

# Japanese moraic dorsalized nasal stop<sup>\*</sup>

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**ABSTRACT:** This study shows some evidence that Japanese moraic nasal /N/ has an underlying closure place. Our methodology consists of i) observation of the lips/mouths of professional singers while singing, ii) interviews of native speakers of standard Japanese, iii) observation of the lip activity while producing /N/ in isolation and word-final position. The results suggest that /N/ is an underlyingly stop rather than continuant, and its closure place is labial for some speakers. Moreover, the place and [continuant] of /N/ does not always assimilate to the following segment in slow speech: for example, /seN-no/ ‘thousand-GEN’ and /koNja/ ‘tonight’ are realized as [se.m.no] and [ko.m.ja] (the dots indicate mora boundaries) respectively as opposed to \*[se.n.no] and \*[ko.ɲ.ja].

**Keywords:** Japanese moraic nasal, place assimilation, continuancy assimilation, labial, singing

## 1. Introduction

This paper discusses underlying features of place and [continuant] (henceforth, [cont]) of the Japanese moraic nasal, as in Honda /ho.N.da/ ‘Honda’ (. = mora boundaries). We will show evidence that /N/ is [-cont] and the place is likely to be labial at least for some native speakers of Japanese.

Previously, the Japanese moraic /N/ was treated as placeless (e.g., Itô 1989), in that /N/ has no independent place feature so that it undergoes nasal place assimilation and the place receives the one from the following segment at the surface representation. When /N/ precedes a vowel, glide, or fricative, which is [+cont], /N/ becomes a nasalized vowel or glide (e.g., Nakaoka and Muraki 1990, Tanaka 2005). This suggests that Japanese moraic /N/ can be a placeless nasal, unspecified for [cont] as well as place feature. However, Kochetov’s (2014) palatographic study also found that, in some cases, /N/ before [ɛ] and [ɸ] showed a complete closure although fricatives are [+cont] (see §2.3 for more details), suggesting that assimilation of [cont] does not always occur. To explain the resistance of [-cont] against the assimilation to [+cont], we suspected that /N/ is underlyingly [-cont], or a nasal stop. To the best of our knowledge, no linguist has investigated its closure place when assimilation does not occur. To fill this gap, we are questioning 1) whether /N/ is in fact underlyingly [-cont], and 2) if so, where the closure place occurs. This study answers these questions

This paper is organized as follows: Section 2 provides an overview of previous studies and our hypothesis, and Section 3 shows evidence from i) observation of professional singers, ii) introspection of native speakers of standard Japanese, and iii) observation of lip activity of /N/ in isolation and word-final position. Section 4 discusses the implications of the results, and Section 5 is the conclusion.

## 2. Hypotheses

We hypothesize that the Japanese moraic /N/ is inherently dorsal. First of all, /N/ as uvular is a common view; in particular, pre-pausal /N/ is [ɴ], typically with incomplete tongue closure at the uvular (e.g., Tanaka 2005). Vance (2008: 103) analyzes /N/ as having [dorsal-uvular closure] as its inherent place. In his analysis, /N/ before a pause stays as uvular and /N/ in /NC/ (C = consonant) receives the place from /C/ and disconnects /N/’s inherent place [dorsal uvular]. In more recent studies, the closure place is not limited to uvular; rather, it occurs in a wider range of places within the dorsal region. For example, Kochetov (2014) briefly mentions that utterance-final /N/ can be [ŋ], [ɳ], or [ũ]. Moreover, some studies show that /N/ stays dorsal without assimilating to the adjacent segments. For example, Yamane’s (2013) ultrasound study observed a considerable constriction in an individual-specific place

in /N/, from velar to uvular/upper pharyngeal; one of the possible realizations is /aNɑ/ → [aũqɑ]. Likewise, Mizoguchi and Whalen (2013) found that /N/'s dorsal gesture can remain even in assimilation environments: for example, /N/ in /Nb/ is a dorsalized labial. Since nasal segments compared to oral segments may be combined with dorsal more easily (see Czaykowska-Higgins 1992), dorsalization of /N/ would not be cross-linguistically unusual.

As for [cont], we hypothesize that /N/ is underlyingly [-cont]. According to Uemura and Takada (1990: 290-4, 512), although their X-ray could not trace the closure between the tongue and the dorsal regions in word-final /N/, their observation of expiratory flow rates showed that air comes only from the nasal cavity but not from the oral cavity for /N/, suggesting that word-final /N/ involves complete oral cavity closure. In non-word-final positions, according to Kochetov's (2014) electropalatographic observation, where native Japanese speakers pronounced /N/s in carrier sentences preceded by various obstruents, sometimes /N/ showed a complete closure in the coronal region before [ei:], and in the dorsal region before [ɸu:]; especially, that one of the five participants made a closure before [ɸu:] 100% of the time is noteworthy.<sup>1</sup> The data still may not give us the compulsive argument that it is [-cont], but it at least suggests that all the individuals' /N/ are not consistently [+cont].

### 3. Evidence of our nasal stop hypothesis

This section gives three kinds of evidence to support the hypothesis that the Japanese moraic nasal is a stop rather than a glide or vowel.

#### 3.1 Labial closure of N: case of professional singers

First, we present the evidence of professional singers. The data of singing is chosen because in singing, each segment is likely enunciated, so assimilation, coarticulation, and reduction are less likely to occur. In other words, it could be faithful to the underlying representation (UR henceforth). Although in songs suprasegmentals may often be deviant from their phonetic prototypes due to discrepancies between pitch of the notes and phonemic pitch accents, and between note lengths and phonemic vowel/consonant lengths, we consider that segmentals are a different story. Segmentals in singing can also be different from those in speaking, in that singing techniques may require some phonologically non-contrastive phonetic variations for rich expressions. Still, we present singers' articulation of /N/ as important linguistic evidence, in believing that unclear segmental gestures can be enhanced, an inaudible sound becomes audible, and a usually hidden gesture may reveal in singing.

Our observation of singing in several Youtube videos shows that Japanese professional singers in various music genres often unambiguously make a complete closure for /N/ in singing and its closure place is often labial, i.e. [m]. As a result, place or [-cont] of /N/ does not agree with the following consonant. More interestingly, this resistance to the nasal place assimilation occurs regardless of the phonological and morphological environments. Since this methodology allows us to observe their lips only when their lips are clearly showed on the screen, it is impossible to measure the frequency of the total occurrence of [m], but it still demonstrates noteworthy facts.

Examples (1) to (3) demonstrate /N/ has a complete closure and nasal place assimilation does not occur (## = pause, # = word boundary, + = morpheme boundary):

#### (1) [m] in all morphological environments

- a. Utterance-final: /i + mas + eN##/ be + POLITE + NEG 'not doing' (sung by M.A.)
- b. Word-final: /seN # no # kaze/ thousand + GEN + wind 'a thousand winds' (M.A.)<sup>2</sup>
- c. Morpheme-final: /tsutsuN + de/ wrap+CONT 'wrap and' (T.U.)<sup>3</sup>
- d. Morpheme-internal<sup>4</sup>: /eiNdzi + te/ believe+CONT 'believe and' (M.M.)<sup>5</sup>

All the /N/s in (1) are realized as [m] regardless of the morphological environment. This makes a sharp contrast with the claim of previous studies, which state that utterance-final (pre-pausal) /N/ is expected to be [ŋ, ñ, ũ] or the like. Likewise, /N/s before /n, t/ are expected to be [n], and /N/s before /ɗ/ are expected to be [ɲ], due to place assimilation; however, /N/s in (2) are realized as [m].

(2) [m] before coronal or palatal

- a. Before coronal: /keisaN # naN + te + no/ ‘stuff like calculation’ (sung by M.M.)<sup>6</sup>
- b. Before palatal: /ɛiNdzi + te/ ‘believe and’ (the same song as (1d))

Furthermore, /N/s before /j/ are expected to be [j] due to both [Place] and [cont] assimilation, but /N/s in (3) are realized as [-cont].

(3) [-cont] before /j/

- a. [m]: /koNja/ ‘tonight’ (sung by A.S.)<sup>7</sup>
- b. [n] (or [ɲ]): /kure + ta + N + jane/ ‘for me, eh?’ (K.U.)<sup>8</sup>

In Example (3a), /koNja/ occurs twice within this song. /N/ in the second occasion was [m], which has a complete closure of lips, though /N/ in the first occasion is (possibly) [n] (but not [j]). /N/ before /j/ in (3b) is realized (possibly) as [n], which is evident from a tight raised jaw, visible raised tongue as well as an abrupt change of the patterns on the spectrogram from the vowel. As a result, heterorganic consonant sequences, i.e. [mn, md, mɗ, mj] appear. The most plausible explanation for this would be that these singers’ underlying representation (UR) of /N/ is a nasal stop, such as /m/. One reviewer suggested that such heterorganic consonant sequences could be caused by dissimilation so that /N/ and the following segment can be perceptually maximized. The realization of the labial place is not likely a case of dissimilation because /N/ before a labial still becomes [m] (e.g., /gaNbari/ ‘effort’ as [m], instead of [n] or [ɲ]).<sup>9</sup> [-cont] of /N/ is not likely either, because it would imply that the UR is [+cont] and the environment triggering dissimilation would be the sequence of [+cont][+cont], otherwise it should stay as [+cont]. However, the fact is that /N/ appears as [-cont] even before [-cont] as in [mn, md, mɗ].

Although /N/ is underlyingly a nasal stop and it retains its underlying place regardless of the following segment in general, some evidence suggests that its underlying closure place is not the same among speakers, indicating that the underlying place has inter-speaker variation. Two videos pertaining to Examples (1a) and (b) show that the singer M.A. and his father sing the same song separately.<sup>10</sup> The son consistently makes a lip closure, while the father does not. It is hard to make a judgment about whether the father’s /N/ is [n] or [ɲ] or whether there is a closure or not inside his mouth, but clearly no labial closure is involved. There is a possibility that the difference between the son and the father is due to generation differences, but the fact that these singers are in the same family and sing the same genre of songs but still pronounce /N/ differently is noteworthy. Furthermore, there seems to be intra-speaker variation. /keisaN<sub>1</sub> naN<sub>2</sub> teno/ (2a) has two /N/s. Figure 1 shows one singer’s lips for two /N/s in /keisaN<sub>1</sub> naN<sub>2</sub> teno/ and /N/s in two occasions with exactly the same melody of /koNja/ (3a).



i) /N<sub>1</sub>/ [m]

/N<sub>2</sub>/ [n]



ii) /N<sub>3</sub>/ [n]

/N<sub>3</sub>/ [m]

/keisaN<sub>1</sub>naN<sub>2</sub>teno/ (M.M.)<sup>11</sup> /N<sub>3</sub>/ in two occasions of /koN<sub>3</sub>ja/ (A.S.)  
 Figure 1. Intra-speaker variation [m~n] of /N/

Thus, Figure 1 suggests that while /N/ is consistently a nasal stop, the closure place may not be consistent within a speaker. Overall, Examples (1) to (3) indicate that the closure place of /N/ has both inter-speaker and intra-speaker variations. The songs raised here ranges from classical music to modern pop music, which indicates that there is no rule for the closure place of /N/ in professional singing techniques.

To sum up, according to our observation of professional singers, /N/ is underlyingly [-cont]. It is not required that the closure place or continuancy of /N/ agrees with the following segment. The closure place of /N/ resists the nasal place assimilation, but its realization varies depending on the speaker and it can vary even within the speaker.

### 3.2 Introspection session of the closure place

The second evidence for /N/ as a stop is the native speakers' introspection – our survey indicates 97% think that /N/ has an oral closure either on the lips and/or inside the mouth. The motivation to review native Japanese speakers' introspection is to examine the intuition of native speakers with no linguistic background. We are aware that native speakers' intuition does not necessarily match the acoustic/articulatory reality of their productions because native speakers' intuition is based on their unconscious knowledge of phonology (c.f., Chomsky and Halle 1968). However, we asked native speakers of Japanese to verbalize how it is articulated because previous researchers, at the time without phonetic instruments, have counted on their introspection. Previous research of place of articulation of /N/, for example, varied depending on the researcher. It therefore seems as if this variability comes from the naïve observation or subjective opinion of each speaker. However, unexpectedly, the ultrasound study of Yamane (2013) found a similar variation across subjects. As a status quo, there is no strong evidence that these introspections are wrong.

The survey was conducted on thirty-four native speakers of standard (or Nishi-Kantô) Japanese from Tôkyô or near Tôkyô, ranging in age from fifteen to fifty-nine. All but one participant in the introspection session were not linguistically trained. The participants were asked to read aloud a sentence in (4a), and then to answer the questions about their own pronunciation of /N/ as in (4b). Figure 2 shows the summary of the participants' responses.

- (4) a. 「この文字は、（一呼吸）「ん」（一呼吸）」  
 /kono # modzi # wa # (pause) N (pause)/  
 this # symbol # TOP 'This symbol is (pause) ん (pause).'

- b. i) Does the tongue touch somewhere on the roof of the mouth?  
 ii) Are the lips closed or not?

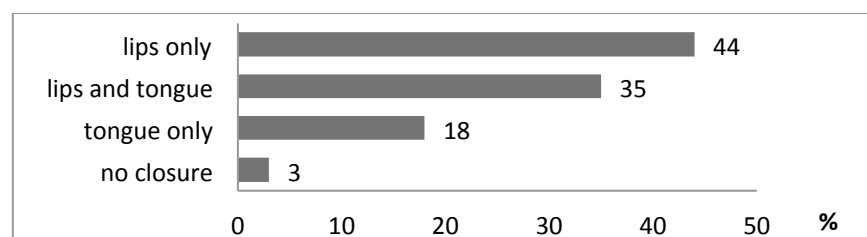


Figure 2. Introspection of /N/ in isolation by thirty four native standard Japanese speakers

Reportedly, fifteen people (44%) responded that they made lip closure only, transcribed as [m]. Twelve (35%) said they made both lip and tongue closure, which can be double articulation and can be transcribed as [mn̩]. Overall, 79% of the participants (twenty-seven out of thirty-four) reportedly made lip closure. On the other hand, seven participants made tongue closure only, without the lip closure. According to informal post-experiment interviews with some participants, one of the [mn̩]-type participants reported that she actively articulated both [m] and [n], rather than the tongue happening to lightly touch the roof of the mouth. On the other hand, one participant who pronounced [n] reported that she might inconsistently pronounce [m] and [n] although during the experiment she pronounced [n]. In any case, 97% said that there is a closure in their conscious productions of /N/, which can be [mn̩], [m], [n], or [ŋ]. Wherever the closure place is, these results support [-cont].

Only one participant (male, 50's) pronounced a nasal vowel like [ũ], suggesting his /N/ is [+cont]. Among the participants, he was the only participant who is linguistically trained. From our general result, this may appear to be his idiolectal version, but interestingly, the first author of this paper (male, 30's from Tôkyô) pronounces /N/ exactly in the same way. Both of them might have been biased by the textbook claim that /N/ is [ɲ] with an incomplete closure (e.g., Tanaka 2005). This participant and the first author have [+cont] in /N/'s UR, unlike the other participants. However, the second author, from Kanagawa, pronounces /N/ in isolation as [mn̩], so not all the phonetically-biased standard Japanese speakers have [+cont]. More research will be needed to investigate phonetics bias.

To sum up, /N/ is [-cont] with a few (idiolectal) exceptions. Its closure place can be [mn̩], [m], [n], or [ŋ], depending on the individual, but [n, ŋ] are in the minority.

### 3.3 Video recording session of lip activities

The third piece of evidence for the lip closure is from the analysis of video recordings of lip activities during the production of /N/. For three out of eight people, a lip closure at /N/ in isolation occurred 100%. The reason to observe /N/ in isolation and word-final position is that when /N/ is followed by a pause, nothing can trigger assimilation, so that the underlying /N/s should emerge. The participants of the recording were eight native speakers of Japanese, from the same group of people who participated in the introspection session. The information is shown in Table 2:

Table 2. Participants' sex and age

Participants' label	P1	P2	P3	P4	P5	P6	P7	P8
Sex	M	F	M	F	F	F	M	F
Age	23	37	23	32	24	24	33	40

The recording session was conducted several months after the introspection session. In this session, the participants were asked to read the tokens in (5) aloud while recording:

- (5) a. /N/ in isolation  
 b. monomoraic vowels (distractors): /i, e, a, o, u/ in isolation  
 c. Word-final /N/: /te:baN/ 定番 'basic item,' /e:taN/ 詠嘆 'admiration,' /e:teaN/ 永ちゃん 'a Japanese singer's nickname,' /ke:kaN/ 警官 'police,' /he:aN/ 平安 'one of the periods of Japanese history'  
 d. Word-initial /N/ (distractors): /NgoroNgoro/ ンゴロンゴロ 'Ngorongoro (a place name in Tanzania),' /NjarugeNge/ ンヤルゲンゲ 'Nyarugenge (a place name in Rwanda),' /Nɸu:noudewa/ ンフーの腕輪 'Nfuu armband,' and four others

Stimuli consists of not only /N/ (5a), but also monomoraic vowels (5b) as distractors. In order to see whether there is any difference between /N/ in isolation and word-final /N/, real words ending with /N/ (5c) were also included. Words beginning with /N/ (5d) were also included as distractors. The template /(C<sub>1</sub>)e:(C<sub>2</sub>)aN/ was used for the crucial items (5c) so that we can make sure that all the tokens have the same rhythmic pattern and are unaccented (or *heibangata* in Japanese). We put a variety of consonant (labial, dental, alveo-palatal, velar, and nothing) in the C<sub>2</sub> position in case consonantal place affects the place of /N/ across the intervening vowel /a/. Each monomoraic stimulus (5a, 5b) was presented in hiragana orthography, i.e. ん for /N/, and い, え, あ, お, う for /i, e, a, o, u/ respectively, and real word stimulus (5c, 5d) was presented in regular orthography. All the stimuli were pasted in PowerPoint. Each token was repeated twelve times, one stimulus per slide. All the slides were randomized. We manually clicked a key on the computer to move to the next PowerPoint slide based on the participant's pace. After recording, occurrences of lip closure were counted. For each person, we counted i) occurrences of lip closure out of 12 times of /N/ in isolation, and ii) occurrences of lip closure out of 60 times (12 times 5 words in (5c)) of /N/ in word-final position, and converted them to ratios. Figure 3 shows the results.

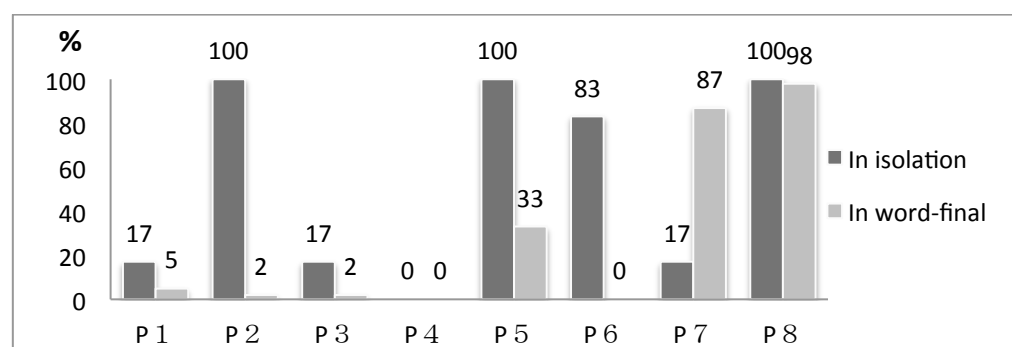


Figure3. Occurrence of lip closure of /N/ for individuals

The x-axis shows labels of individual speakers, and the y-axis shows the ratios of occurrences of lip closure. 100% for /N/ in isolation means 12 occurrences of lip closure out of 12 repetitions of the token, and 100% for /N/ in word-final position means 60 occurrences of lip closure out of all 12 repetitions for each of 5 words. Overall, /N/ in isolation had higher occurrences of lip closure, relative to /N/ in word-final position. P2, P5, and P8 made lip closure, 100% of the twelve utterances of /N/ in isolation. P8 had lip closure, 100% for /N/ in isolation and 98% for /N/ in word-final, which suggests that P8 consistently made lip closure. However, when it comes to /N/ in word-final, P5's lip closure was reduced to 33% and P2's lip closure was reduced to 2%. It seems roughly true that the occurrence at /N/ in word-final was fewer than /N/ in isolation, as P6 (83%) dropped to 0%, P1 (17%) dropped to 5%, and P3 (17%) dropped to 2%. The only exception is P7, who rarely made lip closure (17%) in isolation but increased to 87% at /N/ in word-final positions. Noticeably, P4 never made lip closure. According to an informal post-experiment interview, P4 mentioned that she thought that /N/ was not supposed to involve lip closure. This means that her underlying place of /N/ is not /m/.

We have assumed labial feature is assigned to realize [m] only if lips are closed. There is no disagreement about this because lip closure activities were obvious when compared to the lip state of the rest position. Figure 4 shows P5's lip movement from a rest position to an active lip closure for /N/ in isolation.

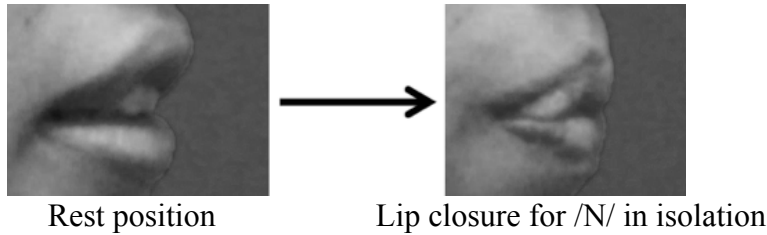


Figure 4. P5's active lip closure for /N/ in isolation

One may wonder if lip activity still occurs even for participants who do not close lips for /N/. In other words, if lip activity happens without the lip closure, then there may be labialized coronal [n<sup>w</sup>] or labialized velar [ŋ<sup>w</sup>] for /N/. However, our observation suggests that lip activities never happened for /N/ without the closure. See the leftmost picture of Figure 5 below:

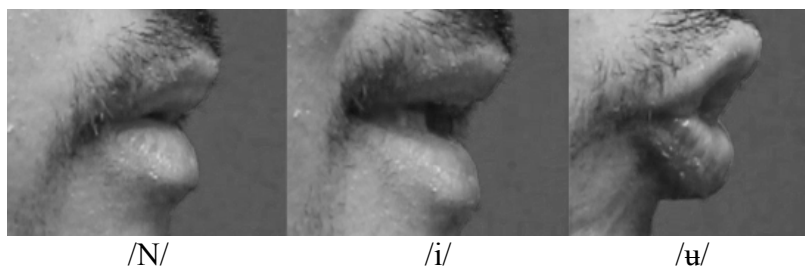


Figure 5. P7's /N/ with no lip movement, actively spread /i/, actively rounded /u/

These pictures are from P7, and the leftmost picture shows /N/ in isolation. You can see that there is no active lip movement for /N/ when it is compared with /i/ with active spreading and /u/ with active protrusion. This suggests that /N/ can emerge with a complete lack of [labial].

To sum up, active users of lips for /N/ in isolation are four people out of eight. Active users of lips for /N/ in word final position are two people out of eight. The frequency greatly varies depending on the individual. When lip closure is not involved, there is no labialization, so \*[n<sup>w</sup>] or \*[ŋ<sup>w</sup>] does not occur.

## 4. Discussion

### 4.1 Nasal place assimilation in short note in singing

We have argued that /N/ is not placeless and has its own place and [-cont] is specified in UR, so that it can resist assimilation to both place feature and [+cont] of the following consonant. If /N/'s UR is a (dorsalized) place-specific nasal stop, such as /m/, then a reasonable question would be when Japanese /N/ undergoes assimilation as various previous studies demonstrated. We suggest that assimilation typically occurs when a speech rate is relatively fast or the duration of /N/ is relatively short. Example (6) shows /N/ assimilates to the following segment when assigned to a sixteenth note:

(6) a. /nemuttēnaNka imaseN# seNno/ (M.A.) (the same song as (1a, b))

[ŋ]          [m]    [m]

‘I am not sleeping. A thousand’

b. /taimiNguo nogasanai keisaN naNteno/ (M.M.) (the same song as (2a))

[ŋ]                          [m]    [m]

‘I don’t miss the timing. Stuff like calculation’

When /N/ is assigned to a relatively short note, assimilation occurs. In contrast, when /N/ is assigned to a relatively long note, it is realized as [m] regardless of context. This suggests that assimilation occurs when /N/ is relatively short. If a speech rate is slow and /N/ is relatively long, /N/ does not have to assimilate to the following segment. Our assumption is that occurrence versus non-occurrence of assimilation is not dichotomized, but gradient in terms of rate and style. We are entertaining the idea that singing is one of the enunciated types of variations of speech. It is easy to imagine that in the speech form that is close to slow singing, such as citation forms, assimilation is less likely to occur. This view is compatible with the speech rate-sensitive gestural reduction account Jun proposes (1995: sec. 3.6.1). However, Kochetov and Pouplier (2008) conclude in their study of Korean place assimilation, that the relation between the speech rate and the gestural reduction is just a tendency and there are more individual variations. Thus, further systematic study needs to be done.

#### 4.2 Individual variation

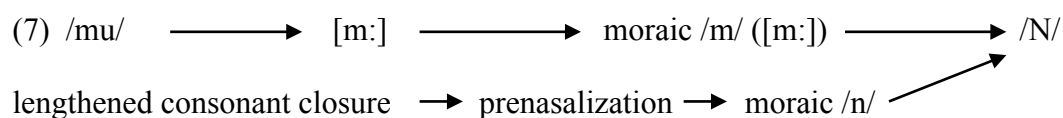
For some speakers, Japanese /N/ in slow speech is consistently labial, but for other speakers it is non-labial. However, it does not mean that Japanese /N/ is placeless. This inter-speaker variation simply means that the underlying place of /N/ could vary among speakers.

In order to say that segment X is placeless, in one interpretation (e.g., Itô 1989), X cannot stand alone with an independent place. We observed that /N/ can stand alone with an independent place, and the nasal place assimilation is not obligatory but is just sensitive to speech rate. In another interpretation of placelessness (e.g., Keating 1988), the surface realization of X should have a wider range of variability compared to other segments. We have seen that one speaker’s /koNja/ becomes either [ko.m.ja] or [ko.n.ja], like free variants. Thus, this surface variability could support the surface placelessness. However, regarding the underlying level of our interest, /N/ is not placeless because /N/ resists assimilating, and the surface place is not entirely predictable from the adjacent place.

The surface inter-speaker variability of /N/ is analogous to the results of an ultrasound study of American English /ɹ/ (Mielke et al. 2010): its articulation exhibits both inter-speaker and intra-speaker variations from “bunched” /ɹ/ to “retroflex” /ɹ/, which could lead to different place of articulations. Interestingly some speakers consistently use one variant, and others use multiple variants (Mielke et al. 2010). It remains to be seen whether this kind of variability is possible for all segments, or just for a subset of segments.

#### 4.3 Motivation of [-continuant] and [labial] of /N/

Now the question is what the origin of [-cont] and [labial] is. Around the *Heian* era (794-1192), /N/ used to be two different moraic phonemes, /m/ and /n/ (Hizume 2003). According to Hizume’s hypothesis, diachronically the moraic /m/ originated from /mu/ (e.g., auxiliary verbs /ramu/ ‘present-estimation’ and /kemu/ ‘past-estimation’ (99)).<sup>12</sup> On the other hand, the moraic /n/ originated from lengthened (and nasalized) consonant closure which may have served as an indicator of morpheme boundaries (e.g., [wo + gaba] ‘small + river’ → [wongaba]) but whether its phonetic quality was in fact [n] is not clear (see Hizume 2003: 102 for more details). (7) shows the summary.



It seems that compensatory lengthening is assumed from /mu/ to /m:/. In the course of the



stage that the /u/ disappears and /m/ is lengthened in order to compensate the loss of mora, possibly the dorsal feature of /u/ in the original /mu/ may have been fused with the labial feature of /m/. And if both labial and dorsal features are taken over to the present /N/, this fusion story would make sense for the current /N/, as it is doubly articulated. A similarity of the dorsality between /u/ and /N/ is obvious in Uemura and Takada's (1990: 512) x-ray microfilm; in the /N/ part in /iNi/ and /eNe/, the back of the tongue moves back and up, in /N/ in /aNa/ the tongue moves upwards, and in /N/ in /oNo/ the tongue moves up and front, and in /N/ in /uNu/ the highest part of the tongue does not move, suggesting that /N/ is closest to /u/ in its tongue position.

As well, as a synchronic explanation of [-cont], speakers may want to maximize perceptual distinction between /N/ and /u/, so they make /N/ [-cont] (and [-round]) as opposed to [+cont] (and [+round]) /u/. The explanation for [m], or a lip closure, can be visual emphasis of [-cont].

#### 4.4 Future research

Since the Japanese /N/ does not necessarily assimilate to the following segment, the phonological constraint Coda Filter discussed by Itô (1989: 224) has to be re-ranked and other constraints that cause assimilation only in fast speech should be discussed, but this is outside the scope of this paper.

#### 5. Conclusion

We conclude that /N/ is a nasal stop with the underlying feature [-cont] by the majority of native speakers of Japanese. /N/ does not have to assimilate to the adjacent segment in [Place] and [cont] in slow speech, such as /koNja/ and /seNno/ becoming [ko.m.ja] and [se.m.no] respectively. This also indicates that Japanese is a language that tolerates heterorganic consonant sequences. Its underlying primary place, or closure place, varies depending on the speaker but the most common place is labial, i.e. /m/. The primary place shows inter-speaker variations, and it even shows intra-speaker variations by some speakers; for example, /koNja/ becomes either [ko.m.ja] or [ko.n.ja] by the same speaker. Some previous studies showed /N/'s dorsal feature, which we think is the secondary underlying place of /N/. If /N/ is in fact underlyingly dorsalized, we conclude that /N/ is a dorsalized nasal stop.

#### Notes

\* This paper is part of the presentation that we made at the Phonology Forum, which took place at the University of Tokyo, Komaba campus, Japan, on August 20th, 2014. We appreciate the audience at the Forum for their helpful comments. We are also grateful to Dr. Ewa Czaykowska-Higgins for her supervision, Dr. Sonya Bird and Dr. Hua Lin for their advice, as well as to Phil Howson and Shu-min Huang for proofreadings.

<sup>1</sup> Nogita, Yamane, and Bird (2013) found that the so-called standard Japanese unrounded high back vowel typically transcribed as /u/ was in fact rounded central or even slightly front vowel [u] or [y] in their ultrasound study, so we use their recommended symbol /u/, in order to distinguish it from those with a complete lack of active roundness, such as [u] or [u].

<sup>2</sup> The examples in (1a, b) are both from '*Senno Kazeni Natte*' (2006) by a classical singer Masafumi Akikawa from Ehime born in 1967

<https://www.youtube.com/watch?v=jcRBtTtP9f8>

<sup>3</sup> 'In the Forest' (1988) by a rock singer Takashi Utsunomiya of TM Network from Tôkyô born in 1957 [https://www.youtube.com/watch?v=8L2oSw\\_hpX8](https://www.youtube.com/watch?v=8L2oSw_hpX8)

<sup>4</sup> While the stem of the *zagyô-kamiichidan* verb /eiNdziɾu/ can be /eiNdʒ/, there can be a morpheme boundary between /eiN/ and /dʒ/ since the /eiN/ part is a Sino-Japanese morpheme. Therefore, /N/ in /eiNdʒite/ in (1d) can also be analyzed as morpheme-final.

- <sup>5</sup> ‘Seishun Collection’ (2010) by Morning Musume in which the members are from various regions in Japan <https://www.youtube.com/watch?v=Xvjo5EMs2Q8>
- <sup>6</sup> ‘Ren-ai Hunter’ (2012) by Morning Musume, in which the members are from various regions in Japan <https://www.youtube.com/watch?v=iFc9L57IT4A>
- <sup>7</sup> ‘Be Together’ (1999) by an idol Ami Suzuki from Kanagawa born in 1982 [http://www.youtube.com/watch?v=2DqBmu9B\\_Pg](http://www.youtube.com/watch?v=2DqBmu9B_Pg)
- <sup>8</sup> ‘Toireno kamisama’ (2010) by a pop singer Kana Uemura from Hyôgo born in 1983 <http://www.youtube.com/watch?v=FICOU3b04-Q>
- <sup>9</sup> ‘Pyokopyoko Urutora’ (2012) sung by Morning Musume <https://www.youtube.com/watch?v=kocK1YhaInA>
- <sup>10</sup> ‘Senno Kazeni Natte’ sung by Masafumi Akikawa’s father, a classical singer Nobuhiro Akikawa born in 1938 <http://www.youtube.com/watch?v=iYSny6QNhGw>
- <sup>11</sup> ‘Ren-ai Hunter’ by Morning Musume focusing on Risa Niigaki from Kanagawa born in 1988 <http://www.youtube.com/watch?v=dDDIYnAKYco>
- <sup>12</sup> We use /mu/ here with the more general symbol /u/, instead of /mʉ/, because we do not know the phonetic quality of /u/ in that time.

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