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An integrated approach to nasality and voicing[*]

KUNIYA NASUKAWA

1. Introduction

The nature and systematic role of voice specification in languages has been debated in various phonological approaches. Many recent theories strongly maintain the position that voice is a privative prime (Piggott 1992, Rice 1992, Itô and Mester 1993, Harris 1994, Harris and Lindsey 1995, Itô, Mester and Padgett 1995, Lombardi 1995). In such frameworks, there is some degree of controversy surrounding the specification of voicing and its relationship to the prime [nasal]. It is usually assumed that nasal sounds contain voice in their internal structure, and consequently, that they trigger, for example, postnasal voicing assimilation in many languages. However, Japanese presents a challenge to this assumption, since this system seems to recognise two types of nasals, differentiated according to phonological context: in postnasal voicing assimilation, nasals appear to be specified for voice; on the other hand, in Rendaku (which I shall describe in 2.2.3), nasals behave as if they have no voice prime.

In order to overcome this paradox, I shall propose that the phonological properties of nasality and voicing are expressed by the same object, and the headship distinction on such an object determines its phonetic interpretation: the headless prime contributes nasality and its headed counterpart manifests itself as voicing. In conjunction with the version of Element Theory developed in, for example, Kaye, Lowenstamm and Vergnaud (1985), Harris (1990, 1994), and Harris and Lindsey (1993, 1995), I shall provide an alternative analysis of the voicing specification on nasals in Japanese.

The structure of this paper is as follows. Section 2 will review the paradoxical behaviour of nasals in Yamato Japanese (e.g. where voice is active for nasals in the context of post-nasal voicing, but inactive in Rendaku). In 3, I shall present my analysis, which accounts not only for the paradoxical behaviour of nasals seen in postnasal voicing and Rendaku, but also for *b* ~ nasal alternations in Japanese verbal inflexion. This will be achieved by assuming a unified structure of nasals within Element Theory.

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[*] An earlier version of this paper was presented at the Autumn meeting of the LAGB held at the University of Essex in September 1995. I am indebted to members of the audience for their reactions. This paper has also benefited from insightful comments by Eugeniusz Cyran, John Harris, Phillip Backley and Toyomi Takahashi. I remain fully responsible for any remaining errors.

2. The relation between voice and nasal

2.1. Voice in nasals

2.1.1. Voicing assimilation in nasal-obstruent clusters

A nasal is sometimes – but significantly, not always – identified as a segment employing a voicing-bearing unit in its internal structure. The choice is determined by the relevant phonological phenomena and the system of a given language. In this section, I shall review these two different types of behaviour, beginning with a consideration of nasal-obstruent clusters. In many languages, a nasal-obstruent cluster shows categorical voicing assimilation. For example, Campa (Arawak), spoken in southern Mexico (Dirks 1953, Herbert 1986), has a distributional restriction whereby an onset obstruent following a coda nasal must share voice with the nasal, as shown in (1).

(1) *Campa*

ko**mb**iróši	'palm leaf'	*kompiróši
niší**nd**^{y}o	'my daughter'	*nišínt^{y}o
kirí**ŋg**a	'downstream'	*kirínka

In the same way, a nasal-obstruent cluster must be voiced in Yamato Japanese.

(2) *Yamato Japanese*

šo**mb**ori	'discouraged'	*šompori
ši**nd**oi	'tired'	*šintoi
ka**ŋg**ae	'thought'	*kaŋkae
ko**ŋg**ari	'done to a golden brown'	*koŋkari

This phenomenon is found not only within lexical items, but also across a morpheme boundary. For example, verbal suffixes such as *-te*, *-ta*, *-tari*, and *-tara*, when attached to a stem ending with a nasal, show voicing assimilation, as illustrated in (3).

(3)

a.	šin + te (gerundive)	→	ši**nd**e	'die' (gerundive)
	kam + te	→	ka**nd**e	'chew' (gerundive)
b.	šin + ta (past indic.)	→	ši**nd**a	'died'
	kam + ta	→	ka**nd**a	'chewed'
c.	šin + tari (alt.)	→	ši**nd**ari	'die' (alternative)
	kam + tari	→	ka**nd**ari	'chew' (alternative)
d.	šin + tara (subj.)	→	ši**nd**ara	'die' (subjunctive)
	kam + tara	→	ka**nd**ara	'chew' (subjunctive)

Inflexion involving verbal stems in (3) is subject to systematic voicing if the stem-final consonant is nasal.

This kind of dynamic voicing alternation is widely attested in the world's languages. Some further examples are given below.[1]

(4) a. *Quichua*

waki**n-d**a	'others-ta/da (object suffix)'
ka**n-ǰ**u	'you-ču/ǰu (question suffix)'
ka**m-b**a	'you-pa/ba (genitive suffix)'
hatu**m-b**i	'big one-pi/bi (locative suffix)'

b. *Zoque*[2]

min-pa	→	mi**nb**a	'he comes'
min-ta	→	mi**nd**amʌ	'compel (pl.)'
pʌn-čʌki	→	pʌ**nǰ**ʌki	'figure of a man'
pʌn-ksi	→	pʌ**ng**ʌsi	'on a man'
N-pama	→	**mb**ama	'my clothing'
N-tatah	→	**nd**atah	'my father'
N-čoʔngoya	→	**ɲǰ**oʔngoya	'my rabbit'

c. *Kpelle*

N + polu	→	**mb**olu	'my back'
N + tia	→	**nd**ia	'my taboo'
N + kɔɔ	→	**ŋg**ɔɔ	'my foot'
N + fela	→	**mv**ela	'my wages'
N + sua	→	**nǰ**ua	'my nose'

All the above examples indicate that nasals act as a trigger for the assimilation of voicing to the immediately following obstruent. This has led many phonologists to posit the presence of a voicing prime in the internal structure of nasals, which spreads, whenever possible, onto the following obstruents.

2.1.2. Dahl's Law

Further support for the presence of voicing in nasals is found in Kikuyu, a Bantu language spoken in Kenya. In this language, the occurrence of voiced conso-

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[1] The languages in (4a) and (4b) are American Indian languages: Quichua in (4a) is mainly spoken in Peru, Bolivia and Ecuador (Gleason 1955, Orr 1962, Rice 1992); Zoque in (4b) is spoken in southern Mexico (Wonderly 1946, 1951, Gleason 1955, Padgett 1994). Kpelle (Niger-Congo) in (4c) is spoken in Liberia (Welmers 1973, Sagey 1986, Padgett 1994).

[2] In fact, before sonorants and fricatives, assimilation does not occur, but deletion of the preceding nasal *N* 'my' occurs. The following examples show this phenomenon.

N + faha	→	faha	'my hat'
N + aʌk	→	aʌk	'my beans'
N + lawus	→	lawus	'my nail'

However, this phenomenon is beyond the scope of the present discussion.

nants is restricted by a constraint known as Dahl's Law (Armstrong 1967, Davy and Nurse 1982, Pulleyblank 1986, Rice 1992). This law prescribes that the initial consonant of a prefix is voiced when the following stem begins with a voiceless consonant. This is shown in (5) below (Rice 1992:310).

(5) a. *[ɣ]-initial prefix preceding a syllable beginning with a voiceless C*

ɣo-tɛm-ɑ	'to cut'
ɣo-koor-ɑ	'to root out'
ɣo-čiimb-ɑ	'to hoe'
ɣɑ-tɛgwa	'small ox'

b. *[k]-initial prefix preceding a syllable beginning with a voiced C*

ko-ɣɑt-ɑ	'cutting'
ko-ruɣ-ɑ	'to cook'
ko-**m**ɛñ-ɑ	'to know'
ko-**n**iin-ɑ	'to finish'
kɑ-βori	'small goat'
ndo-kɑɑ-ɛ-kwe-nde-kɑ	'don't on any account write'

In (5b), the initial consonant of the prefix is voiceless, since the stem-initial consonant is voiced, and therefore, the structural condition for Dahl's Law is not met. Note that, in *ko-mɛñ-ɑ* and *ko-niin-ɑ* in (5b), nasals are treated as voiced; in other words, nasals seem to require voice in their internal structure in the light of Dahl's Law.

2.1.3. Rendaku and Lyman's Law

Yamato Japanese is subject to a constraint similar to Dahl's Law, which is termed Lyman's Law. This constraint places an upper limit of one voiced obstruent on any lexical form (i.e. any single free morpheme). Some examples are given below.

(6)

sa**b**i	'rust'	***z**a**b**i
sa**b**aki	'judgement'	***z**a**b**aki, *sa**b**a**g**i, ***z**a**b**a**g**i
sa**ž**i	'spoon'	***z**a**ž**i
ka**z**ari	'decoration'	***g**a**z**ari
to**g**e	'thorn'	***d**o**g**e
toka**g**e	'lizard'	***d**oka**g**e, *to**g**a**g**e, ***d**o**g**a**g**e

Lyman's Law also functions in compounding, where the independent process of Rendaku is observed. Under Rendaku, the initial voiceless consonant of the second member of a compound turns into its voiced counterpart, as shown in (7).

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(7)

oo + taiko	→ oo**d**aiko	'big drum'
onna + kokoro	→ onna**g**okoro	'woman's heart'
take + sao	→ take**z**ao	'bamboo pole'

However, Lyman's Law blocks Rendaku if the second member of a compound includes a voiced obstruent in its lexical form (McCarthy 1968, Itô and Mester 1986). This is illustrated in (8).

(8)

maru + ha**d**aka	→ maruhadaka (*maru**b**a**d**aka)	'completely naked'
kami + ka**z**e	→ kamikaze (*kami**g**a**z**e)	'divine wind'
onna + koto**b**a	→ onnakotoba (*onna**g**oto**b**a)	'feminine speech'

In Rendaku, voicing in a nasal consonant is invisible for the purposes of Lyman's Law. Therefore, the first consonant of a compound's second member which posses- ses a nasal becomes voiced, as shown in (9).

(9)

yaki + sakana	→ yaki**z**akana	'grilled fish'
ori + kami	→ ori**g**ami	'paper folding'
kami + tana	→ kami**d**ana	'a shelf for the family gods'

This identification of a nasal (unspecified for voice) is also found in a lexical word, as seen in (10).

(10)

tom**b**o	'dragonfly'	***d**om**b**o
šin**d**o-i	'tired'	***ž**in**d**o-i
kaŋ**g**ae	'thought'	***g**aŋ**g**ae

If Rendaku is to be accounted for with a voicing prime, then we must assume that a nasal does not contain any such unit.

From the observations above, it is apparent that we encounter a paradox, such that Japanese must recognize two different structures for nasals under two different sets of circumstances (voicing assimilation and Lyman's Law): voice is specified for a nasal in post-nasal voicing; and voice is unspecified for a nasal appearing in Rendaku. How, then, do we capture this paradoxical behaviour within Yamato Japanese?

Concerning this paradox, let me discuss two analyses – an Underspecification Theory account (Itô and Mester 1986) and an Optimality-theoretic account (Itô, Mester and Padgett 1995).

2.2. Previous analyses of the nasal-voice paradox

2.2.1. Underspecification and rules

In response to the paradox, Itô and Mester (1986) propose a model where default rules are ordered to apply at different levels of derivation – specifically, at the level of compounding and the level of verbal affixation, where the former level precedes the latter. At the level of compounding, nasal receives no [+voice]-specification, and no application of the default rules given in (11) takes place. This is due to the fact that, in the course of compounding, nasals are invisible with respect to the operation of Lyman's Law.

(11) *DR1* [+nasal] → [+voice]
DR2 [–sonorant] → [–voice]

On the other hand, at the following level of affixation, the default rules are assumed to apply, and nasals are consequently specified with the value [+voice]. Then, the feature [+voice] specified in the nasal spreads to the following obstruent, according to the general operation of post-nasal voicing (as in *šinde* (< *šin* 'to die' + *-te* 'gerundive suffix')).

As Itô and Mester (1986) themselves point out, however, their level-ordered solution is empirically unfavourable. From a morphological point of view, the level of verbal affixation should precede the level of compounding. However, if so, an undesirable result emerges from their analysis: if DR1 and DR2 are applied in Rendaku, a nasal in the second member receives voice and the initial obstruent of the same member cannot receive voice, in accordance with Lyman's Law (**yakisakana*); and if DR1 and DR2 are not applied in a nasal-obstruent cluster, then post-nasal voicing does not take place (**šinte*).

2.2.2. Feature licensing and constraints

In order to solve the level-ordering paradox, Itô, Mester and Padgett (1995) shift their viewpoint from a representationally-oriented Underspesification Theory (UT) position, towards a theory of constraint interaction following Optimality Theory (OT: Prince and Smolensky 1993, McCarthy and Prince 1993). Rather than being sequentially ordered, constraints in OT (which are ranked on a language-particular basis), all function simultaneously. The notion of constraint violability provides another way in which the approach departs from that adopted within SPE (Chomsky and Halle 1968). In the latter, the violation of rules is excluded as a derivational possibility. In contrast, all constraints formulated in Optimality-theoretic terms are (in principle) violable, although constraint violation must be minimal.

However, following the general theoretical stance adopted in Itô and Mester (1986), Itô, Mester and Padgett (1995) believe they cannot abandon the representational advantages of underspecification which, by its nature, seems to require a level-ordering approach and, on the face of things, exhibits an incompatibility with constraint-based theory. In order to overcome this paradox, they introduce a universal principle termed Licensing Cancellation, which is formalised as follows.

(12) LICENSING CANCELLATION

If $F \supset G$, then $\neg(F \lambda G)$
'If the specification [F] implies the specification [G], then it is not the case that [F] licenses [G]'

The variables [F] and [G] are determined by segment-internal redundancy implications found in UT. In their analysis, the redundancy implication [sonorant] ⊃ [voice] is given without any apparent motivation (this will be discussed in 2.3.4), and the formula of Licensing Cancellation becomes 'If [sonorant]⊃[voice], then ¬([sonorant]λ[voice])', which means that a segment including [sonorant] does not license [voice].

In addition to this principle, they introduce six constraints. One of these – a member of the family of licensing constraints – is LICENSE (VOICE).

(13) LICENSE (VOICE)

The phonological feature [voice] must be licensed.

This constraint requires that if there is a voice prime in the segment-internal structure, it must be licensed. Coupled with Licensing Cancellation, this constraint induces the condition that, if there is an instance of voice, it can be licensed only in a non-sonorant segment. The feature-licensing constraint and Licensing Cancellation play a central role in their analysis, in the absence of feature cooccurrence formulations such as *[sonorant, voice].

The redundancy implication [sonorant] ⊃ [voice], which is used to determine the variables in the principle in (12), is also treated as a constraint in their model, as shown in (14).

(14) SONVOI

[sonorant] ⊃ [voice]

The constraint in (14) requires that all sonorants must possess voice in their internal structures. Unlike (13), however, there is no licensing relation involved here.

The other four constraints are given in (15). Their definitions are sufficiently self-explanatory for the purposes of the present discussion.

(15) a. NoGap: *α β γ
\ / *where β is a potential bearer of feature F.*
F

b. No-VC-Link: *linkage of [voice] between sonorants and obstruents is prohibited.*

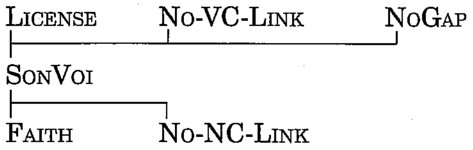
c. No-NC-Link: *linkage of [voice] between nasals and obstruents is prohibited.*

d. Faith *(Feature Faithfulness)*: *this is a collective constraint covering the four constraints below.*

ParseFeat:	*All input features are parsed.*
FillFeat:	*All features are part of the input.*
ParseLink:	*All input association relations are kept.*
FillLink:	*All association relations are part of the input.*

Itô *et al.* assume that these six constraints are hierarchically ranked in the system of Yamato Japanese. The hierarchy is set up in the three levels in (16).

(16)



(16) indicates that the three most highly ranked constraints – License, No-VC-Link and NoGap – are undominated. On the other hand, the two constraints comprising the bottom layer are both dominated by the other four constraints. In Itô *et al.* analysis, this ranking of constraints derives post-nasal voicing in words like *tombo* 'dragonfly'; also, the affixal form *šin* 'to die' plus *-te* 'gerundive suffix' becomes *šinde*. To illustrate their analysis, this second example is shown in the following tableau.

(17) Input: /šin+te/ 'to die' + gerundive suffix

Candidate	NoGap	Lic.	No-VC-Link	SonVoi[3]	No-NC-Link	Faith
a. šinte				***!		
b. šinte | [Voi]		*!		**		*
c.☞ šinte | / [Voi]				**	*	**

This tableau shows that the constraints to the left are ranked higher in the hierarchy than those to the right. Any fatal violations are marked by '!', and the contender in the leftmost column marked with '☞' is deemed the optimal candidate within the set. A '*' under the relevant constraint indicates a single violation of that constraint. Multiply starred candidates are those in which the same constraint is violated more than once, giving a well-formedness gradiency.

The candidate in (17b) violates License – one of the undominated constraints. (17a) and (17c) are differentiated by SonVoi in the second layer: the degree of the violation in (17a) is greater than that in (17c). Therefore, the optimal output is the form in (17c), which most closely respects the higher-ranked constraints.

In the case of a monomorphemic word such as *tombo*, the same mechanism is at work and the optimal output structure is similar to that seen in (17c): *m* and *b* in *tombo* license a single feature [voice]. In (17c), as in *tombo*, only one [voice] exists in a single word, so that we do not encounter any violation of Lyman's Law (which bans any sequence of two [voice] features in a word domain). In other words, a violation of Lyman's Law is not a necessary consequence of this analysis: that is not an independent constraint but a derived notion.

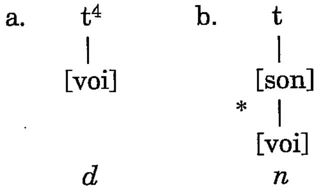
The constraint ranking illustrated in (17) functions within a word domain (either a lexical word or a word derived from affixation), but not beyond. In the case of compounding, therefore, each member of a compound is subject to the evaluation, but the overall shape of the resulting compound is not. For example, a compound *midorigame* 'green turtle' (< *midori* 'green' + *kame* 'turtle') is too big to be subject to the evaluation, but both individual members of the compound, *midori* and *game*, are independently evaluated by the hierarchy.

Thus, under the right constraint ranking conditions, Itô *et al.* succeed in preserving the representational advantages of underspecification. In their framework, one particular constraint – Licensing Cancellation – appears to make a significant contribution to this overall aim. Below, we will re-evaluate the function and role of this constraint.

2.2.3. Licensing Cancellation

In order to illustrate the Licensing Cancellation given in (12), Itô *et al.* provide the following melodic structures (1995:580).

(18)



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[3] In Itô *et al's*. analysis, if a vowel does not link to [voice], it is counted as a violation of SonVoi.

[4] Here, 't' stands for the full set of features (which includes, for example, [coronal] and [anterior]) present in *t*, *d* and *n*.

As seen in (18), the difference between the segments *d* and *n* relates to the features [sonorant] and dependent [voice]: [sonorant] is licensed in *n* but not in *d*; on the other hand, [voice] is licensed in *d* but not in *n*. From these facts we can identify the segment-internal context where [voice] fails to be licensed: [voice] is never licensed if a segment contains [sonorant]. Now, one question arises: what kind of segment-internal context does allow [voice] to appear?

According to Itô *et al.*, [voice] cannot be licensed unless [sonorant] is absent. Alternatively, it could be claimed that [voice] is licensed by [-sonorant] or [obstruent]. However, this condition has undesirable repercussions, since this implicitly indicates that their analysis, which is based upon privative features, admits the notion of bivalency, which has been questioned on the grounds of its theoretical restrictiveness[5] (Piggott 1992, Rice 1992, Itô and Mester 1993, Harris 1994, Harris and Lindsey 1995, Lombardi 1995). Consequently, the privative approach that they adopt is compromised, in order to make way for the incorporation of underspecification theory into an Optimality-theoretic framework.

2.2.4. *The major-class feature [sonorant]*

In Itô *et al's.* analysis, the major-class feature [sonorant] is adopted as a variable in constraints such as Licensing Cancellation and SonVoi. However, it is questionable whether [sonorant] can be identified as an independent unit of melodic representation. The very low contrastive and derivational profile of major-class features such as this is summarised in Harris (in prep.) by the following points.

First, compared to non-major-class features, the distinctive burden that major-class features bear is extremely light. The lexical contrastive status of other features such as [continuant] and [nasal] enjoys much greater independent support. Second, major-class features, unlike those of a non-major-class, are rarely specified as either the target or trigger of processes. This is typically observed in cases of lenition and fortition, where major-class features are rarely adopted as a factor. Third, major-class features have by far the lowest exchange value in the realm of phonetic implementation. For example, they are conspicuously absent from recent geometric models of speech production (Browman and Goldstein 1989, Keyser and Stevens 1994).

These arguments reviewed by Harris significantly undermine the representational status of the major-class feature [sonorant], which is indispensable for Itô *et al.* analysis of the nasal-voice paradox in Yamato Japanese. Below, I will approach the question of this paradox without making any reference to major-class features such as [sonorant].

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[5] Given the situation where an identical number of primes exists in a privative framework as in an orthodox binary-feature-type analysis, the descriptive power of the former is more restricted.

3. An alternative analysis of the paradox

3.1. *Headship and nasal-voice contrast*

In the remainder of this paper I shall offer an alternative analysis in which output representations contain only privative primes, are redundancy-free, and are fully interpretable. I adopt the version of Element Theory assumed in, for example, Kaye, Lowenstamm and Vergnaud (1985), Harris (1990, 1994), and Harris and Lindsey (1995).

In this theory, the melodic prime most similar to the privative feature [voice] is the element pertaining to slack vocal chords, labelled (L). This element is present in fully voiced obstruents, and is also involved in the specification of tonal contrasts in vowels. The acoustic characteristic of (L) is lowered fundamental frequency. The other element relevant to the present discussion is the nasality element (N), which is similar to the privative [nasal] prime employed in distinctive feature models. This element manifests itself in the signal as a broad resonant peak at the lower end of the frequency range.[6]

As discussed in 2, nasals and (L) show a strong correlation, as demonstrated by the phenomenon of post-nasal assimilation found in many languages (Herbert 1986). In other words, while it is (N) that determines the nasality of a segment, it can be said that the elements (N) and (L) are clearly related. This is supported by typological observations: given sequences of sonorant plus obstruent in general, voicing assimilation in an NC-cluster is relatively unmarked (Lass 1984, Itô, *et al.* 1995).

In order to capture the (N)-(L) relation, I assume that these elements are in fact two instantiations of the same object, (N) (cf. Harris and Lindsey 1995, Ploch 1995). This object manifests its prevailing properties without recourse to redundancy rules or markedness conventions and without reference to the major-class feature [sonorant]. But how do we arrive at the dual manifestation of this object, as nasality on the one hand, and as voicing on the other?

I propose that the answer may be found by appealing to the notion of melodic headedness utilised in Element Theory. In the literature on Element Theory, headedness plays a central role in the representation of some vowel systems. In the standard version of the theory (Harris and Lindsey 1995), for example, the contrast between ATR and non-ATR is captured via headship distinctions. It is now widely held that, for example, ATR [i] and non-ATR [ɪ] are distinguished phonologically by the headship status of the prime (I). If (I) is headed, it is interpreted as tense [i]; on the other hand, if (I) is headless, it is interpreted as its lax counterpart.

At this point I propose that, as with the case of tongue root distinctions, the contrast between nasality and voicing may also be expressed by harnessing the idea of melodic headship. In this paper, I propose as a matter of stipulation that,

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[6] See Harris (1994), and Harris and Lindsey (1995) for discussion.

if (N) is the head, then it is interpreted as voicing; and as a non-head, the same element contributes nasality. (The assignment of headship to one of these phonetic properties rather than the other is a matter of stipulation at this point, but will suffice for the immediate purposes of this paper. However, see Nasukawa (in prep.) for arguments supporting this particular configuration.).

(19)

(N) – non-headed (N) → nasality
(N̲) – headed (N) → voicing

Using these hypothetical structures, as we will see in 3.2, phonological phenomena in Japanese can be successfully analysed.

3.2. Rendaku with (N)-headship

Under Rendaku, as already mentioned, the initial voiceless consonant of the second member of a compound becomes voiced. Itô and Mester (1986) assume that the source of the voicing is a compounding conjunctive morpheme, which contains no melodic material other than a voice prime. In Rendaku, then, the conjunctive morphological property is realised at the left edge of the second member of a compound. Here, I adopt their assumption in the following analyses. With the proposed structures in (19), Rendaku is thus represented in terms of the following morphological concatenation.

(20) (N̲)
↘
[onna] [**k**okoro] 'woman's heart'
gokoro *onna* 'woman' + *kokoro* 'heart'

As shown in (20), a headed (N̲) – which is interpreted as voicing in (19) – is realised at the left edge of the second member of a compound.

However, the form in (21) is ill-formed.

*(21) (N̲) (N̲)
↘ |
[maru] [**h**a**d**aka] 'completely naked'
**badaka* *maru* 'completely' + *hadaka* 'naked'

In Rendaku, as already discussed, Lyman's Law prohibits a sequence of two voiced obstruents in a given domain, but allows a sequence of a voiced obstruent and a nasal. In terms of the proposed distinction in (19), it is clear that a sequence of two headed (N̲)s is prohibited in the second member of a compound, while a sequence comprising a headed (N̲) and a non-headed (N) is well-formed, as in (22).

(22) (N̲) (N)
↘ |
[seken] [**b**a**n**aši] 'small talk'
banaši *seken* 'general' + *hanaši* 'talk'

To capture this distribution pattern in Yamato Japanese, we need to posit the following constraint.

(23) *(N̲)(N̲)

Given this constraint, sequences such as (N̲)(N) and (N)(N̲) are legitimate. In the context of (22), the influence of the morphological object (N̲) on the first obstruent of the second member of a compound is not blocked. However, what is the motivation behind the constraint in (23)? Why should this particular sequence not be permitted?

Itô *et al.* (1995) interpret Lyman's Law as an instance of the Obligatory Contour Principle (OCP: Leben 1973) – a line of argument which is also pursued in McCarthy (1986). In compounding, when [voice] is interpreted on the second compound member, this voicing process will be blocked by the OCP whenever [voice] is already present: hence, *[voice][voice]. This OCP-driven analysis draws on a very general constraint that is widely accepted in the phonological literature.

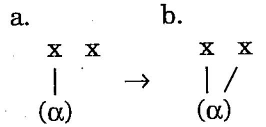
3.3. (N)-activation in NC-clusters

3.3.1. Competing analyses of assimilation

Postnasal voicing assimilation is the second phenomenon to be treated here in terms of the proposed melodic structure in (19). In standard autosegmental theory, this process has generally been analysed in terms of autosegmental spreading (Goldsmith 1976, Sagey 1986, Rice 1992, Padgett 1994). In recent studies, however, alternatives to the spreading operation have been proposed – notably, by Cole and Kisseberth (1994) and Backley and Takahashi (1996).

In autosegmental spreading, a triggering melodic prime becomes associated to positions other than the one to which it is lexically attached. This is illustrated below.

(24)



In an earlier version of Element Theory (Harris and Lindsey 1995), ATR harmony is analysed using a headship switching operation within a wide-scope domain, although spreading is also required in the analysis of other types of harmony. As Backley and Takahashi (1996) point out, in order to account for palatal harmony observed in languages like Chamorro, it is the spreading instruction in (24), rather than the operation of headship switching, that is inevitably referred to. Consequently, we are forced to recognize two different approaches to the description of harmony processes.

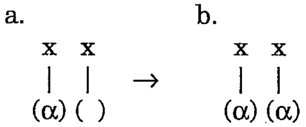
In order to unify the analysis of harmony, Backley and Takahashi (1996) offer an alternative approach named Element Activation, in which all harmony is the result of domain-wide activation. Underlying this approach is the assumption that a full set of resonance elements is present within each position, permitting all the melodic contrasts of a language to be expressed using the same structural configuration. According to this view, melodic oppositions are stated not in terms of the presence or absence of particular elements, but via the active or inactive status of elements latently present in the structure. The operation of activation is formalised as the lexical instruction Activate (α), which is defined in (25).

(25) Activate (α)

Interpret the melodic element (α).

The melodic element (α) can be interpreted only if this instruction is given. Under this instruction, the assimilation illustrated in (24) is captured by the following representation.

(26)



As seen in (26), Element Activation results in a different token of the same unit type being interpreted in each position within an assimilatory span.

In the remainder of this paper, I adopt the notion of activation in order to offer an unified account of the assimilatory phenomena at issue in this paper.

3.3.2. Element Activation: the case of (N)

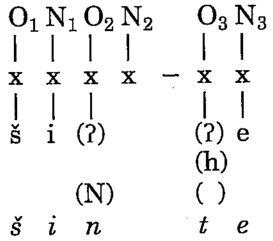
I assume that the element (N) is latently present in non-nuclear sites, and contributes voicing or nasality (refer to (19)) to the overall interpretation of a non-nuclear expression. Under this assumption, (N)s are inactive in voiceless obstruents, but are active in nasals and voiced obstruents.

As far as element activation is concerned, the difference between nasals and voiced obstruents arises from the headship status of (N): (N) in nasals is headless, but headed in voiced obstruents.

In both static distributional and dynamic alternating contexts of postnasal voicing assimilation ((2) and (3) respectively), I suggest that the variable (α) in (25) takes the value of the element (N), and that this instruction has the effect of generating postnasal voicing. Note that, in order to fulfil the instruction Activate (N), a trigger must be lexically active. Otherwise, the instruction fails to be carried out.

Postnasal voicing assimilation takes place between two onset positions separated by an empty nucleus (cf. Yoshida 1995). In such a case, the two positions are adjacent on a level at which onset heads are projected (See Charette 1991 for discussion). Under this context, Activate (N) is triggered by an active (N) in an onset preceding an empty nucleus. Consequently, (N) is interpreted in each onset position in question. According to these, the input representation of *šinte* (< *šin* + *-te*), which is taken from the examples in (17), is illustrated as follows.

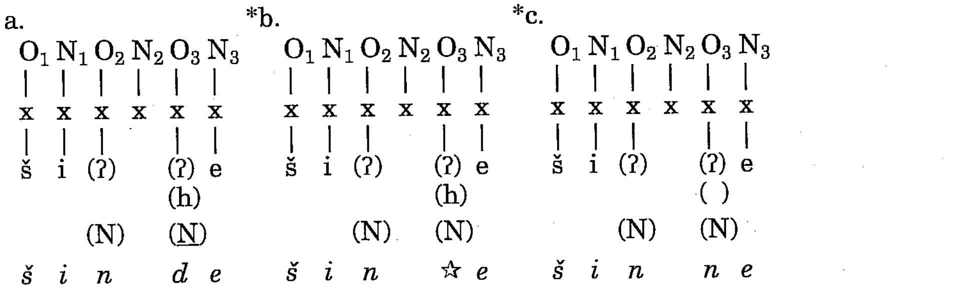
(27)



(27) illustrates the representation of *n*, *t* and *d*. I follow Backley (1993) in assuming that *t* consists of the occlusion element (ʔ) and the noise element (h). The difference between *d* and *t* is determined by the status of (N), which is active and headed in the internal composition of *d*, but inactive in *t*. The structure of *n* consists of (ʔ) and non-headed (N). For the convenience of the present discussion, I omit other element material, which is assumed to reside latently in non-nuclear positions.

In the input form in (27), O_2 and O_3 flank an empty nucleus N_2, forming two adjacent onsets at a level to which onset heads are projected; O_2 contains a lexically active (N), so it triggers postnasal voicing assimilation – Activate (N). The expected output is (28b), but (28a) below is the attested output representation.

(28)



(28b) is ill-formed with respect to the elemental composition of O_3, since (N) and (h) are mutually exclusive. According to Nasukawa (1997), the activated (N) cannot appear with (h) within the same position, because of a cooccurrance restriction *(headless)(N)(h) derived from the observation that nasality and aperiodic energy (noise) are mutually exclusive in many languages. This condition may be complied with by deactivating the lexically-active (h) to derive the structure of O_3 in (28c). This operation is not permitted, however, because Japanese demands that all the lexically-active elements in suffixes be parsed: that is, the status of lexically active elements in suffixes is always retained. In order to fulfil the required activation instruction in accordance with the given structural restrictons, I claim that the activated (N) in O_3 must be headed in Japanese, as illustrated in (28a), since the headed (N̲) contributing voicing can occur with the noise element (h). Consequently, the output sequence *nd* is obtained.

Thusfar, with recourse to Element Theory and the proposed headship distinction, I have offered an analysis of the behaviour of nasals in Yamato Japanese, calling on the lexical instruction ACTIVATE (N).

In contrast to the analysis in Itô *et al.* (1995), where two different primes [voice] and [nasal] are utilised, I have offered an account of the paradoxical behaviour of nasals in a framework where both nasality and voicing are expressed using the relational properties of the same object (N). An additional advantage of my analysis is that it can provide an account of verbal inflexion, which I consider in the following subsection.

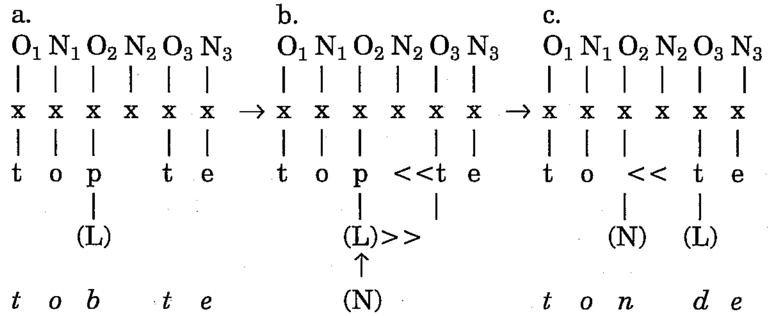
3.4. The appearance of (N) in verb-stem-final 'b'

3.4.1. Earlier work within Element Theory

In the verbal inflexion of Yamato Japanese, the stem-final b in a verbal stem such as *tob* 'to fly' is converted into a nasal that is homorganic with the suffix-initial obstruent of a suffix such as *-te* (gerundive). This phenomenon has been analysed within many different theoretical approaches (McCawley 1968, Ashworth 1976-77, Poser 1986, Davis and Tsujimura 1991, Yoshida 1991). All of these analyses are wholly dependent on stipulative rewrite rules. Below I shall discuss Yoshida's analysis, which is based on a version of Element Theory, and then offer an alternative analysis which has recourse to the proposals presented so far.

Regarding the appearance of nasality in verb-stem-final *b*, Yoshida provides two possible analyses. The first proposes that an ambient nasality element (N) is added to the stem-final *b*, converting the *b* into *m* (which also assimilates to the place specification of the following segment). The second proposal suggests that *b* in Japanese contains the (N) element in its underlying internal structure, which receives interpretation in the process in question. In (29), the first analysis is shown in the concatenation of *tob* 'to fly' and *-te* (gerundive).

(29)



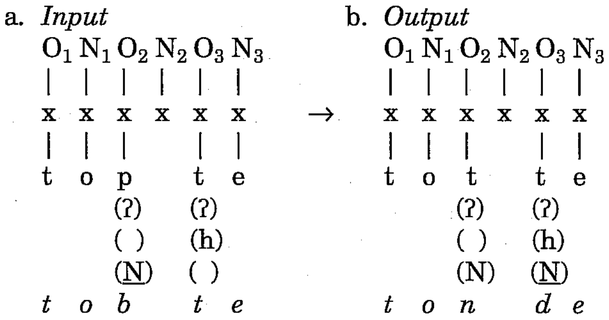
In (29b), an ambient (N) appears in the second onset, which does not contain (N) lexically. In the absence of any obvious lexical source for the (N) in (29a), the process might be viewed as one (N)-epenthesis. However, this treatment is *ad hoc*. We need to identify the source of (N), in order to eliminate this arbitrariness.

The second analysis suggested by Yoshida similarly provides no theoretical reason why *b*, as opposed to any other segment, underlyingly possesses (N) in its internal structure.

3.4.2. Nasal alternation in 'b' and headedness

Following the same line of argument employed in the description of postnasal voicing in 3.3, I now provide an alternative analysis of the *b* ~ nasal alternation in Japanese. In my analysis, structures involved in the process are represented as follows.

(30)



The process occurring in (30) is almost identical to that discussed in the analysis of postnasal voicing assimilation. In accordace with the account in 3.3.2, O_2, which is followed by an empty nucleus and contains lexically active (N̲), becomes a trigger of voicing assimilation. Notice that the head status of (N) does not matter here as long as this element is lexically active. In the following position O_3, as a result, (N) is activated and compelled to assume head status, in order to accommodate the mutual exclusion of (h) and headless (N) within a position and the obligatory parsing of lexically active elements in suffixes. However, we do not obtain the output sequence $(\underline{N})(\underline{N})$, since this violates the constraint $*(\underline{N})(\underline{N})$ in (23). In order to generate a well-formed structure, the $(\underline{N})$ in O_2 – which is a trigger of ACTIVATE (N) – cannot be deactivated, and (h) – which is prevented from cooccurring with non-headed (N) – becomes inactive, since this is the only means of complying with the obligatory parsing of lexically active elements in suffixes, ACTIVATE (N) and $*(\underline{N})(\underline{N})$.

O_2 loses a lexically-active resonance element, labiality, and instead, is interpreted as a coronal articulation, influenced by the coronality in O_3. In contrast to the triggering (N) in postnasal voicing assimilation, we have to stipulate that the triggering resonance element is always in O_3 which is followed by a filled nucleus. This is further illustrated by the examples in (31).

(31)

kaw + ta (past indic.)	→ ka**tt**a	'bought'
kam + ta	→ ka**nd**a	'chewed'
tor + ta	→ to**tt**a	'took'

Thus, in contrast to Yoshida's proposal, the analyses of the *b* ~ nasal alternation and postnasal voicing assimilation are integrated under the same explanatory mechanism, which directly links voicing and nasality.

4. Summary

In this paper, I have discussed the apparently paradoxical behaviour of the voicing specification of nasals in Yamato Japanese: voice is apparently specified for a nasal in voicing assimilation; on the other hand, it is apparently unspecified for a nasal which is transparent to Lyman's Law, the latter prohibiting two voicing specifications in a word domain. I also raised the question of another problematic phenomenon relating to voicing and nasals: nasal alternation of the stem-final *b* in verbal suffixation.

In order to explain this paradox I introduced the notion of headship switching as applied to (N). This was developed within the context of Element Theory: if (N) is headed, its interpretation is voicing; otherwise it manifests itself as nasality. This approach permits the elimination of the element (L) (voicing) from the inventory of elements. With this structural operation, I have adopted the constraint $*(\underline{N})(\underline{N})$ and the instruction ACTIVATE (N), and analysed the three phenomena.

An advantage of my analysis over earlier works discussed in this paper is that postnasal voicing assimilation and the *b* ~ nasal alternation are both analysed within an identical explanatory context. In addition, the analysis does not make use of any redundancy implications, cooccurrence rules/constraints or the major-class feature [sonorant].

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