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An Optimality Theory Study of Nasals in Japanese

1.0 Introduction

The behaviour of nasals in the Japanese grammar has been something of a problem for modern phonological theory. Nasals seem to belong to some kind of conspiracy to avoid voiced obstruents in coda position, forcing them to transform into nasals homorganic with the onset of the following syllable. Although this behaviour could be adequately described using linear rule theory, later theories have fallen somewhat short of the task.[1] Several problems with the traditional approach to this topic cause the analyses to become fundamentally flawed. The primary issues that have clouded judgement in the past are the interpretation of the [i] in the past tense form of the verb [kakɯ] as a compensatory epenthetic vowel, the division of Japanese into several strata with independent phonological grammars, and opacity within the grammar. I demonstrate here that the first two pitfalls stem from the synchronic approach taken to the problem, and as such, can be easily surmounted with a diachronic approach. To overcome the obstacles posed by opacity, the 'Sympathy Approach' (McCarthy 1998) is taken. First a grammar within the framework of Optimality Theory for Sino-Japanese loan words is developed, and then it is applied to the paradigms of the verbs and the mimetics. Evidence is also taken from elision word forms in the Yamato stratum. As a full-fledged grammar would be too cumbersome, I instead focus primarily on the behaviour of nasals in coda position.

2.0 Opacity in the Sino-Japanese Loan Words

The huge number of loan words that followed the adoption of the Chinese writing system have had such a huge impact on the Japanese language that it is still felt today. These loan words were pronounced as faithfully as possible to their Chinese counterparts, within the limits of the Japanese phonological system at that time. However, Middle Chinese (MC) had a much greater variety of nasal phonemes than Old Japanese (OJ).[2] This section is an OT analysis of how OJ handled those nasal phonemes of Middle Chinese loan words that were foreign to its phonological system.

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[1] See Tsujima (1996) for a linear rule analysis of the verb paradigm. See Davis and Tsujima (1991) for a recent autosegmental theory analysis of the same. See Lombardi (1998) for an OT analysis of the same.

[2] Old Japanese refers to the Japanese language of the Nara period and before (-794 AD) (Takeuchi 1999). Middle Chinese refers to the Chinese language of Sui and Tang dynasties (589-906 AD) (Baxter 1992). The use of "Japanese" refers to both Old Japanese and Modern Japanese.

2.1 Historical Background[3]

From about the end of the sixth century, Japan launched a program of massive sinicization. Chinese was used for government administration and law, all documentation, as Japan did not have its own writing system at that time, including private writing and literature composition, and for the state-indorsed religion, Buddhism. Although initially knowledge of the Chinese language was confined to the upper echelon of society, with the official adoption of Buddhism in AD 594 it gradually spread to the masses through religion. The modern Japanese pronunciation of Chinese characters (*kanji*) is believed to have grown out of *hyaku-yomi* 'peasant reading-style', a bastardization of the Chinese pronunciation. After 894, when Japan officially severed ties with China, without direct contact with China maintaining "correct" pronunciation was no longer important, and this *hyaku-yomi* pronunciation gradually gained popularity to the point of eventually establishing itself as the norm within Japan.

2.2.1 Nasals in Middle Chinese and Old Japanese

Middle Chinese had a relatively large selection of nasals - five altogether. They were the bilabial [m], the alveolar [n], the palatal [ɲ], the retroflex [ɳ], and the velar [ŋ]. Of these, [m], [n], and [ŋ] occurred in coda position (Baxter 1992). On the other hand Old Japanese had a very small selection of nasals - only [m] and [n], neither of which occurred in coda position (Iwai 1987).[4] When a Middle Chinese loan word containing a nasal other than an [m] or an [n] in the onset was adopted into the lexicon, Old Japanese was faced with the problem of how to handle it. Different approaches were used, depending on the location of the phoneme. In the case of the nasals in the onset position, the foreign phoneme was replaced with a native one. Following are some examples for each of the nasals.[5]

(1) [ŋ] was replaced with [g]

MC	OJ
*ŋjuw	*giɯ
*ŋjæk	*gjakɯ

(2) [ɲ] was replaced with [ʤ]

MC	OJ
*ɲit	*ʤitsɯ
*ɲak	*ʤakɯ

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[3] The first paragraph of this section is based on Loveday 1996, pp. 29-37.

[4] Some works on modern Japanese phonology argue that the Japanese /n/ at the end of a word is not alveolar, but uvular [N] (cf. Vance 1987). I use the alveolar nasal throughout this paper.

[5] Following historical linguistics practice, I use the asterisk to indicate a historical reconstruction. The MC reconstructions used in this paper are from Baxter (1992). The OJ reconstructions are from Tôdô (1965).

*ɲet	*zetsɯ[6]

(3) [ɳ] was replaced with [n]

MC	OJ
*ɳæw	*neɯ
*ɳjo	*njo
*ɳjaŋ	*njaɯ

The nasals in coda position were dealt with in different ways.

(4) an [m] in coda position was changed to an onset

MC	OJ
*nom	*namɯ
*sim	*ʃimɯ[7]
*kim	*kimɯ

(5) an [n] in coda position was left in coda position[8]

MC	OJ
*lin	*ɾin
*xjun[9]	*kɯn
*ʔan	*an

(6) an [ŋ] in coda position was deleted[10]

MC	OJ
*tɕaŋ	*ʃjaɯ
*kjæŋ	*kjaɯ
*dʑaŋ	*dʒjaɯ
*kwaŋ	*kwaɯ
*khaŋ	*kaɯ

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[6] [dʒ] becomes [z] before [e].

[7] [ʃ] is an allophone of [s] which occurs before [i] or [j].

[8] The modern Japanese nasal in coda position is believed to be a byproduct of Japanese language contact with Chinese (Loveday 1996).

[9] Baxter says that the initial of this morpheme was either [x], or [h], depending on the dialect. As OJ also has the voiceless glottal fricative, I have chosen the place of articulation of the MC morpheme to match that of its OJ counterpart.

[10] The appearance of [ɯ] in its place is do to epenthesis. See §2.3.2.

2.3 OT Analysis[11]

As all languages,OJ has undominated OT constraints against those phonemes that don't occur in the language. For example,

(7) *ŋ – no velar nasals permitted

As we have seen, Old Japanese handles the foreign nasal phonemes in a variety of ways, depending on which phoneme it is, and its location in the syllable. This suggests that there are a number of lower ranking constraints at work. These will be introduced in the following sections.

2.3.1 Place of Articulation Versus Manner of Articulation

The fact that [ŋ] was replaced with [g] in (1) shows that preserving the place of articulation was more important than preserving the manner of articulation, in this case, the nasality. Here are some more examples of preserving the place of articulation while changing the manner of articulation.

(8) examples of preserving the place of articulation

MC	OJ	Place
*kæp	*kaɸɯ	bilabial
*xwa	*ka	velar
*lak	*ɾakɯ	alveolar

This is captured in OT by the following ranking of constraints:

(9) IDENTIO(PLACE) ≫ IDENTIO(MANNER)

where manner is "nasal", "stop", "fricative", etc.

Sometimes Old Japanese didn't have a phoneme articulated at the same place as the phoneme it as trying to replace. In these cases, the phoneme with the closest place of articulation was chosen. In the case of (2), a palatal was replaced with an alveo-palatal. (3) shows that if it is possible, the manner of articulation should still be preserved. Here is another example:

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[11] For the purpose of this analysis, I ignore changes that occur in the nucleus. Generally speaking, vowels are much more difficult to reconstruct, which leaves greater room for error in historical reconstructions. Therefore it is difficult to determine if vowel changes are the result of constraint enforcement or due to erroneous reconstructions. As well, while the Chinese data are historical reconstructions, the Japanese data are IPA renderings of traditional Japanese spellings, based on the modern Japanese pronunciation. It is possible that quality of some of the vowels has changed over the years, while the spelling has not. If so, this introduces another source of error.

(10) example of preserving the manner of articulation

MC	OJ	Manner
*tʂek	*ʃjakɯ	fricative

Preserving the same voicing is also more important than preserving the manner of articulation. Here is an example:

(11) example of preserving the voicing

MC	OJ	Manner
*kæp	*kaɸɯ	bilabial → fricative

Even though OJ had the phoneme [b], it isn't used to replace [p] because that would violate the constraint against changing the voicing. Although the constraint IDENTIO(VOICE) would suffice here, I will from the beginning follow Lombardi (1998) and use MAXIO/DEPIO constraints (combined to save space):

(12) DEPMAXIO(VOICE) – the number of [+voice] obstruents in the input must be the same as in the output[12]

The use of MAXIO/DEPIO constraints instead of IDENTIO(VOICE) will become crucial to the correct selection of the optimal candidate in §3.

2.3.2 Epenthesis

The next phenomenon to be examined is epenthesis of [ɯ] or [i] at the end of a morpheme.[13]

(13) examples of epenthesis at the end of a morpheme

MC	OJ
*sok	*sokɯ
*tek	*teki

When the MC form lacked a coda, epenthesis wasn't necessary.

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[12] The fact that the approximates do not block the *rendaku* phenomenon shows that they are under-specified for voice (Itô and Mester 1986). I assume that they therefore do not violate the constraint against voiced codas.

[13] I do not address the issue of the epenthesis vowel quality, instead following Itô and Mester (1995) that [ɯ] is the least marked vowel in Japanese, and therefore the natural choice as the vowel of epenthesis. However, see also Shinohara (1999) for an OT discussion of [i] as the context-marked epenthesis vowel in Sino-Japanese.

(14) examples of morphemes without epenthesis

MC	OJ
*du	*do
*ku	*kɯ

Since OJ only had syllables of the shape CV or V before contact with MC occurred (Iwai 1987), we can conclude that epenthesis took place to avoid codas. This implies that the constraint against codas (NoCoda) ranks higher than the constraint against inserting extra vowels (DepIO). Why isn't the offensive coda simply deleted? A simple solution would be to say that the constraint against deletion of the offending coda (MaxIO) also ranks higher that DepIO. This yields the following ranking of constraints:

(15) NoCoda, MaxIO ≫ DepIO

We are now capable of explaining the treatment of [m] in coda position; epenthesis occurs to change it to the onset of the following syllable. For example, the derivation of [kimɯ] in (4) is:

(16) tableau for [m] in coda position

input: /kim/	MaxIO	NoCoda	IdentIO (place)	DepIO	IdentIO (nasal)
a) ki	*!				
b) kim		*!			
c) kin			*!		
d) ☞ kimɯ				*	

Note the crucial ranking of IdentIO(place) over DepIO, which rules out [kin] as the most optimal output.[14]

This constraint ranking seems to choose the correct output as the most optimal. But why doesn't epenthesis occur with the alveolar nasal as well? It seems that the Japanese phonological grammar considered the alveolar nasal in coda position not to be a problem.[15] Therefore the alveolar nasal in coda position doesn't violate the NoCoda constraint. But the section of the grammar that governs codas was only modified for the adoption of the alveolar nasal; the other two nasals had to be handled in some other way.

Our analysis of [m] doesn't yet adequately explain the treatment of [ŋ], as shown in (6). In fact, when we try to derive it, we end up with the wrong result, as marked by the ☹:

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[14] However in modern Japanese the final /mɯ/ in words such as /kimɯ/ has been replaced by /n/.

[15] Perhaps the velar and bilabial nasals were considered too marked to occur in coda position. Recall that MC, although it had five distinct nasal sounds, considered two of them (palatal and retroflex) too marked to occur in coda position. Also note that this contradicts the analysis that the Japanese nasal coda is under-specified for position.

(17) tableau for [ŋ] in coda position with the incorrect result

input: / tɕaŋ/	*ŋ	MAXIO	NOCODA	DEPMAXIO (VOICE)	IDENTIO (PLACE)	DEPIO	IDENTIO (NASAL)
a) ʃjaŋ	*!					*	
b) ʃja		*!				*	
c) ☞ ʃjaɯ		*!				**	
d) ʃjag			*!			*	*
e) ☹ ʃjagɯ						**	*
f) ʃjan					*!	*	

The correct output is (17c), but it was ruled out because it violated the constraint against deletion. To derive the correct result, two questions must be addressed. First, why has the segment that corresponds to the [ŋ] been deleted in the optimal output? Second, why does epenthesis still occur if there isn't a coda to change to an onset? I will address this second problem first.

2.3.3 Faithfulness to Morae in the Input

If we use the concept of the syllable to derive the OT grammar, it is difficult to justify the selection of output (17c) over other candidates. We previously saw the general constraint against engma, *ŋ, which ruled out engma occurring as an onset. However, in those cases a [g] appeared in the output in the place of [ŋ] in order to satisfy MAXIO. Here as well we expect a [g] in the place of [ŋ]. Instead a [ɯ] appears.

This answer to this problem becomes obvious when we consider that Japanese is a moraic language. The mora in modern Japanese has one of four realizations (modified from Tsujima 1996):

(18) the four realizations of the Japanese mora

a) (C)V

b) the second part of a long vowel

c) the first part of an obstruent geminate

d) or the moraic nasal /n/

(18c) and (18d) imply that Japanese is a WBP (weight by position) language (cf. Hayes 1989). In other words, the Japanese language treats the coda as having a moraic weight. Given this, we can now see that epenthesis performs two distinct tasks – the preservation of a consonant in coda position by changing it to an onset, and the preservation of the number of mora. This second task is motivated by the following constraint:

(19) IDENTIO(μ) – the output must have the same number of morae as the input

However, the first problem of why deletion occurs in the optimal candidate still remains to be explained.

2.3.4 A Constraint on Voiced Codas

It is possible to find evidence in modern Japanese for the prohibition of a voiced coda in the way geminates pattern. The following examples of Japanese mimetics are from Lombardi (1998):

(20) examples of voiceless obstruents in coda position

base	intensified	gloss
bata	battari	'with a bang'
koso	kossori	'stealthily'
biʃi	biʃʃiri	'tightly'
gaka	gakkari	'disappointingly'

The paradigm changes when the second syllable of the base begins with a voiced obstruent.

(21) examples of avoidance of voiced obstruents in coda position

base	intensified	gloss
zabɯ	zambɯri	'with a splash'
madʒi	mandʒri	'a wink of sleep'
ʃobo	ʃombori	'sadly'
koga	koŋgari	'brown'

What we don't find in Japanese are the following forms:

(22) examples of incorrect forms

base	incorrect form
zabɯ	zabburi
madʒi	madʒdʒiri
ʃobo	ʃobbori
koga	koggari

Lombardi captures this contrast with an OT constraint against voiced geminates. I will instead propose that Japanese prohibits voiced obstruents in coda position, which has the advantage of being a well-known linguistic phenomenon.

(23) *VOICEDCODA – voiced obstruents in coda position are prohibited

So now we see that modern Japanese doesn't allow codas, except nasals and geminates, and that voiced codas are never permitted. This shows that there are two separate constraints on codas, a low ranking constraint on codas in general, and an undominated constraint on voiced codas.

Finally, an anchoring constraint (McCarthy and Prince 1995) is required to assure that the [g] in [ʃjagɯ] remains in coda position.

(24) ANCHOR(σ,FINAL) – syllable-final segments in the input must remain syllable-final in the output

Where should (24) be ranked? If it is undominated, then it will have the undesirable effect of causing [kim] to become the optimal output for /kim/:

(25) An undominated anchor constraint, causing [kim] to become optimal

input: /kim/	MAXIO	*VOICED CODA	IDENTIO (μ)	IDENTIO (PLACE)	ANCHORIO (σ,FINAL)	IDENTIO (NASAL)	NO CODA	DEPIO
a) ki	*!		*!					
b) ☹ kim							*	
c) kiɯ	*!							*
c) kin				*!				
d) ☞ ki.mɯ					*!			*

But if it is ranked lower, then the incorrect result is still obtained for the input of /ʧaŋ/:

(26) A dominated anchor constraint, causing [ʃjagɯ] to become optimal

input: /ʧaŋ/	*ŋ	MAXIO	*VOICED CODA	IDENTIO (μ)	IDENTIO (PLACE)	IDENTIO (NASAL)	NO CODA	ANCHOR (σ,FINAL)	DEPIO
a) ʃjaŋ	*!								*
b) ʃja		*!		*					*
c) ☞ ʃjaɯ		*!							**
d) ʃjag			*!			*	*		*
e) ☹ ʃjagɯ						*		*	**
f) ʃjan					*!				*

It appears as though MAXIO needs to be shifted down if we are to get (26e) to become optimal. But ranking it lower than IDENTIO(PLACE), while giving the correct results for these two tableaus, causes an [ŋ] in onset position to also be deleted.

2.4 The Linear Rules Derivation

Recall that our goal is to choose [ʃjaɯ] over [ʃjagɯ], and that we have just seen that voiced obstruents in coda position are not allowed. At this point it is possible to write linear rules for the deletion of [ŋ] in coda position by concluding that the [g] is being deleted while it is still a coda, and that epenthesis occurs afterwards to compensate.

(27) Linear rules for the deletion of [ŋ] in coda position

Rule 1: $\eta \rightarrow g$

Rule 2: $C]_{\sigma} \rightarrow \emptyset$

$$\begin{array}{l} | \\ +\text{voi} \\ -\text{son} \end{array}$$

Rule 3: syllabify any codas (other than [n]) as onsets of the next syllable

Rule 4: use epenthesis to fill in any empty mora

Here is are some examples of the application of the above rules for two arbitrary inputs:

(28) Example derivations using the linear rules in (26)

input:	/kwaŋ/	/gak/
Rule 1:	kwag | | μ μ	*doesn't apply*
Rule 2:	kwa | | μ μ	*doesn't apply*
Rule 3:	*doesn't apply*	ga.k | | μ μ
Rule 4:	kwa.ɯ | | μ μ	ga.kɯ | | μ μ

Note that a voiced coda is deleted while a voiceless one becomes the onset of the next syllable. It should be pointed out that there isn't any direct evidence for this in the Old Japanese loan words because Middle Chinese also did not have voiced obstruents in coda position.

As simple as the linear derivation is, the fact that it contains intermediate stages poses a problem for OT. In fact, there is no way for OT to derive the correct result without making reference to those intermediate stages. But the intermediate stages are invisible, or "opaque" to OT, and therefore not available.

2.5 The Sympathy Solution to the Problem of Opacity

There have been several approaches proposed to the problem of opacity in OT. Of these, I will focus on only one, the 'Sympathy Approach' (McCarthy 1998). The basic idea is that the optimal candidate must also be faithful, or "sympathetic" to one of the other candidates, which is marked with a ❀. This other candidate should somehow reflect the intermediate stages of the linear rules derivations.

2.5.1 Choosing the ❀-Candidate

According to McCarthy (1998) the ❀-candidate is the optimal member among a set of candidates obeying a designated faithfulness constraint. The problem seems to revolve around codas remaining in position, so the constraint that measures faithfulness to position, ANCHORIO(σ,FINAL), will be used to select the ❀-candidate. The checkmark indicates the selection of the ❀-candidate. Xs mark where the other potential ❀-candidates fail.

(29) trying selecting the ❀-candidate

input: / ʧaŋ/	*ŋ	*VOICED CODA	IDENTIO (μ)	NO CODA	MAXIO	IDENTIO (PLACE)	IDENTIO (NASAL)	ANCHOR (σ,FINAL)	DEPIO
a) ʃjaŋ	*X								*
b) ʃja			*X		*				*
c) ʃjaɯ					*X				**
d) ʃjag		*X		*			*		*
e) ʃja.gɯ							*	*	**
f) ❀ ʃjan						*		√	*

The most optimal candidate (29e) did not participate in the selection process because it violates the constraint used as the selector. Unfortunately the optimal candidate that does not violate is (29f), which in no way reflects the deletion of voiced coda. (29f) could be ruled out by using the constraint IDENTIO(PLACE) as the selector, but then we end up selecting (29e). However if we use a conjunction of these two constraints to select the ❀-candidates, then we end up with the desirable result – the selection of (29c).[16] Now by setting up constraints that penalize insertion or deletion from the ❀-candidate

(30) DEP❀O - the output segments must have corresponding segments in the ❀-candidate

(31) MAX❀O - segments in the ❀-candidate must have corresponding segments in the output

the we can guarantee that the deletion of the voiced coda will be reflected in the optimal candidate, as shown in the following tableau. The shading indicates non-participation in the selection of the ❀-candidate.

(32) tableau showing the correct result for [ŋ] in coda position

input: /ʧaŋ/	MAX ❀O	DEP ❀O	*ŋ	*VOICED CODA	IDENT IO(μ)	NO CODA	MAX IO	IDENTIO(PLACE) & ANCHOR(σ,FINAL)	IDENTIO (NASAL)	DEP IO
a) ʃjaŋ	*!	*	*X							*
b) ʃja	*!				*X		*			*
c) ☞ ❀ ʃjaɯ							*	√		**
d) ʃjag	*!	*		*X		*			*	*
e) ʃja.gɯ		*!						*	*	**
f) ʃjan	*!	*						*		

To summarize the results obtained so far the OJ grammar handles foreign phonemes by changing their manner of articulation, while preserving the place of articulation. However, if the foreign phoneme is an [ŋ] in coda position, changing it to a [g] violates the constraint against voiced codas. This forces the OJ grammar to delete the [ŋ]. The ❀-candidate is the most optimal candidate from the set of candidates that do not violate the conjunction of IDENTIO(NASAL) and IDENTIO(PLACE). Then

[16] See Somolensky (1993) for a description of conjunction in OT. Note that a conjunction of constraints is always higher ranking then the individual constraints.

any candidates that are not faithful to the number of consonants in the ❀-candidate are eliminated.

2.5.2 Sympathy With the Other Nasals

The use of the sympathy constraints is not a selective process that can be turned off at times and left on at others. Therefore it is imperative that the modifications made to the grammar in the last section do not yield incorrect results for loan words with the other nasals.

(33) using the sympathy constraints with [m] in coda position

input: /kim/	*VOICED CODA	IDENTIO (μ)	NO CODA	MAXIO	IDENTIO(PLACE) & ANCHOR(σ,FINAL)	IDENTIO (NASAL)	DEPIO
a) ki		*X		*			
b) ❀ kim			*		√		
c) ☞ kimɯ					*		*
d) kin					*		

This time the ❀-candidate is not the ☞-candidate. To assure that the correct candidate is chosen, insertion of vowels must not hindered when the insertion of consonants is penalized. This can be done by changing (30) and (31) to refer only to consonants:

(34) DEPC❀O - the output consonant segments must have corresponding segments in the ❀-candidate

(35) MAXC❀O – the consonant segments in the ❀-candidate must have corresponding segments in the output

The tableau for an [m] in coda position then becomes

(36) using the new sympathy constraints with [m] in coda position

input: /kim/	MAXC ❀O	DEPC ❀O	*VOICED CODA	IDENTIO (μ)	NO CODA	MAX IO	IDENTIO(PLACE) & ANCHOR(σ,FINAL)	IDENTIO (NASAL)	DEP IO
a) ki	*!			*X		*			
b) ❀ kim					*!		√		
c) ☞ kimɯ							*		*
d) kin							*		

Here we see that the ❀-candidate is not the optimal output in the end, but it is the one that best reflects the consonants as they appear in their original positions in the input. The new version of the sympathy constraints allow epenthesis to occur unimpeded, while blocking the addition or removal of consonants. This way the voiceless obstruents and nasals (other than [n] and [ŋ]) in coda can still become onsets freely.

(37) using the new sympathy constraints with [ɳ] in coda position

input: /ɾin/	MaxC ❀O	DepC ❀O	*Voiced Coda	IdentIO (μ)	No Coda	Max IO	IdentIO(place) & Anchor(σ,final)	Dep IO	IdentIO (nasal)
a) ɾI	*!					*X			
b) ❀ ɾin							√		
c) ☞ ɾinɯ		*!					*	*	

Finally, the grammar needs to be checked against an loan word with [ŋ] in the onset position.

(38) using the new sympathy constraints with [ŋ] in onset position

input: /ŋjuw/	MaxC ❀O	DepC ❀O	*ŋ	IdentIO (μ)	MaxIO	IdentIO(place) & Anchor(σ,final)	DepIO	IdentIO (nasal)
a) ŋiɯ			*X		*			
b) niɯ					*	*		
c) ☞ ❀ giɯ					*	√		*
d) iu					**X			

There is an interesting parallelism between the sympathy solution derived in this section and the linear rules derivation of §2.4. The selection of the ❀-candidate in the tableaus can be equated with the decision to delete the coda in the linear rules. Then by demanding that the optimal result does not insert consonants (DepC❀O) or delete consonants (MaxC❀O), the consequences of the deletion are guaranteed to appear in the optimal candidate.

3.0 Opacity in the Modern Japanese Verb Paradigm

3.1 Background

The traditional approach taken when analyzing the verb paradigm is as follows. The conjugation of the past tense is viewed as the addition of the past tense morpheme /ta/ onto the end of the verb stem. With the exception of the two irregular verbs, all Japanese verbs can be divided into two main groups – the first group of verb stems end in a vowel, and the other group end in a consonant. All of the members of the first group pattern the same way:

(39) past tense of verb stems that end in a vowel

stem	past tense	gloss
tabe	tabeta	'ate'
mi	mita	'saw'
etc.		

The verbs in the second group pattern according to the consonant that they end in:

(40) past tense of verb stems that end in a [t]

stem	past tense	gloss
tat	tatta	'ate'
to:t	to:tta	'saw'

(41) past tense of verbs stem that end in a [w]

stem	past tense	gloss
iw	itta	'said'
kaw	katta	'got to know'

(42) past tense of verbs stem that end in a [ɾ]

stem	past tense	gloss
kaeɾ	kaetta	'went home'
ʃiɾ	ʃitta	'knew'

(43) past tense of verbs stem that end in a [b]

stem	past tense	gloss
tob	tonda	'flew'
job	jonda	'called'

(44) past tense of verb stems that end in a [m]

stem	past tense	gloss
nom	nonda	'drank'
jom	jonda	'read (past)'

(45) past tense of verb stems that end in a [n]

stem	past tense	gloss
ʃin	ʃinda	'died'

(46) past tense of verb stems that end in a [k]

stem	past tense	gloss
kak	kaita	'wrote'
wak	waita	'boiled'

(47) past tense of verb stems that end in a [g]

stem	past tense	gloss
kag	kaida	'sniffed'
ojog	ojoida	'swam'

(48) past tense of verb stems that end in a [s]

stem	past tense	gloss
hanas	hanaʃita	'talked'
sas	saʃita	'stabbed'

The discussion then focuses on the explanation of the change of [b] to [n] in (43), and whether the [i] in (46) and (47) is the result of compensatory epenthesis, or "velar gliding". The conclusions drawn often cannot be extended to (48), and so the data in (48) is conveniently ignored.

However, a look at the verb paradigm of classical Japanese shows that all of the verbs in the second group mentioned above patterned exactly the same way:[17]

(49) past tense of classical forms of the verb stems in (40) to (48)

stem	past tense	gloss
tat	tatʃita	'ate'
ih	ihita[18]	'said'
kaer	kaerita	'went home'
tob	tobita	'flew'
nom	nomita	'drank'
ʃin	ʃinita	'died'
kak	kakita	'wrote'
kag	kagita	'sniffed'
hanas	hanaʃita	'talked'

This shows that in Classical Japanese the past tense morpheme is /ita/. Now we see that in the previous analyses of this paradigm the wrong questions were asked. It is not why [i] was inserted in (46)~(48), but why it wasn't deleted. But before that question is addressed, first we will take a look at motivation for the deletion of the [i] in general.

3.2.1 Elision In Japanese

Like many languages of the world, elision is a common occurrence in spoken Japanese. While there are many examples of the elision of vowels, the elision of consonants is much rarer, and in fact only the elision of the voiceless velar plosive is to be found with any significant frequency. Following are some examples of vowel elision in Modern Japanese:

(50) examples of vowel elision in slang and dialectal Japanese

standard form	slang / dialect form	gloss
wasurete ota	wasuretotta	'I forgot!'
sugoi	suge:	'excellent'
samui	sami:	'cold'

[17] This is called the "*yodan doushi*" verb paradigm in Classical Japanese grammar.

[18] The classical form is different from the modern form for this word, which no longer contains the [h].

ita̲i	itte / iteː	‘ouch!’

Velar elision is much rarer. Following is an example of velar elision in Modern Japanese:

(51) an example of [k] elision in slang and dialectal Japanese

haja̲kɯ sejo̲	hajoː seː	‘Do it quickly!’

There are a number of examples of modern Japanese words that are the velar elision form of their classical Japanese counterparts. Here a few examples:

(52) examples of [k] elision in historical Japanese

historical form	modern form	gloss
arigata̲kɯ	arigatoː	‘thank you very much’
ohaja̲kɯ	ohajoː	‘good morning’
omedeta̲kɯ	omedetoː	‘congratulations’
kono jo̲ki hi ni	kono joi hi ni	‘on this happy day’

Thus we can see from (51) and (52) that contrary to Lombardi (1998) the deletion of the velar plosive is not specific to the verbal paradigm. The elision forms of the verbs seen in Japanese today most likely started out as colloquial variants of the standard form, and over time became established as the spoken norm. Eventually the writing system was reformed to more accurately reflect the spoken form. I will capture this desire for elision with the following constraint:

(53) ELISION – either the vowel [i] must be deleted from the past tense morpheme or the velar plosive must be deleted from the end of the stem

(40)~(45) satisfy ELISION through the deletion of the vowel, (46) and (47) satisfy ELISION through the deletion of the velar, and (48) does not satisfy (53) at all. The fact that elision does not occur in (48) shows that there are higher constraints playing an active role in selecting the optimal candidate. The elision of the vowel was permitted as long as it did not violate those other constraints.

3.3 OT Analysis

I will go through the OT analysis for (40)~(48), using the past tense as shown in (49) as the input. I will also assume that the grammar being derived in this section is fundamentally the same as that developed in §2.0, except that the anchor constraint does not have a role in the verb paradigm, so I will omit it to save space (but see §4.1). Other modifications will be made as their relevance becomes apparent. The sympathy constraints do not play a significant role until tableau (64), but are included from the beginning to avoid rewriting all of the tableaus at the end.

Of all the examples of elision listed in §3.2.1, none violated the constraint IDENTIO(μ), using compensatory lengthening of either a vowel or a consonant instead. Therefore IDENTIO(μ) must outrank ELISION. On the other hand, the elision constraint must outrank both the constraint against deletion and the constraint against codas, which result from elision. As well, as in §2 with the DEP constraint and epenthesis, the MAX constraint will

only refer to consonants in order to avoid blocking elision. Finally, to derive the correct results in the verb paradigm, the 'Coda Condition' constraint (Itô 1986) is also needed:

(54) CODACOND – codas are prohibited unless linked to the place of the following onset. The manner or articulation must also be either linked or nasal.

While NOCODA, is violable as seen in the verb paradigm, CODACOND is not.

The first tableau is for /tat+ita/:

(55) tableau for /tat+ita/

input: /tat+ita/	MAXC ❀O	DEPC ❀O	*VOICED CODA	CODA COND	IDENTIO (μ)	ELISION	MAXC IO	IDENTIO (PLACE)	IDENTIO (NASAL)
a) tatʃita						*!X			
b) ☞ ❀ tatta								√	
c) tanta									*!X
d) tata	*!				*X		*		
e) taita	*!						*X		

The next tableau is for /tor+ita/:

(56) tableau for /tor+ita/

input: /tor+ita/	MAXC ❀O	DEPC ❀O	*VOICED CODA	CODA COND	IDENTIO (μ)	ELISION	MAXC IO	IDENTIO (PLACE)	IDENTIO (NASAL)
a) torita						*!X			
b) torta				*!X					
c) ☞ ❀ totta								√	
d) tonta									*!X
e) tota	*!				*X		*		
f) toita	*!						*X		

At this point we now run into problems when we try to derive the tableau for /tob+ita/. We end up the incorrect result:

(57) the tableau for /tob+ita/, showing the incorrect result

input: /tob+ita/	MAXC ❀O	DEPC ❀O	*VOICED CODA	CODA COND	IDENTIO (μ)	ELISION	MAXC IO	IDENTIO (PLACE)	IDENTIO (NASAL)
a) tobita		*!				*X			
b) tobta		*!	*X	*					
c) totta		*!						*	
d) ☞ tonta		*!						*	*
e) ☞ tonda		*!						*	*
f) tomda		*!		*X					*
g) tomba		*!						*	*
h) ☹ ❀ toida							*	√	

To derive the correct result, the stem needs to be distinguished from the suffix during the selection of the ❀-candidate. This is done with the following two constraints:

(58) IDENTSUFF(PLACE) – the place of articulation of segments in the suffix must not change

(59) IDENTSTEM(PLACE) – the place of articulation of segments in the stem must not change

To avoid ending up with [totta] as the optimal candidate, two more constraints need to be added. The first is a constraint accounts for the voicing of [t] after a nasal:

(60) PNV – post-nasal voicing, obstruents must be voiced after a nasal

The second constraint to be added is (12), repeated here as (61).

(61) DepMAX(VOICE) – the number of [+voice] obstruents in the input must be the same as in the output

The combination of (60) and (61) will penalize candidates with nasals in coda position unless there is a voiced segment in the input, and will penalize candidates without nasals in coda position if there is a voiced segment in the input. This combination, along with the constraint against voiced codas, forces the voiced obstruents at the end of the verb stems to be replaced with nasals, and the voiceless obstruents to avoid nasals.

Tableau (57) then becomes:

(62) the tableau for /tob+ita/, showing the correct result

input: /tob+ita/	MAXC ❀O	DEPC ❀O	DEPMAX VOICE	PNV	CODA COND	*VOICED CODA	ELISION	MAXC IO	IDENTSUFF (PLACE)	IDENTSTEM (PLACE)	IDENTIO (NASAL)
a) tobita							*!X				
b) tobta					*	*!X					
c) totta			*!							*	*
d) tonta			*!	*						*	*
e) ☞ tonda										*	*
f) tomda					*!X						*
g) ❀tomba									*!	√	*
h) toida	*!							*			

The new constraints also help derive the correct result for a verb stem ending in the bilabial nasal:

(63) the tableau for /sɯm+ita/

input: /sɯm+ita/	MAXC ❀O	DEPC ❀O	DEPMAX (VOICE)	PNV	CODA COND	*VOICED CODA	ELISION	MAXC IO	IDENTSUFF (PLACE)	IDENTSTEM (PLACE)	IDENTIO (NASAL)
a) sɯmita							*!X				
b) sɯmta				*!X	*						
c) sɯmda					*!X						
d)☞ sɯnda										*	
e)❀ sɯmba									*	√	
f) sɯpta					*!X						*
g) sɯita	*!							*X			

The grammar is now ready to handle verb stems that end in velars:

(64) the tableau for a stem ending in a velar

input: / kag+ita/	MaxC ❀O	DepC ❀O	*ŋ	DepMax (voice)	PNV	Coda Cond	*Voiced Coda	Elision	MaxC IO	IdentSuff (place)	IdentStem (place)	IdentIO (nasal)
a) kagita		*!						*X				
b) kagta		*!				*X	*					
c) kaŋda		*!	*X			*						*
d) kaŋga		*!	*X							*		*
e) kanda		*!									*	*
f) kaita				*!X					*			
g)☞❀ kaida									*		√	

This tableau illustrates opacity in the verb paradigm. Without the sympathy constraints to eliminate (64e), it would be chosen as the optimal candidate. This is to be expected given the results of tableau (57). (64e) is not chosen as the optimal candidate because it still contains the voiced coda /g/ in the form of /n/.

Tableau (64) was for a verb stem that ended in the voiced velar plosive. The same result will be obtained for the input /kak+ita/, except that (64f) would be selected as both the ❀-candidate and the optimal output in order to satisfy DepMax(voice).

All that remains is a tableau for the input /sas+ita/. As it stands, the grammar groups verb stems ending in /s/ in with stems ending in /t/ and /r/ by choosing [satta] as the optimal output. In order to get the correct output, an undominated constraint requiring that the autosegmental feature [+strident] not be deleted.

(65) Max(fric) – fricatives in the input should remain fricatives in the output

The tableau for /sas+ita/ now becomes:

(66) the tableau for a /sas+ita/

input: /sasi+ita/	MaxC ❀O	DepC ❀O	Max (fric)	DepMax (voice)	Coda Cond	Elision	MaxC IO	IdentSuff (place)	IdentStem (place)	IdentIO (nasal)
a)☞❀ saɕita						*			√	
b) sasta	*!				*X					
c) satta	*!		*X							
d) sanda	*!		*X	*						*
e) saita	*!		*X				*			

4.0 Generalizing the Result

4.1 Comparing Sino-Japanese and Yamato Japanese

The results obtained in §2 and §3 appear to be different in the way the ❀-candidate is chosen. However this is superficial. The constraint that selects the ❀-candidate in §3 could just as well be the conjunction of IdentStem(place) and AnchorIO(σ,final). This would of course eliminate the candidate that is a mirror image of the input from ❀-candidacy. The only tableau that would be effected by this is (63), but even then the correct result is obtained.

(67) the tableau for a /sas+ita/ using conjunction to select the ❀-candidate

input: /sasi+ita/	MaxC ❀O	DepC ❀O	Max (fric)	DepMax (voice)	Coda Cond	Elision	MaxC IO	IdentSuff (place)	IdentStem(place)& AnchorIO(σ,final)	IdentIO (nasal)
a) ☞ saʂita						*			*	
b) ❀ sasta					*!				√	
c) satta			*!X							
d) sanda			*!X	*						*
e) saita			*!X				*			

This implies that there is only one grammar governing the behaviour of both the Sino-Japanese and the Yamato Japanese strata. But what about the fact that the Sino-Japanese stratum clearly violates post-nasal voicing? This can be explained by making a distinction between phonological grammar and morphological grammar. The Sino-Japanese and the Yamato stratum share a common phonological grammar, but use different morphological grammars.

4.2 Including Mimetics

As might be expected, the OT grammar developed in §3 also derives the correct result for the mimetics paradigm as shown in (20)~(21) by assuming that the final syllable of the stem is reduplicated, with the notable exception that the constraint *ŋ is no longer undominated.

(68) tableau for /bata+ta+ɾi/

input: /bata+ta+ɾi/	*Voiced Coda	IdentIO (μ)	DepMax (voice)	Coda Cond	Elision	MaxC IO	IdentIO (place)	IdentIO (nasal)
a) batataɾi					*!			
b) bataɾɪ		*!				*		
c) ☞ battaɾɪ								
d) baːtaɾɪ						*!		

(69) tableau for /koga+ga+ɾi/

input: /koga+ga+ɾi/	*Voiced Coda	IdentIO (μ)	DepMax (voice)	Coda Cond	Elision	MaxC IO	IdentIO (place)	IdentIO (nasal)
a) kogagaɾɪ					*!			
b) kogaɾɪ		*!	*			*		
c) koggaɾɪ	*!							
d) ☞ koŋgaɾɪ								*!
e) koːgaɾɪ			*!			*		

The question is then what happened to the *ŋ constraint? In Japanese the segment /ŋ/ only occurs in a very specific environment – before /g/. This means that the constraint *ŋ is always active, but is dominated by the coda condition. Engma is deleted from the Sino-Japanese loan words and in the verb paradigm because the environment required for its existence is never found. Middle Chinese had words with an engma followed by a velar plosive, but these were always *kanji* compound words with the first *kanji* ending in [ŋ], and the second beginning with the velar. Old Japanese did not import Middle Chinese

words; it imported the morphemes, i.e. the *kanji,* and it was to this morphological unit that the grammar was applied. Because a single *kanji* always consists of a single syllable. The environment required for the existence of /ŋ/ was never found, and hence it was always deleted.[19] In other words, within the boundary of the morpheme, it is the same grammar in all three strata.

5.0 Conclusions

The phonological grammars of what are traditionally viewed as three different strata of Japanese phonology were examined in the light of optimality theory. A single grammar was successfully developed to explain the behaviour of nasals in the three strata by taking a diachronic approach. Sympathy constraints were used to overcome the problem of opacity in the Sino-Japanese and in the verb paradigm. The sympathy constraints forced the optimal candidate to maintain the grammar's sensitivity to the place of articulation of the nasals in coda position.

5.1 Consequences on Japanese Phonology

The conclusions drawn here go against the observations previously made in modern Japanese phonology. It has been argued that the nasal in coda position in both Yamato and Sino-Japanese is under-specified for place (Itô and Mester 1995). Yet we have just seen that the place of articulation of the nasal in coda position plays a crucial role in determining how the grammar will handle it. This suggests that the nasal in coda position is indeed specified for place. Underlyingly it is alveolar, which is the only nasal permitted in coda position. The constraint on coda condition forces it to change its place of articulation to that of the following segment. This means that /m/ and /ŋ/ when occurring in coda position are not nasals linked to the place of articulation of the following segment because they lack their own specification for place, but are allophones of the alveolar nasal forced to change their place of articulation in order to satisfy the higher ranking coda condition constraint.

Finally, that the same grammar is capable of deriving correct results for the patterning of nasals in all three strata shows that while the different strata behave differently across morpheme boundaries, within the morpheme boundary all phonological behaviour is governed by that single grammar. What has been traditionally believed to be quite different behaviour has turned out to be quite similar. Perhaps it is time to reevaluate other generalizations made about the so-called different strata in Japanese phonology.[20]

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[19] Modern Japanese loan words from English add confusion to this issue by being as faithful as possible to consonants, even if it means added extra morae. Therefore an engma at the end of an English word would be rendered in Japanese as [ŋgɯ].

[20] For example, there is the monosyllable generalization that /root/=δ in the Sino-Japanese stratum (Itô and Mester 1995). While this appears to hold try in modern Japanese, it clearly didn't when the

Sino-Japanese stratum was first formed. See also Itô and Mester (1986) for other generalizations about the different strata in Japanese phonology.

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