g., *Hong Kong* ㄱㄴㄴ/hoNkoN/).

The purpose of Experiment 1 was to investigate how the differences in learners' L1 affect Korean and Japanese speakers'

¹I have analysed it as underlyingly /n/ (Aoyama, 1999). In this article, [N] is used for the Japanese coda nasal to avoid confusion with English [n].

²I thank Marilyn Plumlee for providing the Korean examples. The examples were checked with a native Korean speaker.

perception of nasal segments in English. It was predicted that Korean speakers would have less difficulty in English nasal contrasts because /m/ and /n/ contrast syllable-initially and /m/, /n/ and /ŋ/ contrast syllable-finally both in English and Korean. It was predicted that Japanese speakers would have difficulty with syllable-final contrasts because nasals do not contrast syllable-finally in Japanese. Experiment 2 investigated the perceived relation between the Japanese categories and English /m/, /n/ and /ŋ/, because the results of Experiment 1 indicated that one of the contrasts, syllable-final /n/-/ŋ/, was especially difficult for the Japanese speakers.

III Experiment 1

1 Method

a Participants: Twenty native speakers of Korean (10 males, 10 females) and 20 native speakers of Japanese (10 males, 10 females) participated in Experiment 1. Their ages ranged from early twenties to mid fifties. All of them had studied English through secondary systems in Korea or Japan. Their length of stay in an English-speaking country was limited (less than a year), if any. The Korean participants were tested in Seoul, Korea, and the Japanese participants were tested in Tokyo and Osaka, Japan. Twenty native English speakers (10 males, 10 females) also participated as a control group. Their ages ranged from early twenties to mid forties. They were tested in Honolulu, Hawaii, and the majority of them (12 participants) were originally from Hawaii.

b Materials: Twenty pairs – 5 pairs each for 4 different contrasts, syllable-initial /m/-/n/, syllable-final /n/-/ŋ/, syllable-final /m/-/ŋ/ and syllable-final /m/-/n/ – were selected (see Table 1).³ Basic monosyllabic English words were selected in order to minimize a bias for lexical familiarity. Ten irrelevant pairs were also selected as distracters. A male, native speaker of English from California produced 50 English words (40 target words and 10 distracters).

Table 1 The word pairs used in Experiments 1 and 2

Initial /m/-/n/	mitt : knit	map : nap	met : net	mood : nude	mob : knob
Final /n/-/ŋ/	sin : sing	thin : thing	son : sung	kin : king	lawn : long
Final /m/-/ŋ/	swim : swing	rim : ring	slim : sling	some : sung	brim : bring
Final /m/-/n/	scene : seem	hen : hem	sane : same	line : lime	worn : warm

³Some pairs may also differ in vowel quality for some speakers.

Each word was repeated twice, and the inter-stimulus interval was approximately 1 second. The recording was made using a Tandberg TCR 522 in a soundproof room in the foreign language laboratory at the University of Hawaii at Manoa. Three native speakers of English (one phonologist, one graduate student in linguistics and a naive native speaker) listened to the recording, and they confirmed that the intended words were clearly recorded. An answer sheet was prepared (see Appendix 1). Each target pair appeared twice on the sheet. For example, *knit* : *mitt* appeared as the second pair and the twenty-ninth pair. For the second pair, *mitt* was recorded, and hence was the correct answer, and *knit* was recorded and the correct answer for the twenty-ninth pair.

The participants were tested individually. They listened to the tape with a headphone and a Sanyo compact cassette player (model MGR-906D[K]), and were told to indicate the word they heard from the corresponding pair on the answer sheet.

2 Results

The numbers and the percentages of errors for each group are shown in Table 2. The analysis was based on a total of 200 responses for each group for each contrast (10 words × 20 participants). The data from male and female participants were pooled because a preliminary ANOVA showed that the main effect of Gender was nonsignificant ($F(1,58) = 2.42, p > 0.1$), and this factor did not interact significantly with any other factor ($p > 0.1$).

Table 2 Numbers (percentages in brackets) of errors for each contrast and participant group

	English	Korean	Japanese
Initial /m/-/n/	12 (6.0)	21 (10.5)	14 (7.0)
Final /n/-/ŋ/	2 (1.0)	12 (6.0)	55* (27.5)
Final /m/-/ŋ/	2 (1.0)	10 (5.0)	15** (7.5)
Final /m/-/n/	12 (6.0)	25 (12.5)	23 (11.5)

Notes: * Significantly different from the English and Korean groups ($p < 0.05$);

** significantly different from the English group ($p < 0.05$).

The numbers of errors were submitted to a two-way ANOVA in which Language (3 levels) served as a between-subjects factor and Types (4 levels) served as a within-subjects factor. It yielded a significant two-way interaction ($F(6,173) = 13.56, p < 0.01$), indicating that the numbers of errors for the four types of contrasts were significantly different among the three groups (see Figure 1). The numbers of errors for Initial /m/-/n/ and Final /m/-/n/ were not

statistically different across the three groups (Initial /m/-/n/, $F(2,57) = 1.45, p > 0.1$; Final /m/-/n/, $F(2,57) = 2.36, p > 0.1$). The effect of Language was significant for Final /n/-/ŋ/ ($F(2,57) = 69.86, p < 0.001$), and for Final /m/-/ŋ/ ($F(2,57) = 3.76, p < 0.02$). A series of Tukey's post-hoc tests revealed that the Japanese speakers made more errors than the English and Korean speakers for Final /n/-/ŋ/ ($p < 0.05$). The Japanese speakers also made more errors than the English speakers for Final /m/-/ŋ/ ($p < 0.05$), although the difference between the Korean and Japanese groups was nonsignificant for Final /m/-/ŋ/. The difference between the English and Korean groups was nonsignificant for all four contrasts ($p > 0.05$). This suggests that, overall, the Japanese group differed from the English and Korean groups for Final /n/-/ŋ/ and Final /m/-/ŋ/ whereas the numbers of errors did not differ significantly between the English and Korean groups.

Although the Korean speakers made more errors in general, similar overall patterns of errors were found for the English and Korean groups (see Figure 1); for both groups, more errors were found for Initial /m/-/n/ and Final /m/-/n/ than for Final /n/-/ŋ/ and Final /m/-/ŋ/. For both groups, significant differences were found in the numbers of errors among the four contrasts (English $\chi^2 = 14.96$,

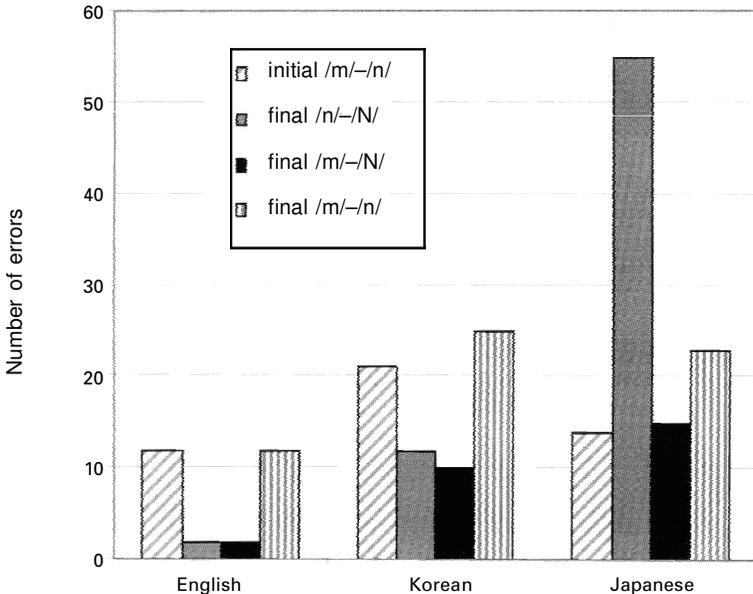


Figure 1 Numbers of errors for four contrasts in Experiment 1

df = 3, $p < 0.05$, Korean $\chi^2 = 10.02$, df = 3, $p < 0.05$). For the English group, significantly more errors were found for Initial /m/-/n/ than for Final /n/-/ŋ/ ($\chi^2 = 7.40$, df = 1, $p < 0.05$) and Final /m/-/ŋ/ ($\chi^2 = 7.40$, df = 1, $p < 0.05$). Also significantly more errors were found for Final /m/-/n/ than for Final /n/-/ŋ/ ($\chi^2 = 7.40$, df = 1, $p < 0.05$), and Final /m/-/ŋ/ ($\chi^2 = 7.40$, df = 1, $p < 0.05$). Similarly for the Korean group, significantly more errors were found for Initial /m/-/n/ than for Final /m/-/ŋ/ ($\chi^2 = 4.23$, df = 1, $p < 0.05$), while the difference between Initial /m/-/n/ and Final /n/-/ŋ/ was nonsignificant ($p > 0.05$). More errors were found for Final /m/-/n/ than for Final /n/-/ŋ/ ($\chi^2 = 5.03$, df = 1, $p < 0.05$) and Final /m/-/ŋ/ ($\chi^2 = 7.05$, df = 1, $p < 0.05$). In sum, the English and Korean speakers made more errors for the /m/-/n/ contrast both initially and finally than for Final /n/-/ŋ/ and Final /m/-/ŋ/.

A different pattern of errors was found for the Japanese group compared to the other two groups. A chi-square analysis showed that there were significant differences in the numbers of errors among the four contrasts ($\chi^2 = 50.32$, df = 3, $p < 0.001$). Significantly more errors were found for Final /n/-/ŋ/ than for Initial /m/-/n/, Final /m/-/ŋ/ and Final /m/-/n/ ($\chi^2 = 16.30$ to 29.44 , df = 1, $p < 0.001$). Differences in numbers of errors for Initial /m/-/n/, Final /m/-/ŋ/ and Final /m/-/n/ were nonsignificant ($p > 0.05$).

The results indicate that the Japanese speakers had considerable difficulty distinguishing /ŋ/ from /n/ syllable-finally (see Table 3). All but one Japanese speaker had at least one error for Final /n/-/ŋ/ and the percentage of errors (27.5%) for Final /n/-/ŋ/ was higher by far than for the other three contrasts. The initial /m/-/n/ contrast was expected to be the easiest for the Japanese speakers because that is the only contrast that exists in Japanese. However, the results indicated that the syllable-final /m/-/ŋ/ and syllable-final /m/-/n/ contrasts were as easy as syllable-initial /m/-/n/ for the Japanese speakers. It was not that all syllable-final nasal contrasts were difficult for the Japanese speakers, but the difficulty was on a particular contrast, syllable-final /n/-/ŋ/.

Table 3 Japanese speakers' perception of English syllable-final nasals in Experiment 1 (Final /n/-/ŋ/, /m/-/ŋ/ and /m/-/n/ combined)

Stimulus	Perceived final		
	/m/	/n/	/ŋ/
[m]	192 (96.0%)	7 (3.5%)	1 (0.5%)
[n]	16 (8.0%)	179 (89.5%)	5 (2.5%)
[ŋ]	14 (7.0%)	55 (25.0%)	131 (68.0%)

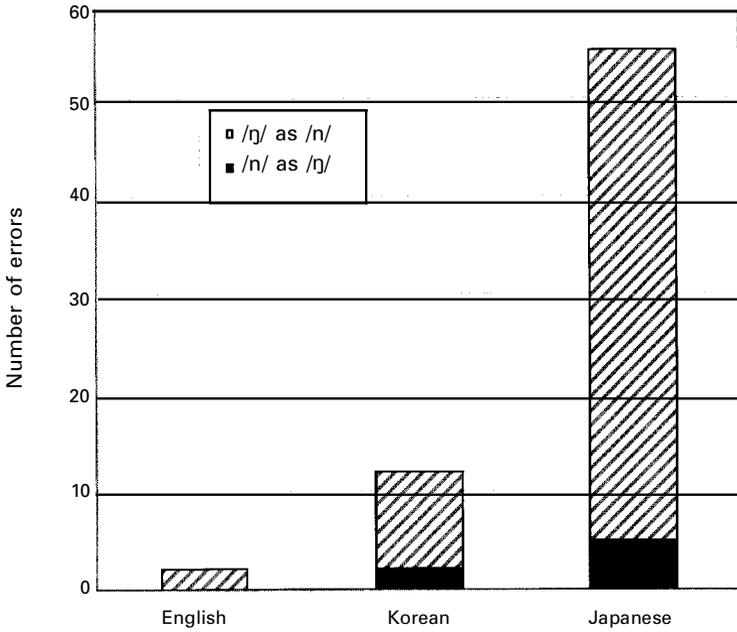


Figure 2 Kinds of errors for Final /ŋ/-ŋ/ in Experiment 1

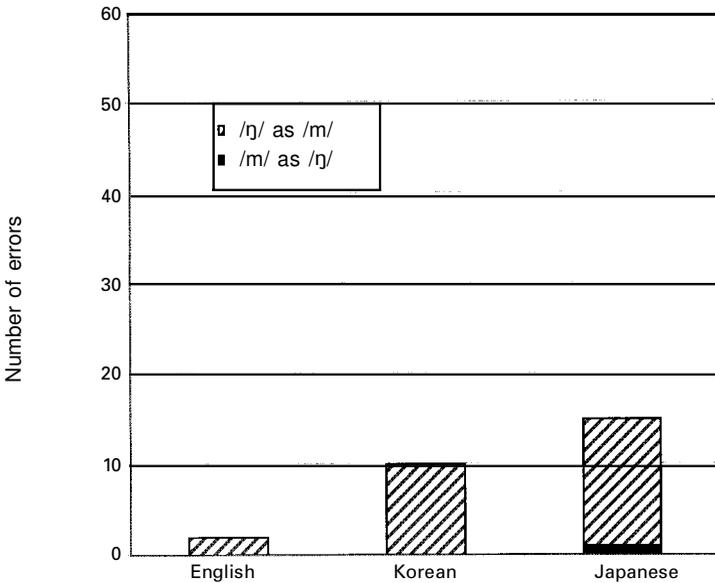


Figure 3 Kinds of errors for Final /m/-ŋ/ in Experiment 1

Figures 2 and 3 show the kinds of errors for Final /n/-/ŋ/ and Final /m/-/ŋ/ respectively. Interestingly, the Japanese speakers misheard /ŋ/ as /n/ more than vice versa (50 vs. 5 errors, $\chi^2 = 50.78$, $df = 1$, $p < 0.001$). The Korean participants also misheard /ŋ/ as /n/ more often than vice versa (10 vs. 2 errors, $\chi^2 = 5.67$, $df = 1$, $p < 0.02$). Also for Final /m/-/ŋ/, significantly more errors were found in the direction of /ŋ/ heard as /m/ than vice versa (Japanese: 14 vs. 1 errors, $\chi^2 = 12.18$, $df = 1$, $p < 0.001$; Korean: 10 vs. 0 errors, $\chi^2 = 6.73$, $df = 1$, $p < 0.01$). Table 4 shows the kinds of errors for Initial /m/-/n/ and Final /m/-/n/. The errors seem to be bi-directional for Initial /m/-/n/; /m/ was misheard as /n/ and /n/ was misheard as /m/. For Final /m/-/n/, /n/ was misheard as /m/ more often than vice versa for the Japanese group (16 vs. 7 errors, $\chi^2 = 3.98$, $df = 1$, $p < 0.05$) and for the English group (10 vs. 2 errors, $\chi^2 = 5.67$, $df = 1$, $p < 0.02$).

Table 4 Kinds of errors for the /m/-/n/ contrasts

	Syllable-initial			Syllable-final		
	English	Korean	Japanese	English	Korean	Japanese
/m/ heard as /n/	4	11	8	2	10	7
/n/ heard as /m/	8	10	6	10	15	16
Total	12 (6%)	21 (10.5%)	14 (7%)	12 (6%)	25 (12.5%)	23 (11.5%)

3 Discussion

Different patterns of errors were found among the three participant groups in the perception of syllable-initial and syllable-final nasals in English. The English and Korean speakers found it more difficult to distinguish /m/ from /n/ both syllable-initially and syllable-finally than to distinguish /ŋ/ from /n/ and /m/ syllable-finally. On the other hand, syllable-final /n/-/ŋ/ was the most difficult contrast among the four contrasts for the Japanese speakers. This was an expected result to a certain extent; the contrasts were expected to be easier for the Korean speakers than for the Japanese speakers because all the contrasts exist in Korean but not in Japanese. However, the results cannot be fully explained by comparing English, Korean and Japanese. First, the Korean speakers, as well as the native-English speakers, found the initial and final /m/-/n/ contrasts more difficult than the final /n/-/ŋ/ and /m/-/ŋ/ contrasts although all contrasts exist in English and Korean. Second, the final /m/-/ŋ/ and /m/-/n/ contrasts were as easy as the initial /m/-/n/ contrast for the Japanese speakers. The final /n/-/ŋ/ contrast was particularly difficult for them.

The relative difficulty for the initial and final /m/–/n/ contrasts for the English and Korean groups might be attributed to perceptual similarity between /m/ and /n/. Miller and Nicely (1955) reported that /m/ and /n/ could be confused with each other syllable-initially, and the confusion seemed to be bi-directional (/m/ heard as /n/, and vice versa). Black (1969) examined the perceptual similarity of 60 initial consonants, and concluded that /m/ and /n/ were relatively more similar to each other among the consonants he examined. Thomas (1992) made a similarity index among 40 English phonemes, in which he ranked phoneme pairs from the most similar to the least similar. According to his index, /m/–/n/ was ranked the thirty-sixth, while /m/–/ŋ/ and /n/–/ŋ/ were ranked the eighty-second and one hundred and forty-fourth respectively. Thomas's similarity index suggested that /m/ and /n/ were more similar to each other than /n/ and /ŋ/, and /m/ and /ŋ/ were.

The fact that /n/–/ŋ/ was ranked the lowest among /m/–/n/, /n/–/ŋ/ and /m/–/ŋ/ on the Thomas similarity index – together with the small numbers of errors made by the English and Korean participants – suggests that the Japanese speakers' difficulty with final /n/–/ŋ/ has to do with their L1 background. The numbers of errors that the Japanese speakers made for syllable-final /m/–/ŋ/ and /m/–/n/ contrasts did not differ significantly from the numbers of errors for the initial /m/–/n/ contrast, despite the lack of syllable-final contrasts in nasals in Japanese. The perceptual relation between English syllable-final nasals and Japanese categories was examined in Experiment 2 in order to provide insight into why /n/–/ŋ/ was particularly difficult among the three final contrasts for the Japanese speakers.

IV Experiment 2

Experiment 2 examined the perceived relation between English syllable-final /m/, /n/ and /ŋ/ and Japanese categories. Based on the Perceptual Assimilation Model (Best, 1995), it was hypothesized that, if two consonants were classified by L2 learners in two different ways, the two would be relatively easy to discriminate, but if both consonants tended to be classified as a single L1 category then they would be difficult to discriminate.

1 Method

Eight native speakers of Japanese (4 males, 4 females) participated in Experiment 2. Their ages ranged from early twenties to early thirties. They were tested in Birmingham, Alabama. All of them had

studied English through secondary systems in Japan, and had lived in the US for an average of 2.9 years.

The same materials from Experiment 1 were used. The participants were told to write the words they heard in the Katakana orthography, which is used to write foreign words phonologically in Japanese. They were tested individually in a quiet room. They listened to the tape with an Emerson cassette player and a headphone. They were told that they could stop the tape, or listen to the word more than once if needed.

2 Results and discussion

The focus of Experiment 2 is on the syllable-final nasals, and only the Katakana used for syllable-final /m/, /n/ and /ŋ/ is reported. Table 5 shows the percentage of times each Katakana or combination of Katakana was used for English syllable-final /m/, /n/ and /ŋ/. Each percentage was based on 80 classification responses (10 words × 8 participants). The percentages in boldface indicate the modal response category.

ム /mʉ/ was used for final /m/ in 96.3% of instances. It was also used for /n/ and /ŋ/, but in only 2.5% and 1.2% of instances respectively. For syllable-final /n/, ヌ (the coda nasal, /N/) was used in 85% of the instances. ヌヅ /Nɡʉ/ and ヌド /Ndo/ were also used for syllable-final /n/ in 5% and 7.5% of the instances respectively. For syllable-final /ŋ/, ヌヅ /Nɡʉ/ was used most of the time (70%), but ヌ (/N/) was also used in 28.8% of the instances.

Table 5 Katakana transcription of English syllable-final nasals in Experiment 2

Stimulus	Katakana			
	ム /mʉ/	ヌ /ŋ/	ヌヅ /Nɡʉ/	ヌド /Ndo/
[m]	77 (96.3%)	3 (3.7%)		
[n]	2 (2.5%)	68 (85.0%)	4 (5.0%)	6 (7.5%)
[ŋ]	1 (1.2%)	23 (28.8%)	56 (70.0%)	

The results of Experiment 2 showed that the Japanese speakers almost always used ム /mʉ/ for syllable-final /m/, which they rarely used for either /n/ or /ŋ/. There is therefore little overlap in classification between /m/ and /n/, and between /m/ and /ŋ/. On the other hand, there was a relatively high degree of overlap in classification between /n/ and /ŋ/; the same orthographic representations – ヌ (/N/) and ヌヅ /Nɡʉ/ – were used for both /n/ and /ŋ/.

V General discussion

The results obtained in Experiment 1 demonstrated that the Korean speakers did not differ significantly from the English speakers for any contrasts, whereas the Japanese speakers made significantly more errors than the English and Korean speakers for the final /n/-/ŋ/ contrast. Experiment 2 showed that there was little overlap between syllable-final /m/ and /n/, and between /m/ and /ŋ/ in the Japanese speakers' classification, and that there was a relatively high degree of overlap in classification between /n/ and /ŋ/.

Best (1995) outlined three perceptual assimilation patterns of non-native segments for PAM:

- assimilated to a native category,
- assimilated as uncategorizable speech sound; and
- not assimilated to speech.

Harnsberger (2001) used a 90% criterion for a stimulus to be said 'categorized' as a particular L1 category; it has to be identified with the same label in 90% of listener responses. Following Harnsberger, the final /n/-/ŋ/, /m/-/ŋ/ and /m/-/n/ contrasts for Japanese speakers were classified as one of the assimilation types of PAM using the 90% criterion. When one sound is assimilated to an uncategorizable speech sound and the other sound is assimilated to a native category, the contrast is considered as Uncategorized versus Categorized (UC) type. Both final /m/-/ŋ/ and /m/-/n/ contrasts are classified as UC type, because /m/ was classified as Δ /mu/ more than 90% of the time, but /n/ and /ŋ/ were classified as a single Japanese category less than 90% of the time (see Table 5). PAM expects discrimination to be very good for UC contrasts (Best, 1995: 195). The final /n/-/ŋ/ contrast is classified as Both Uncategorizable (UU) type, because neither /n/ nor /ŋ/ was classified as a single Japanese category more than 90% of the time. The discriminability of UU assimilation is expected to range from poor to very good, depending on the similarity between the two categories (Best, 1995: 195). Here it is expected to be relatively poor, because the Japanese speakers used the same labels for both /n/ and /ŋ/.

In summary, the final /n/-/ŋ/ contrast was particularly difficult for the Japanese speakers because neither /n/ nor /ŋ/ was consistently classified with one L1 category and the same L1 categories (\succ /N/ and $\succ\text{ŋ}$ /Nŋu/) were used for both /n/ and /ŋ/. Other final contrasts, /m/-/ŋ/ and /m/-/n/, were easier for the Japanese speakers than /n/-/ŋ/ because /m/ was assimilated to Δ /mu/ more than 90% of the time and Δ /mu/ was not used to classify either /n/ or /ŋ/.

VI Summary and conclusions

In summary, the native English, Korean and Japanese speakers demonstrated different patterns of errors in perceiving syllable-initial and syllable-final nasals in English. The English and Korean speakers found both the syllable-initial and syllable-final /m/-/n/ contrasts more difficult than the syllable-final /n/-/ŋ/ and /m/-/ŋ/ contrasts. The Japanese speakers, on the other hand, had difficulty distinguishing /ŋ/ from /n/ syllable-finally. The numbers of errors made by the Japanese speakers did not differ from the English and Korean speakers for the other three contrasts, initial and final /m/-/n/ and final /m/-/ŋ/. Experiment 2 examined the perceived relation between English /m/, /n/ and /ŋ/ and the Japanese categories. It was found that English syllable-final /m/ was almost always classified as Δ (/mu/), whereas two or more different classifications were used for syllable-final /n/ and /ŋ/.

The results of this study showed that perceptual difficulties in an L2 cannot be predicted simply from the comparison of phoneme inventories between learners' L1 and L2 (see Eckman and Iverson, 1994; Major, 1987), and suggest that the perceived relationship between L1 and L2 segments plays an important role in how L2 segments are perceived.

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Appendix 1 The word list

1. <u>heat</u>	hit	18. <u>kin</u>	king	35. <u>bit</u>	beat
2. <u>mitt</u>	knit	19. some	<u>sung</u>	36. <u>same</u>	sane
3. sin	<u>sing</u>	20. line	<u>lime</u>	37. <u>sling</u>	slim
4. swing	<u>swim</u>	21. mitt	<u>meat</u>	38. sung	<u>son</u>
5. <u>scene</u>	seem	22. <u>mob</u>	knob	39. <u>net</u>	met
6. <u>cap</u>	cab	23. lawn	<u>long</u>	40. <u>tack</u>	tag
7. map	<u>nap</u>	24. <u>brim</u>	bring	41. lime	<u>line</u>
8. <u>thin</u>	thing	25. <u>worn</u>	warm	42. sung	<u>some</u>
9. rim	<u>ring</u>	26. <u>seem</u>	scene	43. <u>king</u>	kin
10. hen	<u>hem</u>	27. swim	<u>swing</u>	44. nude	<u>mood</u>
11. <u>tin</u>	teen	28. sing	<u>sin</u>	45. nip	<u>knit</u>
12. <u>met</u>	net	29. <u>knit</u>	mitt	46. <u>warm</u>	worn
13. son	<u>sung</u>	30. kit	<u>kid</u>	47. <u>bring</u>	brim
14. <u>slim</u>	sling	31. hem	<u>hen</u>	48. long	<u>lawn</u>
15. <u>sane</u>	same	32. ring	<u>rim</u>	49. <u>knob</u>	mob
16. <u>hit</u>	hid	33. <u>thing</u>	thin	50. pig	<u>big</u>
17. mood	<u>nude</u>	34. nap	<u>map</u>		

Note: The underlined words were recorded on the tape. The underlines were, of course, not on the sheet for the participants.

