

Tadius Frank
 Professor Brogan
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Distribution of Nasals in Japanese

1. Introduction

This paper deals with the distribution of nasal sounds in Japanese, a Japonic or Japanese-Ryukyuan language utilized by approximately 128 million speakers across the Japanese Archipelago, Palau, and North America (Lewis, 2009). The data set utilized in this analysis originated from *Introductory Phonology* (Hayes, 2009). In this data, we observe that Japanese nasals—which are the sounds in the Japanese phonetic inventory displaying a [+nasal] feature—show evidence of complementary distribution and contextually limited contrast. While some nasals contrast or belong to separate phonemes which is evident by minimal pairs and near minimal pairs in the data set, nasals fail to contrast in certain environments—more specifically in the context where nasals are preceded by consonants or occupy word-final position. In short, Japanese nasals participate in allophonic alternations, which neutralizes the contrastive distribution of the phonemes in certain contexts.

In this paper, we propose that Japanese nasals have phonemic contrast, and participate in allophonic alternations in specific environments to assimilate to the place of articulation [place] and [\pm glide] feature of the proceeding [-syllabic] phone or dorsalize in word-final position. Interestingly, the underlying forms of the proposed phonological rules are ambiguous because the phonemes /n/ and /m/ are both nasal consonants that the rules can affect. As a result, the underlying forms will be simplified to [+nasal]. This feature choice captures both of the phonemes and accurately represents that /n/ and /m/ are both subject to the proposed phonological rules of Nasal Assimilation and Word-Final Nasal Dorsalization. As a result, the allophonic alternations observed in these data are not idiosyncratic but rather systematic, providing evidence for the theorization of phonological rules.

This paper is organized as follows. First, §2 examines the empirical patterns which indicates the minimal and near minimal pairs in the data set and posits the phonemes and allophonic alternations present in the provided Japanese data while discussing our theoretical framework. Next, §3 proposes the formal phonological rules to account for the phonemes and allophones identified in §2 and establishes phonemicization based on those rules. In addition, this section also discusses the cases of neutralization that arises from the proposed phonemicization. Lastly, §4 illustrates and discusses our complete analysis via a series of derivations representative of all possible underlying forms.

2. Minimal Pairs, Allophonic Alternations, and Distribution

2.1 Japanese Phonemes and Minimal Pairs

The phonetic inventory of Japanese includes five nasalized consonants which are consonants with the [+nasal] feature: [m, n, ŋ, ɲ, ɰ̃]. Each Japanese nasal can be organized by their places of articulation with the features [+Labial], [+Coronal], and [+Dorsal] and by their demonstration of the [+glide] or [-glide] feature (which is abbreviated to the [± glide] feature). Note that [ɰ̃] is a voiced labial-velar approximant meaning that it has two places of articulation hence the (*) symbol. This classification system is illustrated in (1):

(1) Classification of Nasals in Japanese Phonetic Inventory:

	[+Labial]	[+Coronal]	[+Dorsal]
[-glide]	m	n	ŋ
[+glide]	*ɰ̃	ɲ	*ɰ̃

For the first group of data (2), which are drawn from items 3, 4, 6, 8, 9, and 10 of the provided Japanese data set (Hayes, 2009). We posit that the nasal phones [n] and [m] in (1) can be grouped into the phonemes /n/ and /m/ by the evidence of minimal pairs (2) and near minimal pairs (3) in the given Japanese data.

(2) Minimal Pairs in Japanese for [n] and [m]:

[m]	gloss	#	[n]	gloss	#
[ma]	‘interval’	3	[na]	‘name’	8
[mo]	‘also’	6	[no]	‘field’	9
[muɰ̃i]	‘neglect’	4	[nuɰ̃i]	‘owner’	10

(3) Near Minimal Pairs for [n] and [m]:

[m]	gloss	#	[n]	gloss	#
[ɸud͡z̃ijama]	‘Mount Fuji’	50	[ikebana]	‘flower arranging’	49
[jama]	‘mountain’	15	[jana]	‘fish weir’	23

Shared Phonological Environment: a__a

The three minimal pairs in (2) contrast [m] and [n] because the sequence of sounds is identical and interchanging [n] and [m] alone yields different meanings. For instance, [mo] ‘also’ transforms into [no] ‘field’, a word with new meaning, when [m] was substituted with [n]. Therefore, suggesting that they are contrastive and are the separate phonemes /n/ and /m/. Another example that supports the contrastive

distribution between [n] and [m] are the near minimal pairs in (3). [n] and [m] occur in similar phonological environments which are present in different words with different meanings; as a result, they contrast. However, further evidence from both the minimal pairs and near minimal pairs strongly posits that [n] and [m] contrast only in environments where they precede vowels or more specifically phones with the [+syllabic] feature. For instance, in the words [nuʃi] ‘owner’ and [jomu] ‘read-past’ the two phones [n] and [m] occur before the [+syllabic] phone [u], notice that these words are not entirely identical and the immediate environments the phones occur in differ. Thus, the two phones [n] and [m] are in contrastive distribution and belong to the separate phonemes /n/ and /m/ only in the context where the phones [n] and [m] occur before a [+syllabic] consonant. Hence, the phones [n] and [m] are in a contextually limited contrast distribution, and this syllabic-initial contrast will be represented with a phonological rule in §3.1. Right way, this theory has theoretical advantages: a majority of languages do not have strictly contrastive or complementary distributions of their phonemes and allophones; instead, a contextually limited contrast is significantly more common therefore such a distribution pattern in Japanese where [n] and [m] are contrastive before a [+syllabic] phone is a sound phenomenon here (Hayes, 2009).

2.2 Allophonic Alternations: Place of Articulation

In the data set, the generalization that nasals alternate for [place] is supported by the observation that the phonemes /n/ and /m/ fail to contrast in a certain environment. Specifically, the environment were the two phones [n] and [m] occur before a [-syllabic] phone or consonant. The treatment of place of articulation as the feature [place] which means “all of the values for the place features” allows us to account for the distinct place features of a proceeding consonants (Hayes, 2009). This pattern is illustrated in (4):

(4) Environments for Alternation of [place]:

[m]	gloss	#	[n]	gloss	#	[ŋ]	gloss	#
[zamburi]	‘with a splash’	31	[kento:]	‘examination’	35	[gengogaku]	‘linguistics’	46
[nihomppoi]	‘Japanese-y’	30	[honda]	‘brand of automobile’	36	[zanʃki]	‘remaining time’	42

[m]	#	[n]	#	[ŋ]	#
a__b	31	e__t	35	e__g	46
o__p	30	o__d	36	a__k	42

In the environments in (4), the phones [m], [n], [ŋ] share a specific feature with the consonant they precede. The phone [m] shares the [+Labial] place feature with the phones [b] and [p]. The phone [n] shares the [+Coronal] place feature with the phones [t] and [d]. Similarly, the phone [ŋ] shares the [+Dorsal] place feature with the phones

[k] and [g]. However, in §2.1 when the phones [m] and [n] occurred before [+syllabic] phones they did not share the same place features as they did here. For instance, all [+syllabic] phones have a [+Dorsal] place feature; however, in the words [nuɸi] ‘owner’ and [jomu] ‘read-past’ the two phones [n] which is [+Coronal] and [m] which is [+Labial] did not assimilate with the place feature of the following [+syllabic] phones which is [+Dorsal] to surface as [ŋ]. As a result, place assimilation is an allophonic alternation that occurs when nasals are preceded by [-syllabic] phones or consonants as shown above with (4). The Japanese data set allows for the conclusion of /n/ and /m/ to be phonemes in a contextually limited contrast as elaborated in §2.1; however, the contextually limited contrast of the phonemes signifies that it’s unnecessary to strictly assign an allophonic alternation such as place assimilation to one phoneme since phonological rules will affect the underlying forms with the [+nasal] manner feature which both phonemes /n/ and /m/ possess. Consequently, the underlying form for this phonological rule and other phonological rules will encompass both /n/ and /m/ through the utilization of the [+nasal] manner feature, which will isolate /n/ and /m/ in the Japanese phonemic inventory. In short, if Japanese did have [+nasal] sounds followed by [-syllabic] sounds in its underlying forms, they would be pronounced with the place of articulation of the following consonant. Therefore, the distribution of allophones or surface form generated by the underlying forms in this context would be in complementary distribution with /m/ and /n/ as underlying forms as illustrated in §3.4.

A sound phonological rule for Nasal Assimilation was proposed utilizing the [place] unit introduced by Hayes, and the underlying form [+nasal] in §3. Our theory proposes that phonologies should be as simple as possible in order to be successfully acquired by the learner, and therefore nasal assimilation which is a cross-linguistic occurrence does occupy a sound space in our theory. Nasal assimilation is a relatively simple phonological process that makes it articulatory easier to produce speech sounds by matching the place of articulation of two adjacent sounds which reduces the energy the lower articulators (tongue, jaw) expend since they’re in similar locations in the oral cavity (Hayes, 2009). In contrast, producing adjacent sounds with differing places of articulation would require the movement of the lower articulators which expends energy.

2.3 Allophonic Alternations: Nasalized Glides

In items 40, 41, 47, and 48, we can observe that [+nasal] phones have assimilated to the [+glide] feature mentioned in §2.1 of the following glide. More importantly, nasals are matching the place of articulation of the glide. This is illustrated in (6):

(6) Environments for Alternations of [± glide]:

[j]	gloss	#	[w̃]	gloss	#
[hoj̃ja]	‘bookstore’	40	[jaŋwari]	‘softly’	47
[boj̃jari]	‘vacantly’	41	[hoŋwa]	‘booktitle’	48

[ɿ]	#	[w̃]	#
o__j	40	a__w	47
o__j	41	o__w	48

The environments listed in (6) demonstrate that the underlying [+nasal] form assimilated the [± glide] feature of the following consonant which is a pattern our phonological rule in §3 and §2.2 addresses with the phonological process of Nasal Assimilation. For instance, in the word [jaŋwari] ‘softly’, [w] is a phone with the [-syllabic] and [+glide] feature causing the underlying [+nasal] to surface as [w̃] a nasalized glide. In comparison, in the word [zaŋki] ‘remaining time’ [k] is a phone with the [-syllabic] and [-glide] feature, so the underlying [+nasal] assimilated to the [place] of [k] which is [+Dorsal] surfacing as [ŋ].

Since nasals assimilate to both the place of articulation and to the feature [± glide] of the following phone which causes the nasal to adopt the place of articulation and glide feature of the following [-syllabic] phone, a general rule utilizing Haye’s ideology that the features system is not “homogenous” and flexible can be used to create a general phonological rule that will capture both of the patterns here and in §2.2 (Hayes 2009). Once more, our theory emphasizes that phonologies should be as simple as possible in order to be successfully acquired by the learner, and there this proposal that nasals assimilate to the [± glide] feature of following [-syllabic] phone is a logical proposal since it is a common phonological process and articulatorily beneficial as mentioned in §2.2.

2.4 Allophonic Alternations: Allophone [ŋ]

In the data set, we can observe that the underlying [+nasal] forms surface as the allophone [ŋ] in the surface form when in word-final position. This pattern is illustrated in (7):

(7) Environments for Alternations of Allophone [ŋ]:

#	[ŋ]	gloss	environments
25	[hoŋ]	‘book’	o__#
26	[paŋ]	‘bread’	a__#
28	[supeɪŋ]	‘Spain’	i__#

Here in (7), the nasal phone [ŋ] occurs at word-final position. For instance, in the words [paŋ] ‘bread’, [hoŋ] ‘book’, [supeɪŋ] ‘Spain’ the immediate environment of the nasal phone is in word-final position. Furthermore, the underlying [+nasal] form adopted a

[+Dorsal] feature to surface as [ŋ] in the surface form. Therefore, our proposed nasal assimilation rule and contextually limited contrast do not capture this pattern, and a separate phonological rule is explicitly proposed in §3 to express it. The underlying form here would be the underlying [+nasal] form representing /n/ and /m/ which indicates that this pattern is a complementary distribution in which [ŋ] is an allophone of /n/ and /m/ when they occur in word final position.

This proposal has theoretical advantages: cross-linguistically languages perform interesting phonological processes at the end of words to reduce the articulatory work needed to produce a word final speech sound; for instance, final consonant devoicing is when a voiced consonant surfaces as a voiceless consonant at the end of a word (Hayes, 2009). Articulatorily and Acoustically, [ŋ] is relatively the simplest nasal to produce compared to [n] and [m] because [ŋ] has relatively no side branch in the oral cavity since it so far back in the oral cavity, which allows the anti-formants travel time from the side branch channel to the nasal cavity to be relatively shorter than other nasals which consumes energy since voicing is an energy consuming process (Hayes, 2009).

3. Phonological Rules and Phonemicization

3.1 Syllabic Initial Phonemic Contrast

As the reader will recall, we observe that [n] and [m] are contrastive in the context where the two phones are followed by a [+syllabic] phone, which groups these phones into the /n/ and /m/ phonemes, which serve as the ambiguous underlying forms of our data through the [+nasal] feature refer to §2.1 for minimal and near minimal pair evidence from the data set.

We propose that [n] and [m] are contrastive when followed by a [+syllabic] phone and so surface as themselves, as formalized here in (8):

(8) Syllabic Initial Phonemic Contrast

[+nasal] → [+nasal] / ____ [+syllabic]

Convert a [+nasal] underlying form to [+nasal] when followed by a syllabic phone.

3.2 Nasal Assimilation

Recall from §2.2 and §2.3, that underlying [+nasal] forms assimilate to the place of articulation of the following consonant and the [± glide] feature of the following glide. According to Hayes, we can utilize the versatility of the features system – which has manner features, place features, laryngeal features, etc.—to create phonological rules that encompass our patterns accurately (Hayes, 2009). In short, Hayes proposes the idea of grouping place of articulation under a group unit called [place] (Hayes, 2009). The [place] feature allows us to adjust to the different places of articulations different [-syllabic] phones will display and append them to our underlying forms to generate our surface forms. Similarly, we can utilize a similar grouping strategy for the manner

feature [\pm glide] which will capture if the following [-syllabic] consonant is a glide [+glide] or not a glide [-glide]. Appending a [+glide] to our underlying [+nasal] generates a nasalized glide a surface form, but appending a [-glide] and [place] to our underlying [+nasal] form and generates a nasal with just the place of articulation of the [-syllabic] phone.

We propose that the nasal assimilation encompasses underlying [+nasal] forms assimilating to [place] and the [\pm glide] feature of the following [-syllabic], as formalized here in (9):

(9) Nasal Assimilation:

$$[+nasal] \rightarrow \begin{bmatrix} \alpha \text{ place} \\ \lambda \text{ glide} \end{bmatrix} / \text{---} \begin{bmatrix} \text{-syllabic} \\ \alpha \text{ place} \\ \lambda \text{ glide} \end{bmatrix}$$

Assimilate the underlying [+nasal] to the [place] and [\pm glide] of the following non-syllabic phone.

Here, alpha (α) indicates the place of articulation of the following [-syllabic] phone and appends it onto the underlying form to create a surface form with that place of articulation. In addition, the rule produces nasalized glides with lambda (λ) which indicates whether the [-syllabic] displays the features of a glide [+glide] or not [-glide]. If the [-syllabic] has a [+glide] feature, we append it onto the underlying form to generate a surface form with the [+glide] feature and the [+nasal] which is a nasalized glide.

3.3 Word-Final Nasal Dorsalization

Finally, readers can recall from section §2.4 that the word final position of the underlying [+nasal] form yielded the dorsalized nasal [ŋ] as the surface form.

We propose that word final nasals dorsalize, as demonstrated here in (10):

(10) Word-Final Nasal Dorsalization:

$$[+nasal] \rightarrow [+Dorsal] / \text{---}]_{\text{WORD}}$$

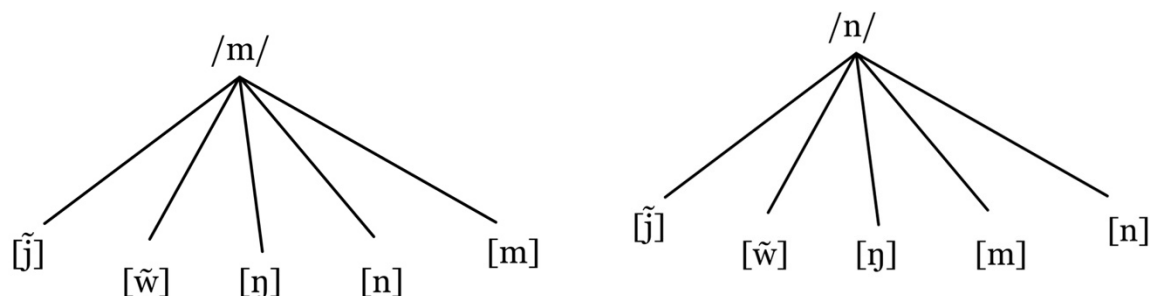
Dorsalize a nasal in word final position.

3.4 Phonemicization

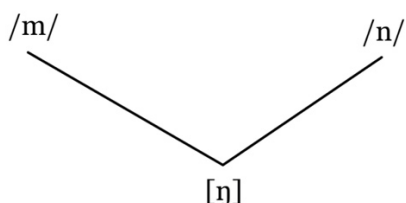
Based on the rules described in this section, we now propose phonemicization for the phones relevant to Japanese allophonic alternations, which can be visualized in (11):

(11) Phonemicization Diagrams:

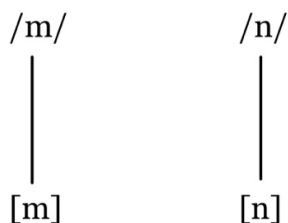
Before a [-syllabic] phone _____ $\begin{bmatrix} \text{-syllabic} \\ \alpha \text{ place} \\ \lambda \text{ glide} \end{bmatrix}$



Word-Final Position _____]_{WORD}



Before a [+syllabic] phone or elsewhere



Our phonemicization diagrams captures, reveal two cases of neutralization. First, we see that $[m]$ surfaces both as an allophone of itself— whenever $/m/$ is underlying and followed by a [+syllabic] phone—and an allophone of $/n/$ in the context where $/n/$ is followed by a [-syllabic] phone. Second, $[n]$ surfaces both as allophone of itself— whenever $/n/$ is underlying and followed by [+syllabic] phone—and an allophone of $/m/$ in the context where $/m/$ is followed by a [-syllabic] phone. In addition, we observe that when $/n/$ or $/m/$ are underlying in word final position that they surface as the allophone $[\eta]$.

4. Derivations

As the reader recalls, we proposed two phonological rules that represent allophonic alternations in this Japanese data set. Since our underlying form is [+nasal] for reasons expounded upon in §2.2, to achieve the underlying forms of the Japanese words utilized in this derivation the marker ‘N’ was used to represent the [+nasal] underlying form as demonstrated in (12):

(12) Successful derivation with correct rule ordering:

/mo/ ‘also’	/zaNburi/ ‘with a splash’	/zaNki/ ‘remaining time’	/jaNwari/ ‘softly’	/paN/ ‘bread’	Underlying Forms
-----	zamburi	zan̩ki	jaɰ̥wari	-----	Nasal Assimilation [+nasal] → $\left[\begin{smallmatrix} \alpha \text{ place} \\ \lambda \text{ glide} \end{smallmatrix} \right] / \text{-----} \left[\begin{smallmatrix} \text{-syllabic} \\ \alpha \text{ place} \\ \lambda \text{ glide} \end{smallmatrix} \right]$
-----	-----	-----	-----	paŋ	Word-Final Nasal Dorsalization [+nasal] → [+Dorsal] / _____] _{WORD}
[mo]	[zamburi]	[zan̩ki]	[jaɰ̥wari]	[paŋ]	Surface Forms

In (12), we see that the two proposed phonological rules in the present analysis, work in tandem to derive the correct surface forms for Japanese words with no allophonic alternations and phonemic contrast, such as /mo/ ‘also’; words with a [+nasal] phone followed by a [-syllabic] phone, such as /zaNburi/ ‘with a splash’ and /zaNki/ ‘remaining time’; words with a [+nasal] phone followed by a [+glide] phone, such as /jaNwari/ ‘softly’; and words with [+nasals] in word-final position, such as /paN/ ‘bread’.

6. Conclusion

In Japanese we observe that Japanese nasals participate in allophonic alternations, which neutralizes the contrastive distribution of the phonemes in certain contexts. In an effort to make sense of this puzzle, we first scrutinized this data set for minimal and near minimal pairs which proved that [n] and [m] are in contrastive distribution—the phones [n] and [m] are the phonemes /n/ and /m/—in the context where they occur before a [+syllabic] phone. However, this syllable-initial phonemic contrast between [n] and [m] fail in other contexts. More specifically, syllable-initial phonemic contrast fails

in the contexts where [+nasal] underlying forms— [+nasal] indicating the phonemes with nasal quality which are /n/ and /m/— occur before a [-syllabic] phones, [+glides] phones, and in word final position. As a result, allophonic alternations occur in certain environments which neutralizes the contrastive distribution and to represent these alternations phonological rules were proposed. It was observed that [+nasal] underlying forms assimilated to the [place] —feature unit utilized to represent all the features necessary to express the place of articulation of phone— and the [\pm glide] feature of the following phone. The proposed Nasal Assimilation rule accounts for the underlying [+nasal] form to surface as a phone with the [place] and [\pm glide] feature of the following phone. In addition, at word final position the underlying [+nasal] form surfaced with a [+Dorsal] place feature which is accounted for in another proposed rule: Word-Final Dorsalization. The analysis proposed here is able to account for the observed alternations in Japanese nasals, and additionally provides support for the postulation of a contextually limited contrastive distribution in Japanese nasals.

While the present analysis is sufficient to account for the [+nasal] phones that appear in the given data set, it is still possible that an expanded data set would complicate what we have proposed in this paper. For instance, it is likely that the allophone [ŋ] only belongs to /n/ or /m/ and it is not a shared allophone; additional data constructed from a more robust data set is required to investigate this hypothesis. In addition, we are curious as to whether the phonemes /m/ and /n/ have additional allophones that our phonological rules could generate. For instance, Nasal place assimilation is a phonological rule that is able to generate a nasal with the place features of the following phone; however, we've only observed place assimilation for labials, alveolar, and velar consonants. As a result, to thoroughly test our phonological rule on all possible place of articulation of [-syllabic] phone, a larger data set with all of the possible [-syllabic] phones in Japanese is need to reinforce the validity of our rule.

References

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