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REANALYZING THE JAPANESE CODA NASAL
IN OPTIMALITY THEORY¹

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Japanese is often said to have a relatively simple syllable structure (Spencer 1996:81, among others), in which the coda consonants are more highly restricted compared to a language such as English. Many studies on Japanese phonology (Amanuma et al. 1983, Vance 1987, Nakajo 1989) analyze coda nasals as an archiphoneme /N/, which is distinct from the other nasal phonemes in Japanese, /m/ and /n/. There are two distinctive properties of the coda nasal to be differentiated from other nasal phonemes: (1) Various segments appear as allophones of /N/, and (2) /N/ can constitute a mora, unlike /m/ and /n/ in the onset (Vance 1987:38).

This paper proposes an alternative view of the coda nasal: The various nasal segments in the coda position are allophones of an alveolar nasal /n/, rather than an archiphoneme /N/. This analysis makes the analysis of Japanese simpler because the abstraction represented by /N/ is eliminated. This analysis of the coda nasal will be presented in the framework of Optimality Theory (henceforth OT): an OT analysis which assumes that /n/ is the underlying phoneme can describe both of the above properties of the Japanese coda nasal. The results of two experimental studies on Japanese speakers' performance in English will be provided as evidence.

1. BACKGROUND: TRADITIONAL ANALYSIS OF THE JAPANESE CODA NASAL. Various scholars claim that the Japanese coda nasal is a separate 'mora phoneme' which only appears lexically in the coda (Amanuma et al. 1983, Vance 1987, Nakajo 1989, Shibatani 1990). It appears as a uvular nasal [N] before a pause (Vance 1987:34); [N] is articulated "with the posterior part of the soft palate together with the uvula touching the back tongue" according to Nakano (1969:220). When the coda nasal is not followed by a pause, it appears as a wide variety of sounds due to place assimilation, partly shown in Table 1 (Vance 1987:35). Other nasal and nasalized segments are reported as appearing as allophones of this coda nasal. Amanuma et al. (1983:78), for example, listed 18 segments, including the nasal segments shown in Table 1.

There are two distinctive properties of the coda nasal which differentiate it from other nasal phonemes: (1) Various segments appear as allophones of /N/, and (2) /N/ can constitute a mora, unlike /m/ and /n/ in the onset (Vance 1987:38). It is

important to note that various allophones of this coda nasal are written with the same symbol in Japanese syllabary (kana). Vance calls this the *mora nasal*, and it is also called *hatsuon* (literally ‘skipped sound’) in Japanese. It has been written as /N/² in the literature (Amanuma et al. 1983, Vance 1987, Nakajo 1989, Shibatani 1990).

<i>hon mo</i> ‘book too’	[hom:mo] ^a
<i>hon da</i> ‘is a book’	[hon:da]
<i>hon ni</i> ‘in a book’	[hoɲ:ji]
<i>hon ka</i> ‘book?’	[hoŋ:ka]

TABLE 1. Some allophones of the coda nasal.

^aThe symbol [:] after a nasal consonant means that the nasal is moraic.

2. AN ALTERNATIVE ANALYSIS. I propose in this paper that /n/ is the underlying form for the coda nasal (see Table 2). In the following sections, I will first reanalyze Japanese nasal phonemes in OT, and then I will briefly summarize two experimental studies which support this analysis.

Phoneme ³	Distribution and characteristics	Example
/m/	appears in the onset position only	<i>me</i> ‘eye’
/n/	appears in the onset and coda positions; constitutes a mora when it appears in coda	<i>neko</i> ‘cat’ <i>hon</i> ‘book’

TABLE 2. Alternative view of Japanese nasal phonemes.

3. JAPANESE NASAL PHONEMES ANALYZED IN OT. Prince and Smolensky (1993:3) claim that languages have a universal set of constraints, and that languages differ in the way they rank these constraints. Thus OT differs from derivational paradigms in the mechanism by which output is mediated (Archangeli 1997:13); and there are no intermediate forms between the input and the output, but all possible variants are produced in one step and evaluated in parallel (Prince and Smolensky 1993:5).

3.1. SYLLABLE STRUCTURE IN JAPANESE. According to Vance (1987:64), all Japanese syllables conform to a shape proposed in the following schema. Q stands for mora obstruents.

$$(C)(y)V \{V \text{ or } N \text{ or } Q\}^4$$

This schema can be interpreted with the following constraints: First, the relevant constraints are listed, and then, a partial ranking of them will be examined.

Relevant constraints are as follows:

*COMPLEX: Syllables have at most one consonant at an edge.

PEAK: Syllables have a vowel.

FAITHFULNESS (FAITH):

NASALITY: The nasal segment/feature of the input has an identical correspondent in the output.

DEP: Every segment/feature of the output has an identical correspondent in the output.

ONSET: Syllables begin with a consonant.

NO CODA: Syllables end with a vowel.

The crucial ranking is that FAITH [NAS] outranks NO CODA. Table 3 summarizes the possible syllable structures in Japanese (syllables which contain mora obstruents /Q/ are omitted from this table since they are irrelevant to this paper). C stands for consonants in general, and the coda nasal is not included in C. Although CVC syllables do exist in Japanese (e.g., *kit.te* 'stamp'), there are no words containing only a CVC syllable. It is disregarded here for brevity's sake.

Syllable structure	Example	*COMPLEX	PEAK	FAITH [NAS]	DEP	ONSET	NO CODA
CV	<i>me</i> 'eye'						
CVN	<i>sen</i> 'thousand'						*
CVV	<i>koe</i> 'voice'						
VN	<i>en</i> 'yen'					*	*
CCV	---	*					
CC	---		*				

TABLE 3. Syllables in Japanese.

3.2. THE ALVEOLAR NASAL /n/ IN THE CODA. Some additional constraints are necessary to analyze the coda nasal. One of the properties of this coda nasal is that it can be realized as various nasal and nasalized segments phonetically. This characteristic can be described even if we assume that /n/ assimilates its place of articulation to the following segment. The relevant constraints are:

IDENTICAL CLUSTER CONSTRAINTS (ICC):

[PLACE]: A sequence of consonants must be identical in *place of articulation*.

FAITHFULNESS (FAITH):

PLACE/ONSET: Place of articulation of the onset in the input has an identical correspondent in the output.

PLACE/CODA: Place of articulation of the coda in the input has an identical correspondent in the output.

Since the coda nasal assimilates its place of articulation but retains its nasality, it is apparent that ICC [PLACE] is ranked higher than FAITH [PLACE/CODA]. Tableau 1 illustrates place assimilation of the coda nasal.

/hon ka/ 'book?'	ICC [PLACE]	FAITH [PLACE/CODA]	FAITH [NAS]
[hon: ka] ⁵	*!		
☞ [hoŋ:ka]		*	

TABLEAU 1. /n/ assimilation to /k/.

The coda nasal loses its place of articulation in front of a pause, and it is phonetically realized as a uvular nasal [ɴ]. Pulleyblank noted that codas make poor hosts for a number of features, including place distinctions, and it is common that phonemes are neutralized in the coda position (1997:81). He proposes the following constraint, which requires that codas be minimally specified:

CONTRASTIVE CODA: A coda does not bear contrastive features.

/hon/ 'book'	ICC [PLACE]	FAITH [NAS]	CONTRASTIVE CODA	FAITH [PLACE/CODA]
[hon:]			*!	
[hom:]			*!	
☞ [hɒɴ:]				*

TABLEAU 2. /n/ before a pause.

The only way for coda /n/ to satisfy the CONTRASTIVE CODA is for it to lose its point of articulation, i.e., it becomes [ɴ]. CONTRASTIVE CODA is ranked higher than FAITH [PLACE/CODA], since the underlying /n/ loses its point of articulation in the coda. It is, however, ranked lower than FAITH [NAS], since the underlying /n/ does not lose its nasality. It is ranked lower than ICC [PLACE]: /n/ assimilates its place and does not appear as [ɴ] when it appears before another consonant, as follows:

ICC [PLACE], FAITH [NAS], FAITH [PLACE/ONSET] >> CONTRASTIVE CODA >> FAITH [PLACE/CODA]

/hon ka/ 'book?'	ICC [PLACE]	FAITH [NAS]	FAITH [PLACE/ ONSET]	CONTRASTIVE CODA	FAITH [PLACE/ CODA]
[hon: ka]	*!			*	
[hON: ka]	*!				*
^h [hoŋ: ka]				*	*
[hON: ʔa]			*!		*

TABLEAU 3. /n/ assimilation to /k/.

Tableau 2 shows that it is possible to describe [N] before a pause as an allophone of /n/ with these constraints. Tableau 3 is a revised version of Tableau 1 with a candidate which contains [N]. Only FAITH [PLACE/CODA], but not FAITH [PLACE/ONSET], is ranked lower than CONTRASTIVE CODA, so a candidate with [N] at the onset is not an optimal candidate.

One of the distinctive properties of /N/ in the traditional analyses is the fact that it constitutes a mora. Hammond states a constraint (syllabic) LICENSING, which requires all words to be composed of syllables (1997:35). According to Hammond, LICENSING is ranked high in English, and all segments must satisfy this constraint: a hypothetical word like *tkin* is not possible in English, since *t* does not satisfy LICENSING (1997:41). It is known that a smaller phonological unit than a syllable, called a *mora*, plays an important role in Japanese, and all syllable-final consonants must constitute a mora (Shibatani 1990:140). I want to propose a constraint MORA LICENSING, which requires the last segment in Vance's schema {V or N or Q} to have a mora in its own right:

MORA LICENSING: Each segment in the rhyme must bear a mora.

Since nasal segments in the coda are not deleted, I assume MORA LICENSING is ranked higher than NO CODA. Tableau 4 is a revised version of Tableau 3, with more candidates and constraints.

/hon ka/ 'book?'	ICC [PLACE]	FAITH [NAS]	MORA LICENSING	FAITH [PLACE/ ONSET]	CONTRASTIVE CODA	NO CODA	FAITH [PLACE/ CODA]
[ho ka]		*!					*
[honka]	*!		*		*	*	
[hon: ka]	*!				*	*	
[honka]	*!		*			*	*
[hon: ka]	*!					*	*
[hoŋka]			*!		*	*	*
☞[hoŋ: ka]					*	*	*
[hon: ʔa]				*!			*

TABLEAU 4. /n/ assimilation to /k/.

3.3. CONTRAST BETWEEN THE TRADITIONAL ANALYSIS AND THE ALTERNATIVE ANALYSIS. Now reconsider the two major properties of /N/ in traditional analyses: (1) Various segments appear as allophones of /N/; (2) /N/ can constitute a mora, unlike /m/ and /n/ in the onset (Vance 1987). As seen in Tableau 4, an analysis which assumes that /n/ is the underlying phoneme can describe both properties. Thus, it is not necessary to have an archiphoneme /N/, but reconsideration of the phoneme /n/ is needed.

Differences between the traditional analysis of the coda nasal and the alternative analysis proposed here are summarized in Table 4. The main advantage of the alternate analysis is that the analysis of Japanese becomes simpler, without the abstraction represented by /N/.

Traditional analysis		Alternative analysis	
<i>Phonemes and Archiphoneme</i>	<i>Distribution and Characteristics</i>	<i>Phonemes</i>	<i>Distribution and Characteristics</i>
Bilabial nasal /m/	Onset only	Bilabial nasal /m/	Onset only
Alveolar nasal /n/	Onset only	Alveolar nasal /n/	Onset and coda
Mora nasal /N/	Coda only ⁶ Moraic		Moraic in coda

TABLE 4. Comparison of the traditional view and the alternative view.

4. EVIDENCE FROM JAPANESE SPEAKERS' PERFORMANCE IN ENGLISH.

4.1. JAPANESE SPEAKERS' PERCEPTION OF ENGLISH /n/. Findings from studies of Japanese speakers' performance in English support the alternate analysis which proposes /n/ as the underlying phoneme of the coda nasal.

A significant difficulty in distinguishing English coda /n/ and /ŋ/ was found in Japanese speakers' perception (Aoyama 1997a). This study was originally

motivated by two hypotheses: (1) there are not significant differences between Korean and Japanese speakers for the contrast of /m/ and /n/ in word-initial position in English, since both languages distinguish the phonemes /m/ and /n/ in the onset. (2) Korean speakers will have less difficulty in distinguishing contrasts in the coda because Korean distinguishes these phonemes in the coda. Japanese speakers will have difficulties distinguishing /m/, /n/ and /ŋ/ in the coda because of the interference of the archiphoneme /N/.

The data were collected from native speakers of Korean in Seoul, Korea, and from native speakers of Japanese in Osaka and Tokyo, Japan. There were 40 subjects, 10 Korean females and 10 Korean males, and 10 Japanese females and 10 Japanese males. Their ages ranged from early 20s to mid 50s. All of them had studied English through the secondary school systems in Korea or Japan. Their length of stay in an English speaking country, however, was limited (less than a year), if any. There were also 20 native English speakers who listened to the same tape as a control group. There were 10 males and 10 females among this group as well.

	Korean (20 subjects)		Japanese (20 subjects)		English (20 subjects)	
	Number	Percentage	Number	Percentage	Number	Percentage
Type 1 (m- vs. n-)	21	10.5%	14	7.0%	12	6.0%
Type 2 (-n vs. -ŋ)	12	6.0%	54	27.0%	2	1.0%
Type 3 (-m vs. -ŋ)	10	5.0%	15	7.5%	2	1.0%
Type 4 (-m vs. -n)	24	12.0%	23	11.5%	12	6.0%

TABLE 5. Number of mishearings in each type and subject group.

Forty minimal pairs were listed on an answer sheet, and the listeners were asked to select the word they heard from the corresponding pair. There were four different types of minimal pairs: Type 1: word-initial /m/ vs. /n/ (e.g., *mitt* : *knit*); Type 2: word-final /n/ vs. /ŋ/ (e.g., *sin*: *sing*), Type 3: word-final /m/ vs. /ŋ/ (e.g., *swim*: *swing*); and Type 4: word-final /m/ vs. /n/ (e.g., *seem*: *scene*). Each type included five pairs and each pair was examined twice so that both words from each pair were read aloud one time.

As seen in tables 5 and 6, the Japanese speakers had considerable difficulty in distinguishing /n/ and /ŋ/ in coda position. All but one of the Japanese speakers misheard at least one of the pairs in this type. The percentage of mishearings among the Japanese speakers for Type 2 was higher by far than the other three types (27.0% vs. 7%, 7.5% and 11.5%).

Stimulus	Perceived final		
	/m/	/n/	/ŋ/
[m]	192	7	1
[n]	16	174	10
[ŋ]	14	44	142

TABLE 6. Overall results: Japanese speakers' perception.

In the Japanese data, statistically significant differences were found only between Type 2 (-n vs. -ŋ) and others ($\chi^2 = 15.45$, $p < 0.001$). No significant difference was found between Types 1 (m- vs. n-), 3 (-m vs. -ŋ) and 4 (-m vs. -n) ($\chi^2 = 2.41$, $p > 0.1$). This means that Japanese speakers had approximately the same number of mishearings in Types 1, 3 and 4, although Type 1 consisted of onset minimal pairs and Types 3 and 4 consisted of coda minimal pairs. Thus, the distinction between English nasal phonemes in the coda was not in general difficult for Japanese speakers, although nasal phoneme distinctions do not exist in the coda in Japanese. Rather, the difficulty was in the distinction of particular English phonemes, /n/ and /ŋ/.

Interestingly, Japanese speakers misheard English /ŋ/ as /n/ more than they misheard /n/ as /ŋ/. (81.5% of the total mishearings, see Table 7 and Figure 1). Japanese speakers had a very hard time in distinguishing /ŋ/ and /n/ when the target word contained /ŋ/ word-finally, as in *sing* (44 mishearings out of 100 tokens).

Whether or not [ŋ] is a phoneme in Japanese is a matter of controversy (cf. Vance 1987:110, Nakajo 1989:76-78). There may be some minimal pairs contrasting non-initial [g] and [ŋ], such as [daigo] 'fifth' and [daiŋo] 'an emperor's name' in some varieties of Japanese (Nakajo 1989:77), but the contrast is marginal at best. Hibiya (1995) observed a rapid ongoing change from [ŋ] to [g], and showed that young Tokyo speakers tend to have [g] where older speakers have [ŋ] or variation between [ŋ] and [g]. For the younger speakers in Hibiya's study, this intervocalic [ŋ] could be simply an allophone of [g]; then, [ŋ] is not a phoneme for the younger speakers.

All but one of the Japanese subjects in this study were in their 20s or early 30s. Therefore, for the relatively young speakers represented in this study, [ŋ] could be simply an allophone of [g]. The observed difficulty of distinguishing English /ŋ/ from /n/ is evidence that [ŋ] is an allophone of the coda nasal in Japanese.

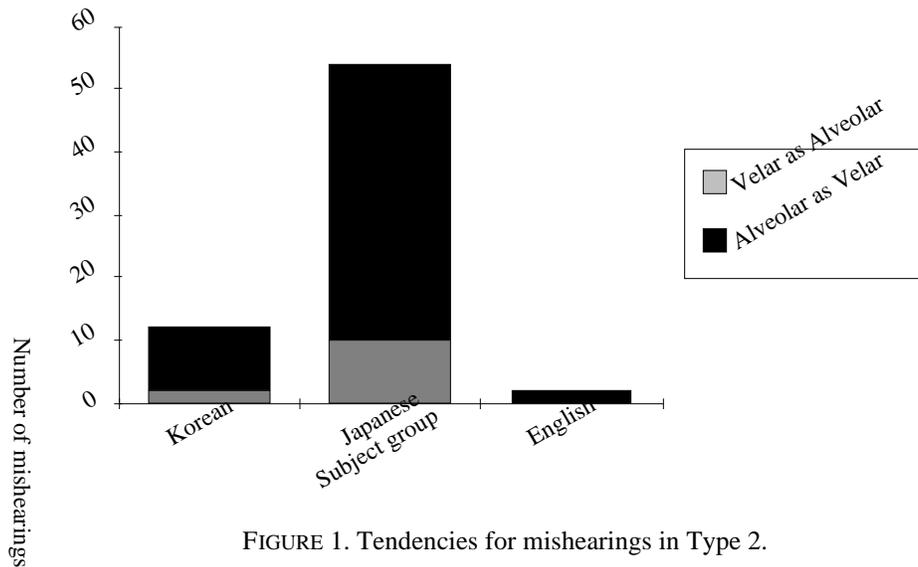


FIGURE 1. Tendencies for mishearings in Type 2.

	Number of mishearings (=27% of Type 2)	Percentages in total mishearings of this type
[n] heard as /ŋ/	10	18.5 %
[ŋ] heard as /n/	44	81.5 %

TABLE 7. Japanese speakers' tendency to mishear Type 2: word-final /n/ vs. /ŋ/.

In addition, Japanese speakers did not have difficulty with Type 3 (-m vs. -ŋ). This tells us that Japanese speakers can distinguish /ŋ/ from /m/. In the traditional analysis of the coda nasal, [m], [n] and [ŋ] are all allophones of /N/; however, this type of analysis does not explain why Japanese speakers did well on /m/ vs. /ŋ/, but had difficulty with /n/ vs. /ŋ/.

In Type 4 (-m vs. -n), the tendency of mishearings was opposite from Type 2 (-n vs. -ŋ). Japanese speakers preferred /m/ in a pair such as *scene: seem* (see table 8). This denies that the preference of alveolar /n/ in Type 2 (-n vs. -ŋ) was simply because of orthographic influence (the coda nasal is usually spelled with the letter *n* in Japanese romanization). If it is mere orthographic influence, we would expect that Japanese speakers would prefer /n/ in both Types 2 (-n vs. -ŋ) and 4 (-m vs. -n); however, this preference for /n/ was found only in Type 2, and not in Type 4.

	Number of mishearings (=11.5% of Type 4)	Percentage of total mishearings in this type
[m] heard as /n/	7	30.4%
[n] heard as /m/	16	69.6%

TABLE 8. Japanese speakers' tendency of mishearings in Type 4: word-final /m/ vs. /n/.

4.2. JAPANESE SPEAKERS' PRODUCTION OF ENGLISH /n/. In the perception study, I found that Japanese speakers showed considerable difficulty in distinguishing /n/ and /ŋ/ in the coda position. I hypothesized that similar patterns of difficulty would be found in their production of nasal phonemes as well. Accordingly, Japanese speakers' production of English nasal was also investigated (Aoyama 1997b).

Six native Japanese speakers (3 male and 3 female international students at the University of Hawai'i at Mānoa) were asked to read a list which consisted of 14 simple English monosyllabic words containing a nasal phoneme either in the onset or coda. The speakers' lengths of stay in the US or other English-speaking countries varied: the shortest was 2 months, and the mean was 3.3 years. One speaker had spent his early years (ages 3 to 9) in the UK, and one year of his adolescence in Idaho. However, the difference in length of stay was not controlled, since the differences among individual speakers were not the main focus of this study.

The recordings were done in the language laboratory at the University of Hawai'i at Mānoa. The speakers were asked to come to the laboratory individually, and they read the word list in the investigator's presence. A recording technician controlled the sound level in the room next to the one where the speaker and the investigator were sitting. Each subject read both the number and the word (for example, 'One, *mitt*.' and 'Fourteen, *seem*.') into the microphone.

Intended	[m]	[n]
/m/	6	0
/n/	0	6

TABLE 9. Japanese speakers' production of /m/ and /n/ in the onset position.

Japanese speakers did not have difficulty producing the English /m/ and /n/ in the onset. Each speaker read the words *mitt* and *knit*, and their pronunciation was summarized in table 9. Each speaker read four words for both /m/ and /n/: *swim*, *some*, *seem*, and *same* for /m/, and *sin*, *kin*, *scene*, and *sane* for /n/. They did not have particular difficulty in producing /m/ in the coda either (table 10). /m/ was pronounced as [m] by all speakers, although one speaker added epenthetic [u] in

two of the six words (*swim* [sw μ mu] and *some* [sə μ mu]). This was a surprising finding: Japanese speakers did not have difficulty in producing /m/ in codas, although /m/ does not contrast with other Japanese nasals in the coda in Japanese.

A variety of sounds appeared when the Japanese speakers intended to produce /n/ in codas (see table 10); /n/ was pronounced as [n] in only 9 out of 23 utterances (39.1%), and /n/ was most often pronounced as [N] (13 out of 23, 56.5%). One speaker pronounced a nasalized vowel, which is reported to appear as an allophone of the coda nasal (Shibatani 1990:139): *sane* was pronounced as [sẽ̃].

Since the task was to read a word list, the speakers produced all these nasal phonemes before a pause. More than half (60.1%) of the Japanese speakers' production of English /n/ corresponded to a typical pronunciation of Japanese coda nasal before a pause. Thus, it is possible that the Japanese speakers believed that English nasal /n/ to be the same or at least similar to the Japanese coda nasal, and pronounced English /n/ as in Japanese.

Intended	[m]	[m + u]	[n]	[N]	[sẽ̃]
/m/	22	2	0	0	0
/n/	1 ⁷	0	9	13	1

TABLE 10. Japanese speakers' production of /m/ and /n/ in the coda position.

One important thing to note here is the fact that Japanese speakers' confusion of English /n/ with the Japanese coda nasal did not affect the production of English /m/: /m/ was almost always pronounced as [m] in the coda as well as in the onset. If the Japanese coda nasal is underlyingly /N/, both /m/ and /n/ should be difficult, since they are both allophones of /N/ in the traditional analysis. However, Japanese speakers were able to produce final /m/, while they had difficulty producing final /n/. The difference of difficulty in producing /m/ and /n/ denies the analysis that they are perceived as mere allophones of the coda nasal.

4.3. LIMITATIONS OF THE STUDIES. There are some limitations of these studies. First, the Japanese speakers' production cannot be strong evidence of an underlying /n/ for the coda nasal. The coda nasal is usually spelled with the letter *n* in Japanese romanization and it is possible to analyze its production as the influence of Japanese orthography. It is possible that Japanese speakers regarded the English /n/ as the same as Japanese /n/ simply because of orthography.

Second, the subjects' backgrounds were not controlled in either study. The data collections were done randomly in Seoul, Osaka, Tokyo, and Honolulu. The places in which the subjects grew up, their age and their English proficiency (for Korean and Japanese speakers) were not well-controlled. The subjects' original hometowns were not taken into consideration in these studies. This might affect

the data, since some dialects of Japanese retain the velar nasal as a phoneme (Vance 1987); consequently the Japanese speakers who speak those dialects might have performed better than speakers of other dialects did.

4.4. SUMMARY OF THE STUDIES. Japanese speakers demonstrated significant difficulty in perceiving and producing the English phoneme /n/: they had difficulty distinguishing /ŋ/ from /n/ in the perception study, and their production of English /n/ was similar to that of the Japanese coda nasal. Other contrasts in the coda position (/m/ vs. /ŋ/, and /m/ vs. /n/) were found to be as easy to distinguish as the contrast of /m/ vs. /n/ in the onset. These results are problematic if one assumes that the coda nasal is an archiphoneme /N/ in Japanese; the traditional analysis of the coda nasal as an archiphoneme /N/ with [m], [n], and [ŋ] as allophones would predict that perception and production of all English nasal phonemes in coda would be equally affected. The uneven difficulty found in Japanese speakers' perception and production supports the alternative analysis of the Japanese coda nasal: It is underlyingly /n/, not an archiphoneme /N/.

5. CONCLUSION. In the traditional analysis of Japanese, the coda nasal has been analyzed as /N/, an archiphoneme. This paper shows that it is theoretically possible to analyze the coda nasal as underlying /n/; further, studies of Japanese speakers' performance in English support this analysis.

One might wonder why Japanese speakers distinguish syllable-final /m/ from /n/ and /ŋ/ easily, but have difficulty distinguishing syllable-final /ŋ/ from /n/. An archiphonemic analysis is unable to account for Japanese speakers' differential ability to distinguish and produce English syllable final nasals.⁸ I propose that a sound which is recognized as a phoneme in one position (/m/ in the onset in Japanese) is easier to distinguish in other positions, where the sound does not occur in the native language. I propose that [ŋ] is only an allophone for the young Japanese subjects who participated in the studies; therefore, English [ŋ] is not perceived as itself but often as /n/. [m] and [n] are phonemes of Japanese, so English [m] and [n] are perceived as themselves.

In conclusion, I propose a non-archiphonemic analysis of the Japanese coda nasal, which makes the analysis of Japanese simpler because the abstraction represented by /N/ is eliminated.

NOTES

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² It is not clear whether /N/ stands for a uvular /N/ or an archiphoneme /N/ in the traditional analysis (for instance, Vance 1987). In either case, however, it is clearly differentiated from the alveolar /n/; thus, whether it is an archiphoneme or a uvular nasal is not crucial to the argument in this paper. I take /N/ in the traditional analysis as an archiphoneme in this paper. I thank an anonymous reviewer who made this point clear.

³ Whether /ŋ/ is a phoneme or not is another problem in the Japanese nasal phoneme inventory, but I will not discuss it in this paper.

⁴ Vance mentions the exception of over-long syllables; for example, /*tooQ-ta*/ ‘pass-PERFECTIVE’. In fact, these over-long syllables are rather common. Including overlong syllables, however, is beyond the scope of this paper. Thus, the following analysis of Japanese syllable structure is based on Vance’s schema.

⁵ Why the nasals are moraic will be explained shortly.

⁶ Vance mentions some cases of /N/ appearing utterance initially (1987:39); however, he agrees that /N/ occurs only after a vowel aside from marginal examples.

⁷ The speaker pronounced *sane* as [sə̃m] probably because it was an unfamiliar word for him. This token is not further considered in the discussion.

⁸ It is pointed out that the alternative analysis I am claiming here does not provide evidence for this difference much more clearly. Blaine Erickson and Patricia Donegan pointed out an analysis of the coda nasal as phonemic /m/ and /n/. This accounts for Japanese speakers’ ability to produce and perceive English /m/ in the coda. An anonymous reviewer also pointed out to me a claim of Freedom of the Input (FOTI) in OT; the constraints are all on the output. Thus, even if we assume that underlying form is /m/, the surface form will be the same.

It may be true that my analysis does not go far enough to fully explain why /n/ is the underlying phoneme; further investigation is needed to see if /n/ really is the underlying phoneme of the coda nasal in native Japanese words.

Sullivan (p.c.) has pointed out that /m/ and /n/ may be easier to perceive as distinctive because the point of articulation of [m] is visible. However, this cannot explain Japanese speakers’ ability to distinguish /m/ from /n/ in the coda for several reasons. First, only auditory stimuli were provided in this study, and Japanese speakers could not see the point of articulation. Second, native English speakers had same difficulty distinguishing /m/ and /n/ in the coda in their own native language (see table 5). Third, it is reported in the literature that [m] and [n] are perceptually more similar than [m], [n] vs. [ŋ] (Black 1969, Thomas 1992).

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² It is not clear whether /N/ stands for a uvular / / or an archiphoneme /N/ in the traditional analysis (for instance, Vance 1987). In either case, however, it is clearly differentiated from the alveolar /n/; thus, whether it is an archiphoneme or a uvular nasal is not crucial to the argument in this paper. I take /N/ in the traditional analysis as an archiphoneme in this paper. I thank an anonymous reviewer who made this point clear.

³ Whether /N/ is a phoneme or not is another problem in the Japanese nasal phoneme inventory, but I will not discuss it in this paper.

⁴ Vance mentions the exception of over-long syllables; for example, /*tooQ-ta*/ 'pass-PERFECTIVE'. In fact, these over-long syllables are rather common. Including overlong syllables, however, is beyond the scope of this paper. Thus, the following analysis of Japanese syllable structure is based on Vance's schema.

⁵ Why the nasals are moraic will be explained shortly.

⁶ Vance mentions some cases of /N/ appearing utterance initially (1987:39); however, he agrees that /N/ occurs only after a vowel aside from marginal examples.

⁷ The speaker pronounced *sane* as [s´m] probably because it was an unfamiliar word for him. This token is not further considered in the discussion.

⁸ It is pointed out that the alternative analysis I am claiming here does not provide evidence for this difference much more clearly. Blaine Erickson and Patricia Donegan pointed out an analysis of the coda nasal as phonemic /m/ and /n/. This accounts for Japanese speakers' ability to produce and perceive English /m/ in the coda. An anonymous reviewer also pointed out to me a claim of Freedom of the Input (FOTI) in OT; the constraints are all on the output. Thus, even if we assume that underlying form is /m/, the surface form will be the same.

It may be true that my analysis does not go far enough to fully explain why /n/ is the underlying phoneme; further investigation is needed to see if /n/ really is the underlying phoneme of the coda nasal in native Japanese words.

Sullivan (p.c.) has pointed out that /m/ and /n/ may be easier to perceive as distinctive because the point of articulation of [m] is visible. However, this cannot explain Japanese speakers' ability to distinguish /m/ from /n/ in the coda for several reasons. First, only auditory stimuli were provided in this study, and Japanese speakers could not see the point of articulation. Second, native English speakers had same difficulty distinguishing /m/ and /n/ in the coda in their own native language (see table 5). Third, it is reported in the literature that [m] and [n] are perceptually more similar than [m], [n] vs. [N] (Black 1969, Thomas 1992).