

# PERCEPTION OF ASSIMILATED AND NON-ASSIMILATED CODA NASAL BY JAPANESE LEARNERS OF GERMAN

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## ABSTRACT

This study investigates the perception of the German coda nasal contrast /n/-/m/-/ŋ/ by Japanese learners of German compared to German native speakers. The phonological distribution of coda nasals differs with/without word boundaries in the two languages. Word final coda before a pause in Japanese is neutralized to /N/ but the place feature remains in German. Assimilation of coda nasals before consonants is obligatory in Japanese but not in German. Two experiments were conducted to test how syllable-final nasals with/without word boundary are perceived by Japanese speakers. The results show that Japanese listeners are sensitive to the duration of the nasal, a perceptual cue to word-final neutralized nasals. Durational manipulation reinforced or weakened Japanese learners' perception, suggesting that nasal assimilation is related to the length of the nasal.

**Keywords:** assimilation, coda nasal, durational cue, German, Japanese learner, perception

## 1. INTRODUCTION

Asymmetry in place assimilation of coda-nasals in Japanese and German depends on phonemic status and position at phonological boundaries. Japanese has one underlying nasal phoneme /N/, a moraic nasal in the coda position, and four nasal allophones ([n], [m], [ŋ], [N]). Assimilation of a coda nasal before stops in non-final word position such as syllable, compounds or word boundaries is obligatory in Japanese so the surface nasal is homorganic with the following stops. It could be said that the nasals are placeless and receive place definition through regressive assimilation [6]: [sandai] (three things), [sambai] (threefolds), [sanjgai] (third floor). In word final position before a pause, however, the coda nasals are neutralized as [N]: [san] (three) or [ŋ] [cin] (true) depending on the preceding vowels [12, 13].

German on the other hand has three phonemic and phonetic coda nasal distinctions: /n/, /m/, /ŋ/ which can undergo assimilation or non-assimilation depending on the speaking rate and discourse style. That is, place assimilation in heterogeneous nasal-

stop sequences across morphological boundaries and word boundary are optional, with the assimilated form being equally acceptable [14]. ['an+bi:tən], (*to offer*) [kan#'bi:tən] (*can offer*) and ['an+kəmən] (*to arrive*), [kan#'kəmən] (*can come*) could also be ['am+bi:tən], [kam#'bi:tən] and ['aŋ+kəmən], [kaŋ#'kəmən], respectively. Assimilation is obligatory across syllable boundaries within words: ['lan.dən] (*to arrive*), ['lam.pən] (*lamps*), ['leŋ.kən] (*to guide*), though with a few exceptions for /m/ and /ŋ/: ['həm.dən] (*shirts*), ['im.kə] (*bee-keeper*), ['laŋ.tə] (*was enough*). In word-final position before a pause, however, the phonetic realizations are preserved: "ran" ([n]), "ram" ([m]) and "rang" ([ŋ]).

In previous studies on acoustic correlates on nasal perception, measurements of formant transition have been made, F2-F3 at the nasal-vowel juncture [9], nasality [4], [8], vowel duration and nasal duration [8]. Nasal murmur (occlusion in the oral cavity with low F1 and an anti-formant) offers important information about place of articulation due to its resonance characteristics. Recasens [10] pointed out that although transitions are the predominant cue for place of articulation, murmurs contribute to the [n]-[ŋ] distinction. Kurowski and Blumstein [7] postulate that nasal murmurs are as effective as transitions. As Japanese is a mora-timed language and duration together with pitch is important, this study concentrates especially on nasal length.

The purpose of the study is to investigate how Japanese listeners identify and discriminate L2 German assimilated and unassimilated coda-nasals; i.e. whether duration is important as a cue for the perception of L2 German influenced by moraic nasal in Japanese.

Experiment 1 examines the perception of missing coda nasals [m n ŋ] before a pause where, in Japanese, the opposition is de facto neutralized to [ŋ] or [N]. Following the perceptual and durational results from Experiment 1, Experiment 2 concentrates on the perception of durational differences in [n-ŋ] and [m-ŋ] in assimilated/unassimilated coda-nasals after the manipulation of nasal duration. Syllable-final nasals within words are excluded from the study because of their inconsistent distribution in German: /m/+coronal,

dorsal and /ŋ/+ coronal may be non-assimilated but /n/ is obligatory to assimilation (see above).

## 2. METHOD

### 2.1. Participants

Two groups of subjects participated, one of which was a control group, consisting of three native female German exchange students from Duisburg-Essen, Trier and Bremen universities. The other group, consisting of 46 Japanese German learners (17 male and 29 female), all freshmen in the German Department of Sophia University in Tokyo, completed a perception test. All of them had been learning German for about nine months. Their age ranged from 18 to 20. The participants received an answer sheet and had to mark the items they perceived in each test. All the participants listened over headphones in a CALL room in the Sophia University.

### 2.2. Sound stimuli

All stimuli were spoken by a trained female German phonetician in a phonetic laboratory at the University Halle-Wittenberg in Germany. The stimuli were recorded on a PCM recorder (Sony PCM-DJ). The sampling rate was 44.1 kHz with 16 bit quantization. For randomization of the stimuli as well as durational manipulation Praat [3] was used. Each stimulus was uttered three times and two of them were chosen. The stimuli were randomized. A stimulus comprised two repetitions separated by a pause of 2 msec. for experiment 1, and 3 msec. for experiment 2. Before the test, there were 5 trial stimuli. The vowel preceding the nasals was [a] and [ɛ] because of co-occurrence in both languages.

### 2.3. Procedure

In experiment 1 perception of the vowel [a] + nasals ([am]/[an]/[aŋ]) in word final coda-position was tested to see how the neutralized phoneme /N/ in Japanese is perceived. The participants judged the similarity between two mono-syllables selected from [am]/[an]/[aŋ] in an AX forced choice discrimination test which consisted of 27 items in total. Acoustic measurement for vowel and nasal duration was obtained to see the correlation between perception and acoustic properties. The nasal was measured at the sharp spectral changes at the beginning and end of the nasal.

The second experiment was a word-final identification test to see whether the assimilation influences perception. The participants heard the sentence and had to choose between [n m ŋ]. The

purpose was to investigate whether the durational cue can help to identify the nasals in word boundary position with/without assimilation. The stimuli of two sentences *Sie kennen Kassel/Passau.* (*You know Kassel/Passau.*) were used to manipulate the schwa-deleted and syllabified ending <en> ([n]) which is followed by a stop [k/p] (*Kassel* or *Passau*). There is an assimilated and unassimilated /n/ ([n], [m], [ŋ]) for each sentence: [zi: kɛn 'kasl] (unassimilated), [zi: kɛŋ 'kasl] (assimilated), [zi: kɛn 'pasau] (unassimilated), [zi: kɛm 'pasau] (assimilated), which are both appropriate in German context. The vowel and final nasals [n m ŋ] were manipulated to have five different durations in the four different sentences, giving 20 items which were repeated once resulting in a total of 40 tokens. Manipulation was carried out in five equal steps from the value of the segment in the sentence spoken at normal speed to the value in the sentence spoken at a relatively slow speed (see Tables 1a, 1b).

**Table 1a:** The 5 levels of vowel-nasal duration (in secs) for [ɛn] and [ɛm] in [zi: kɛn/kɛm 'pasau]. ( ) is the ratio of 5 in relation to 1.

	[ɛ] (1.12)	[n] (1.59)	[ɛ](1.09)	[m] (1.64)
1	.072	.176	.080	.176
2	.075	.207	.082	.204
3	.077	.233	.084	.232
4	.079	.259	.086	.260
5	.081	.281	.088	.288

**Table 1b:** The 5 levels of vowel and nasal duration (in secs) for [ɛn] and [ɛŋ] in [zi: kɛn/kɛŋ 'kasl]. ( ) is the ratio of 5 in relation to 1.

	[ɛ] (1.16)	[n] (1.29)	[ɛ] (1.08)	[ŋ] (1.20)
1	.062	.176	.090	.185
2	.065	.191	.092	.194
3	.067	.203	.094	.204
4	.069	.215	.096	.214
5	.072	.227	.098	.223

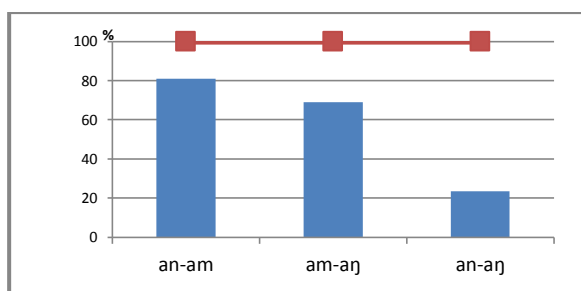
## 3. RESULT AND DISCUSSIONS

### 3.1. Experiment 1

In this experiment the perception of coda nasals labial vs. coronal, labial vs. dorsal, coronal vs. dorsal in word-final condition with a pause was explored. Japanese learners are expected to have problem perceiving different coda-nasals as Japanese only has [ŋ] and [N] finally. As predicted, Japanese had difficulty distinguishing some nasal contrasts in coda-position. The average numbers of correct answers is presented in Graph 1. This result supports the previous research on English (Aoyama [1], [2])

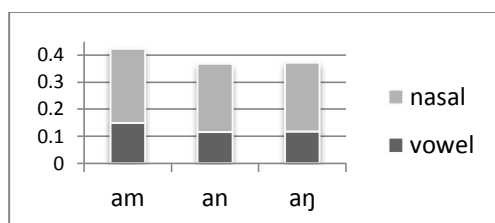
who also found that the nasal place contrast is less salient, with the exception of the [an-am] contrast pair. It appears that the Japanese participants have considerable ability to perceive the [an-am] contrast and a slightly more reduced ability to perceive the [am-an] contrast. But they have extreme difficulty with the [an-aŋ] contrast. The ANOVA between the three contrasting pairs of coda nasals showed a significant difference ( $F(2,151) = 141.18, p < 0.01$ ). The three native German listeners had no problems and perceived all contrasts of coronal/ non-coronal nasals at the word end.

**Graph 1:** Average (percentage) of correctness ratings to the coda nasal identification [an-am], [am-an] and [an-aŋ]; bars: Japanese, line: German.



The duration of coronal/non-coronal nasals indicate that their perceptual discrimination relies on durational differences, where [n] is the shortest and [m] the longest of the three (nasal duration: [n] = 0.25 sec, [ŋ] = 0.26 sec, [m] = 0.27 sec) The durational difference between [an]-[aŋ] is the smallest, for the vowel as well as for the nasal. For [am]-[an] and also for [am]-[aŋ], the differences are longer making /m/ easier to identify. (Graph 2).

**Graph 2:** Difference between vowel and nasal in ms [am-an], [an-aŋ], [am-aŋ].

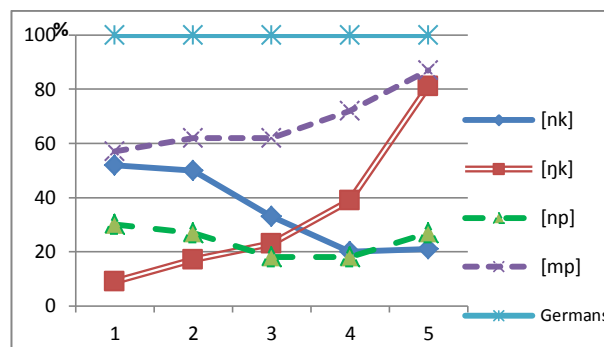


Statistical analysis with ANOVA of the measured value with ANOVA was significant for nasals:  $F(2, 51) = 12.86, p < 0.01$  but not for vowels:  $F(2, 51) = .07, p > 0.01$ . The post-hoc LSD test showed that [am]-[an] and [an]-[aŋ] as [am]-[aŋ] and [an]-[aŋ] respectively, were significantly different ( $p < 0.05$ ) in terms of nasal duration. This could suggest that the nasal duration could cue the perceptual distinction of the three nasals.

### 3.2. Experiment 2

Based on the above results, this experiment tests whether the difficulties in discriminating between [n-ŋ], [m-ŋ] could be influenced by nasal duration and assimilation vs. non-assimilation to the following stops at the word boundary. Presented with the nasal-stops of five different durations in the sentence [zi: kən/kəm 'pasao] and [zi: kən/kəŋ 'kasl], the participants were asked to identify which nasal they perceived: [n], [m] or [ŋ]. The results show that increased duration enhanced perception of assimilated nasals while unassimilated nasals were more difficult to perceive with or without increased duration. The native German listeners had no problem to identify the nasals whether in assimilated or unassimilated context (Graph 3).

**Graph 3:** Average of correctness in 5 steps (x-axis) from 1 (least lengthened) to 5 (most lengthened).



The lack of coda-nasal assimilation to following stops impeded perception by Japanese learners and they failed to perceive the correct coda nasals.

**Table 2:** Average of sound [n], [m] or [ŋ] chosen by Japanese participants in percentage by level 5. Shadowed is the correct answer, italic is the most frequently chosen wrong answer.

	n%	m%	ŋ%
[nk] (unassim.)	20.65	29.34	50
[np] (unassim.)	27.17	14.13	58.69
[ŋk] (assim.)	14.13	6.5	79.34
[mp] (assim.)	6.5	86.95	6.5

Table 2 shows at the level 5 (most lengthened) percentage of nasals that Japanese participants failed to identify. For the unassimilated [nk] and [np] half of the participants wrongly chose [ŋ].

The statistical analysis with ANOVA was significant for four nasal-stop combinations at level 5:  $F(3, 364) = 36.64, p < 0.01$ . A post-hoc LSD test showed [mp]-[np], [mp]-[nk], [ŋk]-[np], [ŋk]-[nk] were significantly different ( $p < 0.05$ ). The phonological unit of mora has proved to be linked to

phonetic perceptibility. The Japanese nasal is a temporal unit of mora and determines the phonological length, which is longer than unstressed syllables [11]. When lengthened the syllable could be recognized as a mora unit which is easier for the Japanese participant to perceive when the nasals are assimilated to homorganic stops and more difficult to perceive when they are heterorganic clusters of nasal + stop.

#### 4. CONCLUSION

The two experiments showed that differences between Japanese and German coda nasal distribution influence the perception of place of articulation by Japanese learners. In the two experiments reported here, nasal duration was shown to be a possible perceptual cue for coda nasals in two ways: 1) for distinguishing word final nasals that are not distinctive in L1 Japanese, and 2) to enhance the sensitivity for the nasal + stop assimilation that is obligatory in Japanese.

Experiment 1 indicated that the durational difference between [m] and [n ŋ] could be a perceptual cue for distinguishing coda nasals that are not distinctive in Japanese. It seems that Japanese learners tend to perceive different places of articulation as a function of nasal duration differences. The relationship between the durations of labial/coronal/dorsal nasals could support perception, as Japanese participants did not perceive the neutralized [ŋ] and had poorer perception of [an]-[aŋ] or [am]-[aŋ] than [an]-[am] contrasts. The nasal duration is therefore perceptually salient for place distinction in coda nasals.

Experiment 2 examined whether the coda-nasal differences that Japanese learners failed to perceive in Experiment 1 would be perceptually strengthened by increased (moraic) duration. That was indeed the case: when nasal duration approached the ‘moraic’ value, the participants were sensitive to nasal-assimilation that matched the place of following stops. In Japanese the moraic nasal is a unit of mora-timing. According to Cutler & Otake [5] Japanese perceive nasals in syllabic coda position as if they were equivalent to moraic nasals and the assimilation enhanced or reduced the perception of coda nasals. With the lengthening of the nasal segment in a sentence, interference from L1 occurred. It could be said that the durational cue for L1 mora occurred by phonological adjustment.

Germans who are accustomed to hearing assimilated and unassimilated forms preserve the original place of articulation in perception. The perceptual saliency of German coda nasal for

Japanese learners indicates the interference from Japanese nasal phoneme distribution.

#### 5. ACKNOWLEDGEMENT

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