Nasal harmony as prosody-driven agreement[*]

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Abstract

Unlike vowel harmony, which operates between nuclear projections, nasal harmony is usually considered to display string adjacency. This paper attempts to unify these two types of assimilation by bringing nasal harmony into line with vowel harmony. The conclusion is that all assimilatory processes are controlled by higher-level prosodic structure rather than by segment-to-segment relations.

1 Introduction

Nasal harmony is often considered as a segment-to-segment assimilatory process free of prosodic conditioning (Cohn 1989; Piggott 1988, 1992; Noske 1993; Trigo 1993). In contrast to this, vowel harmony is typically viewed as a process which operates between nuclei, reflecting structural relations in prosody (Anderson & Ewen 1987, Lowenstamm & Prunet 1988, Charette 1991, Archangeli & Pulleyblank 1994, Harris & Moto 1994, van der Hulst & van de Weijer 1995, Backley 1998, Charette & Göksel 1998).

Here I attempt to unify these two approaches to the analysis of assimilation by bringing nasal harmony into line with vowel harmony. Ultimately, I conclude that all assimilatory processes are controlled by prosodic hierarchical structure rather than by segment-to-segment relations. Underlying this proposal is the assumption that assimilatory processes fall within the scope of the generalised constraint PEx ([α]) (Backley 1998), which transmits the lexical instruction ACTIVATE [α]. ACTIVATE [α] is a functional property of the ultimate head of a word-level domain between prosodic categories in a given span via a licensing path defined by prosodic dependency relations (Harris 1994, 1997). In addition, I shall discuss the phonetic interpolation of nasality, since this issue will prove to be crucial in presenting a convincing argument for prosody-driven nasalisation.

This paper is structured as follows. §2 discusses characteristics of nasal harmony. In §3, I discuss some previous analyses of nasal harmony. In §4, in conjunction with the

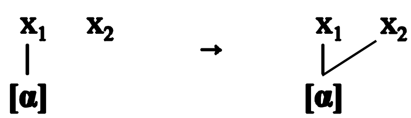
[*]An earlier version of this paper forms part of Nasukawa (2000). I am very grateful to John Harris and Phillip Backley for their insightful comments and suggestions.

predictions of phonological licensing (Kaye 1990; Harris 1994, 1997), I present a reanalysis of nasal harmony within element theory and tier geometry (Backley 1998, Backley & Takahashi 1998).

2 Classes of target, scope and directionality

To describe the general mechanism of assimilation, the autosegmental literature (Goldsmith 1976, *et passim*) typically adopts the operation of **spreading**. Under this notion, the basic mechanism of assimilation is captured by the following scheme:

(1) (a) Input (b) Output



A segment which is unspecified for [α] acquires the missing prime [α] from its neighbouring position. As a result, not only the position which is lexically associated to [α] but also the target position of [α]-spreading interprets α-ness phonetically. In nasal harmony, [α] is nasality. Assuming the formulation in (1), we may note three distinct characteristics of nasal harmony.

The first characteristic refers to the kind of segmental target involved. Nasal harmony is cross-linguistically classified into two types: Type I shows opacity effects while Type II exhibits transparency effects. Although both types can affect vowels, we do observe certain classes of consonant which are not subject to the process. These vary from language to language, as shown in (2) for Type I languages.

(2) Opaque segments in Type I nasal harmony

Type		Opaque Seg. Glides	Liquids	Fricatives	Plosives
IA	Sundanese	✓	✓	✓	✓
IB	Malay		✓	✓	✓
IC	Urhobo			✓	✓
ID	Applecross Gaelic				✓

According to Walker (1998), the majority of languages exhibiting opacity effects belong to either Type IB or Type IC. From these findings, we may thus identify fricatives and plosives as the consonant classes which most typically block nasalisation.

In contrast to Type I, languages belonging to Type II exhibit only a single pattern of transparency: fricatives and plosives are transparent to nasal harmony, and all other segment types undergo nasalisation.

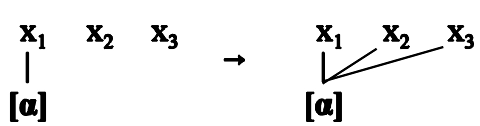
(3) Transparent segments in Type II nasal harmony

Type		Transparent Seg. Glides	Liquids	Fricatives	Plosives
II	Guaraní			✓	✓

From these transparency (2) and opacity (3) cases, we arrive at the observation that obstruents typically resist nasalisation.

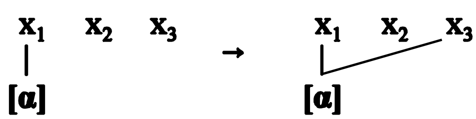
The second characteristic in behaviour of nasal harmony refers to the scope of the assimilatory process. As the term implies, nasal harmony occurs not only between two adjacent positions as in (1), but also across a wide-scope domain. This type of [α]-spreading is shown in (4).

(4) (a) Input (b) Output



In contrast to (4b), autosegmental theory generally considers the spreading device shown in (5b) — where [α] in X_1 skips X_2 and associates to X_3 — to be ill-formed, since it violates the condition of **string-adjacency/locality** (van der Hulst & Smith 1986; Archangeli & Pulleyblank 1994; cf. Kaye, Lowenstamm & Vergnaud 1990, Harris 1994).

(5) (a) Input *(b) Output

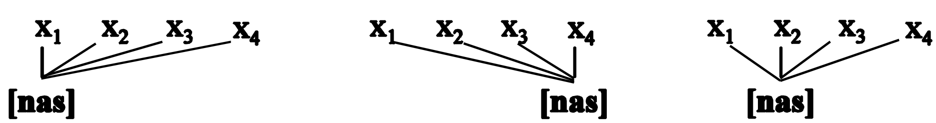


The notion of string-adjacency requires that a given spreading process be local.

The third characteristic of nasal harmony involves directionality. Within conventional derivational approaches, the direction in which feature spreading operates is determined on a system-specific basis.

(6)

(a) (b) (c)



In the case of nasal harmony, the three possibilities illustrated in (6) present themselves: rightward, leftward and bi-directional spreading.

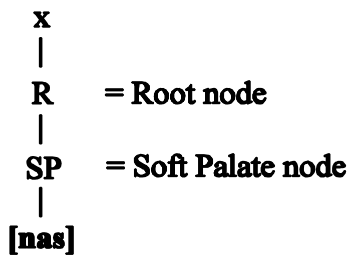
In the rest of this paper I develop an account which unifies these apparently diverse characteristics of nasal harmony.

3 Nasal harmony
3.1 Opacity and transparency in autosegmental spreading

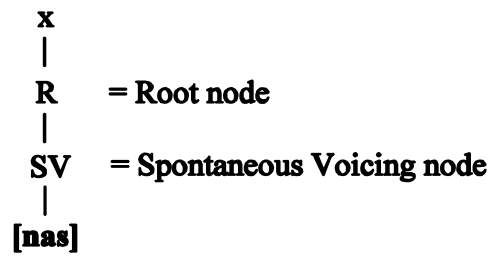
To account for the behaviour of neutral segments in harmony domains, Piggott (1992) introduces a degree of parametric variation into the structure of nasal consonants. He proposes the following dependency relations (1992: 49):

(7) The variable dependency of nasality

(a)



(b)

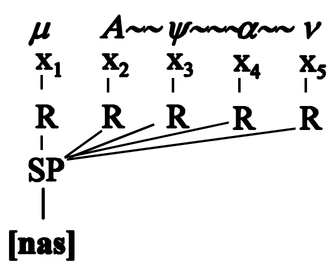


In Type I nasal harmony, the feature [nasal] is a dependent of the Soft Palate node, as in (7a), while in Type II, it is dominated by the Spontaneous Voicing (SV) node. The structure in (7a) reflects the fact that the production of nasality involves lowering of the soft palate. Support for (7b) is provided by Avery & Rice (1989), who distinguish non-contrastive voicing in sonorants from contrastive voicing in obstruents.

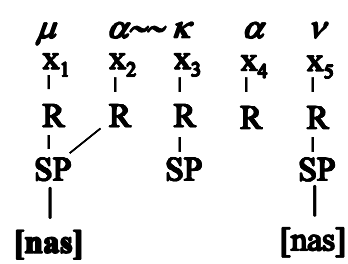
Piggott proposes that, in the case of Type I, the Soft Palate node is specified in the triggering nasal and opaque segments but unspecified in all other segments. In addition, opaque segments employ an SP node but no dependent feature. With this melodic configuration, complete nasalisation is depicted as in (8a) (Piggott 1992, 1996):

(8) Malay nasal harmony

(a) *μα~ψ~α~ν* ‘stalk (palm)’



(b) *μα~καν* ‘to eat’

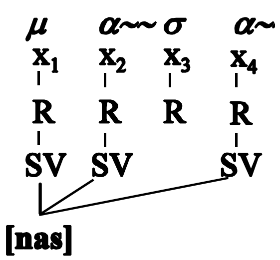


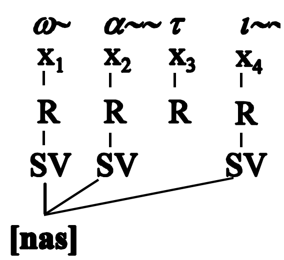
In (8a), only the leftmost nasal is specified for the SP node, and it is this SP node itself, rather than the nasal feature, which spreads to the other segments in the domain: as a result, all the segments in the word are nasalised. Spreading is blocked only by opaque segments which employ the SP node but no dependent feature. With the rightward spreading of the SP node, only the leftmost nasal — which contains the SP node with dependent [nasal] — can trigger the process; the opaque segment containing an SP node without [nasal] can never initiate harmony in this way. Although the rightmost nasal employs the feature [nasal], it cannot initiate rightward spreading. In short, the trigger must be specified as SP with dependent [nasal], rather than as SP alone.

In contrast, Piggott (1992: 53) regards Type II nasal harmony as the spreading of the feature [nasal] itself. In this case, languages employ the SV node instead of the SP node, which is specified in all sonorants and dominates [nasal]. From this configuration, the following transparency effects are achieved:

(9) Southern Barasano nasal harmony

(a) *μα~σα~* ‘people’ (b) *ω~α~τι~* ‘demon’





In Type II languages like Southern Barasano in (9), [nasal] — a dependent of the SV node — cannot spread to obstruents which are not specified for the SV node. Without a landing site for [nasal], these segments fail to prevent the spread of nasality to the following segment because the process operates at the level of the SV node. The notion of strict locality is not violated on this tier.

However, the representations in (9) cannot account for another harmonic event — tautosyllabic agreement for nasality — found in Southern Barasano (Piggott & van der Hulst 1997: 99) and all other Type II languages. This phenomenon is exemplified as follows:

(10) Southern Barasano

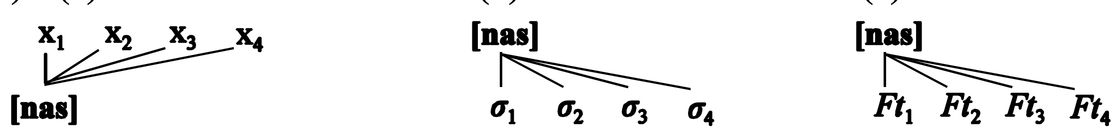
(a)	*ριμα~*	‘poison’	(b)	**wα~τι~*
	ρομι~ο~	‘woman’		**γυρα~*
	ψι–μα~	‘they say’		*$^{\nu}$*διρο~*
	ηατι–αμι~	‘he sneezes’		**ηικορι~*

In the example language of Southern Barasano, nasal agreement is a rightward process, resulting in a distributional restriction where nasalised liquids and semivowels must be followed by nasal vowels, while their oral counterparts can appear only before oral vowels. We never find strings such as those given in (10b), where oral liquids and semivowels are followed by nasal vowels. This distribution pattern indicates that the nasalisation of sonorants in Southern Barasano is independent of the rightward harmonic agreement of nasality, since sonorants to the left of a nasal vowel must be nasal, never oral. This obligatory rightward sonorant nasalisation can be identified as tautosyllabic sonorant-vowel agreement for nasality, and cannot be explained merely by the rightward spreading operation in (9). Instead, we need an additional device to account for this event.

3.2 Nasality as a property of prosodic categories

To provide an account of the obligatory agreement for nasality within syllables in the Type II harmony pattern, Piggott & van der Hulst (1997) retain the geometric structure in (7a) and propose that nasality may exist not only as a property of the melodic part of a segment, but also as that of a prosodic category (i.e. syllable, foot). In this way, the harmonic agreement of nasality (= [nas] in feature terms) is expressed as follows.

(11) (a) (b) (c)

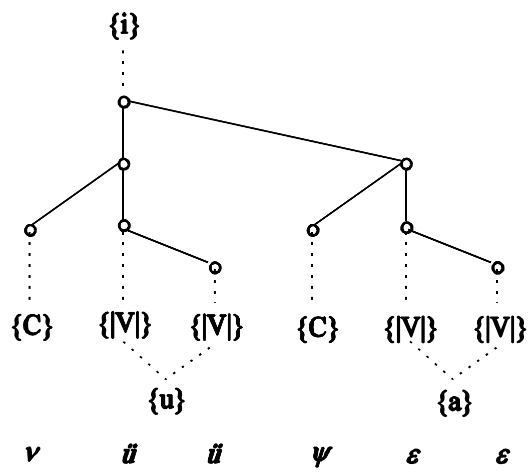


The representation in (11a) shows that the lexically given [nasal] in the leftmost position is specified in the other positions at a string-adjacent level in the output form. On the other hand, the representations in (11b) and (11c) exhibit prosodically-oriented [nasal]-agreement: [nasal] is a lexical property of the leftmost syllable in (11b) and of the leftmost foot in (11c), and is then specified in the remaining syllables/feet in the output following harmonic agreement.

Harmony of this sort, between prosodic categories, is found elsewhere in the literature. Several analyses of vowel harmony are based on this type of model (Anderson & Ewen 1987, Lowenstamm & Prunet 1988, Archangeli & Pulleyblank 1994, Harris & Moto 1994, Harris & Lindsey 1995, van der Hulst & van de Weijer 1995, Humbert 1995, Cobb

1997, Backley 1998, Backley & Takahashi 1998, Charette & Göksel 1998).[1] For example, within the framework of Dependency Phonology (DP), Anderson & Ewen (1987: 278) allow the harmonic prime to be a lexical property of a prosodic node in their analysis of Khalkha Mongolian palatal harmony. An example word is given in (12), in which the palatal prime {i} is lexically specified in the foot/word-head node. ({i}, {u} and {a} indicate 'frontness', 'roundedness' and 'lowness'. For the conventions surrounding the use of braces and verticals, see Anderson & Ewen 1987: 28-9.)

(12) *nüüyee* 'let me love'



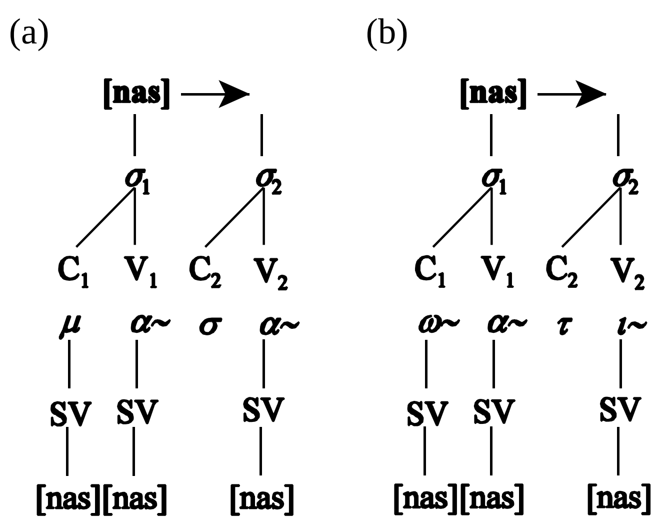
The structure in (12) is built around binary asymmetric (head-dependent) relations holding between categorial units. As {u} and {a} are depicted in (12), melodic units are generally considered as dependents of prosodic categories. But in addition, primes can also be specified in nodes **within** prosodic structure. In Anderson & Ewen's analysis of Khalkha Mongolian, for example, the prime {i} is specified lexically as a property of the foot/word-head node. All languages that exhibit harmonic agreement are assumed to follow this basic construction, where a property of a prosodic node percolates downwards and is realised in each relevant position in the melodic string. So in (12), {i} is realised with {u} and with {a} in the long vowel positions to the left and right respectively; the combination of {i} and {u} yields *ü* and {i} and {a} together generate *e*. (In terms of the combination of primes, the basic vowel architecture used in DP is identical to that of element theory. However, we do find some disagreement as to the

[1]The analysis of nasal harmony in Nasukawa (1995b) also employs this line of argument. This will be discussed in §4.2.

precise definition of each prime in the two systems. For a detailed discussion, refer to Backley 1998: Ch3.) As just described, the literature analyses vowel harmony as a process which takes place only between nuclear positions, neglecting consonantal (non-nuclear) positions altogether.

In order to explain both rightward agreement for nasality and tautosyllabic agreement for nasality in Type II harmony systems, Piggott and van der Hulst abandon the formation in (11a) used for Piggott's analysis of Type I harmony systems. Instead, they adopt the core mechanism of vowel harmony in (12) and claim that the structure in (11b) — where [nasal] agreement takes place at the level of the syllable — can be better represented in this way. The facts of nasal harmony in Southern Barasano are then described as follows (see Piggott & van der Hulst 1997: 102-3):

(13) A revised analysis of Barasano nasal harmony

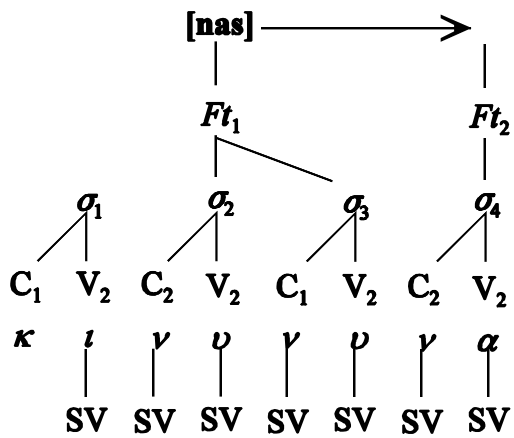


The representations in (13) show that, by allowing the feature [nasal] to be specified in the syllable head/nucleus, the two events in question can be accounted for simultaneously. On the one hand, in Southern Barasano, as well as all other languages of Type II, nasality must be expressed in each unit within the syllable when the feature is associated with the syllable head, since the properties of the head of a constituent are simultaneously the properties of the entire structure. Therefore, the [nasal] lexically specified in σ_1 is inherited by each constituent within the syllable. In this treatment, no direct relation between individual tokens of [nasal] need be specified at the segment-internal level.

On the other hand, the lexical property [nasal] in σ_1 is regarded as a trigger of harmonic agreement. As a result of the rightward agreement of [nasal], the [nasal] in σ_1 is specified in the adjacent syllable head σ_2. Then, the acquired nasal property in σ_2 must also be transmitted down to all the segments in that syllable. In the examples in (13), however, obstruents in C_2 are not nasalised because those segments lack an SV node — a prerequisite for the specification of [nasal], as (7) shows.

Piggott (1996: 161) also adopts this mechanism to explain other languages like Kikongo which employ [nasal] at the foot level.

(14) Kikongo nasal harmony



In the above structure, [nasal] is a lexical property of Ft_1 and is a trigger of rightward nasal agreement.[2]

In contrast to the prosodically-oriented analysis of the Type II harmony pattern in (13) and (14), Piggott & van der Hulst maintain the analysis in (8) for Type I harmony patterns: harmonic agreement of nasality takes place at the segmental level. In this way, the possibility of obligatory tautosyllabic sonorant-vowel agreement for nasality is predicted never to occur in Type I systems where those sonorants which are followed by nasal vowels are not necessarily nasal. In this way, their analysis successfully excludes unattested phenomena.

[2]In this case, unlike the widespread Type II patterns, vowels (including other types of sonorant) are transparent to nasalisation (Piggott 1996: 147). However, at least in phonetic terms, it seems that those segments are subject to the process.

To summarise: in Piggott & van der Hulst's analysis, opacity and transparency in nasal harmony are accounted for by recognizing a direct connection between segments and prosodic categories: the opacity effect results from a segment-to-segment nasal assimilatory process, while the transparency effect is derived from the nasal assimilation that operates between prosodic categories.

3.3 Problems

There are, however, some questions concerning Piggott & van der Hulst‘s analysis that ought to be addressed. First, they treat nasal harmony differently from other types of harmony, such as height (Bantu), rounding (Yawalmani), fronting (Turkish) and ATR harmony (Akan). In their proposed analysis of nasal harmony, two different mechanisms are called for — a segment-to-segment agreement for the Type I pattern and an agreement between nuclei or between syllable heads for the Type II pattern. In contrast, for most other types of harmony it is only nuclei/syllable heads which are involved in harmonic agreement.[3] They fail to explain why nasal harmony must be treated as a unique case — exploiting both inter-prosodic-categorial agreement and inter-segment assimilation.

Second, Piggott & van der Hulst treat transparency as an unmarked effect in nasal harmony, while opacity is seen as the marked case: the former is analysed using a mechanism (inter-nuclear agreement) similar to the most prevalent/unmarked wide-scope agreement process — vowel harmony; the latter is analysed by a segment-to-segment agreement process which is never found in vowel harmony. However, this treatment of the two different effects of nasal harmony fails to square with cross-linguistic facts, since the majority of languages displaying nasal harmony exhibit opacity rather than transparency, indicating the former as the unmarked state in nasal harmony systems.

Third, in Piggott & van der Hulst's analysis of Type II nasal harmony, [nasal] is treated as a property of the syllable head, which forces all segments (both nuclear and non-nuclear) to be specified for the feature. However, this kind of specification across an entire constituent domain never occurs in other types of harmony; instead, non-nuclear positions typically inherit no harmonic features from their heads (nuclear positions). Piggott & van der Hulst provide no formal explanation for this peculiarity.

Fourth, Piggott & van der Hulst offer no account of the relation between the SV node and the use of [nasal] in prosody. In their analysis, only harmony systems employing the

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[3]Systems such as Chumash and Basque provide examples where onsets seem to play an important role in the assimilatory process of palatality, but these cases are beyond the scope of this paper.

SV node, rather than the SP node are allowed to exploit nasality as a property of prosodic categories. However, no clear explanation for this restriction is offered. Unlike the SV node, the SP can spread to the other segmental positions in a given domain in Type I harmony systems. The SV node itself does not participate in any dynamic alternation involving nasality, but the SP node itself contributes to the harmonic agreement of nasality. Again, the difference in behaviour between the SV node and the SP node is left unexplained.

Fifth, we have reason to question the status of the feature-geometric SV node, which was originally introduced in Piggott (1992) and Rice (1993) as a means of capturing phenomena involving obstruent-sonorant alternations and the postnasal voicing of obstruents. In this function it takes the place of the traditional feature [sonorant]. Yet according to Harris (in prep.: 24), it is possible to analyse these phenomena without referring to major-class features or equivalent geometric class nodes. The analysis of obstruent-sonorant alternations can be expressed in terms of manner features such as [lateral] or [nasal], and postnasal obstruent voicing can be straightforwardly captured by referring to the affinity of nasality and voicing (Nasukawa 1995a, 1997, 1998b, 1999, 2000).

Next, I shall offer an alternative analysis of nasal harmony which avoids the problems outlined above. Following Backley (1998), Backley & Takahashi (1998) and Nasukawa (1997, 1998b), the model I develop rejects the notion of spreading in favour of activation as a harmonic mechanism for nasal harmony.

4 A unified analysis of opacity and transparency effects in nasal harmony

4.1 Elements

In order to provide support for my arguments in this section, I adopt the set of privative primes known as **elements** (Kaye, Lowenstamm & Vergnaud 1985, 1990; Harris 1990, 1994, in prep.; Harris & Lindsey 1995, 2000), which are privative, independently interpretable and redundancy-free. Those elements relevant to the present discussion are listed below with specifications of their acoustic interpretation and articulatory execution.

(15) (a) Resonance

ELEMENTS	PATTERN	ACOUSTIC PATTERN	ARTICULATORY EXECUTION
[A]	mAss	Central spectral energy mass (Convergence of F1 and F2)	Maximal expansion of oral tube; maximal constriction of pharyngeal tube
[I]	dIp	Low F1 coupled with high spectral peak (Convergence of F2 and F3)	Maximal constriction of oral tube; maximal expansion of pharyngeal tube
[U]	rUmp	Low spectral peak (Convergence of F1 and F2)	Trade-off between expansion of oral and of oral and pharyngeal tubes

(b) Non-resonance

ELEMENTS	PATTERN	ACOUSTIC PATTERN	ARTICULATORY EXECUTION
[?]	edge	Abrupt and sustained drop in overall amplitude	Occlusion in oral cavity
[h]	noise	Aperiodic energy	Narrowed stricture producing turbulent airflow
[N]	murmur	Broad resonant peak at lower end of the frequency range	Lowering of the velum

4.2 Harmonic agreement

In spite of the differences outlined above, vowel harmony and nasal harmony are similar in a significant respect: in both cases, nuclei are central to the mechanisms concerned. This fact must be the key to a unified analysis of harmony. In the interests of a coherent and restrictive theoretical position, which is in many ways at odds with Piggott & van der Hulst and many others (van der Hulst & Smith 1982; Kiparsky 1985; Cohn 1989; Piggott 1988, 1992, 1996, 1997; Noske 1993; Trigo 1993; Cole & Kisseberth 1994ab; Walker 1995, 1998), I propose that nasal harmony functions principally between nuclear positions in the same way that other types of harmony do.

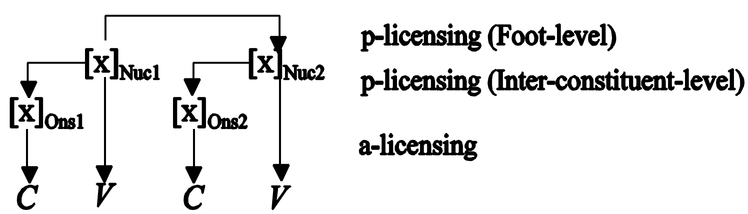
To describe nuclear-centred agreement processes, the literature often uses higher prosodic levels as the driving force of the processes. The levels are defined by asymmetric licensing relations holding between two phonological positions/constituents.

Licensing is a head-dependent relation that controls all aspects of phonological architecture in accordance with (16):

(16) **PHONOLOGICAL LICENSING PRINCIPLE** (Kaye 1990)
Within a domain, all phonological units must be licensed save one, the head of that domain.

Phonological licensing manifests itself in one of two guises: p[rosodic]-licensing defines a licensing relation established between two positions in prosodic structure, while a[utosegmental]-licensing describes the licensing relation between a melodic unit and a prosodic position (see Harris 1997).

(17)

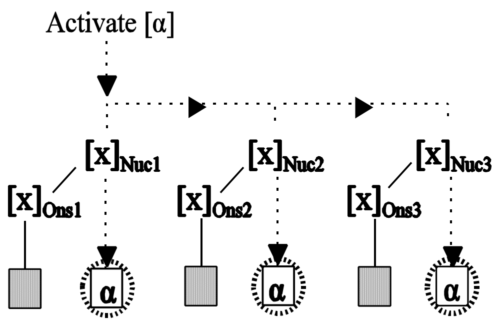


In (17), Nuc_1 is the ultimate head of the p-licensors in the domain. Ons_1 (its preceding onset) and Nuc_2 (another nucleus in the domain) are directly p-licensed by Nuc_1 at the inter-constituent and the foot level respectively, whereas the onset Ons_2 is indirectly p-licensed by Nuc_1 through Nuc_2 at an inter-constituent level.

In the licensing-driven framework which is pursued here, we can characterise harmonic agreement as in (18).[4]

[4]Following the metatheoretical assumption of minimal componentiality, Takahashi (1993) eliminates constituent nodes from phonological representation and proposes the **minimal prosodic domain** which is the model I adopt here.

(18)



Within geometry-based element theory, proposed by Backley (1998) and Backley & Takahashi (1998) to unify different types of harmonic agreement, the above structure illustrates that the lexical instruction ACTIVATE [α] — which is lexically a functional property of the ultimate head of a given domain at the word level — is transmitted to the other nuclei in a given span via a licensing path (indicated by dotted lines) defined by dependency relations.

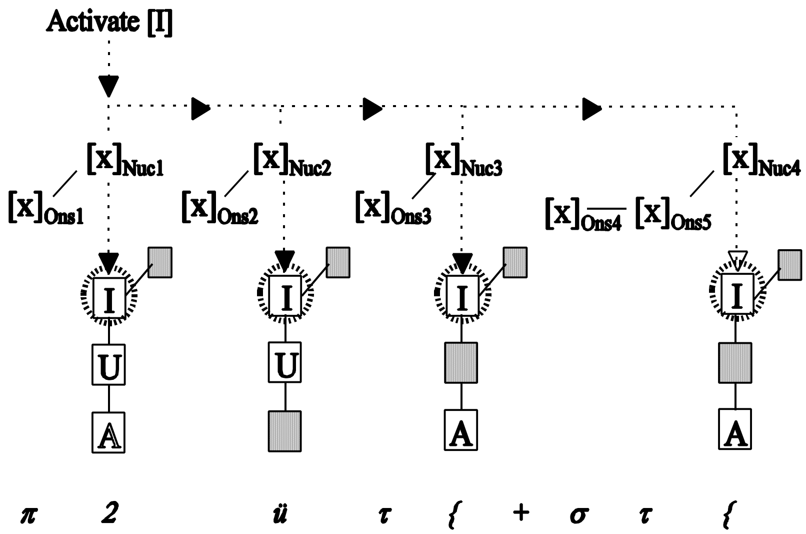
This type of wide-scope agreement is expressed by Backley (1998: 174) as follows.

(19) **PRINCIPLE OF EXTENSION** (PEX)
Extend the domain of ACTIVATE [α] to enhance element interpretability.

A version of this principle is given in Cole & Kisseberth (1994a) as WIDE SCOPE ALIGNMENT — a member of the family of ALIGN constraints within their Optimal Domains Theory. WIDE SCOPE ALIGNMENT functions to match the domain of interpretation of a melodic prime with a morphologically or prosodically determined span. Interacting with an independent constraint termed Expression, which ensures that the concordant feature is associated with every potential target within the domain, WIDE SCOPE ALIGNMENT is responsible for harmonic agreement. In contrast, PEx requires only a single specification of the relevant prosodic category (e.g. foot, word) which suffices to isolate the target sequence. This exhibits the unified nature of the melodic and prosodic hierarchy: the prosodically-specified active unit (e.g. at the level of the foot or word) is interpreted in every potential target further down the same licensing path. Via this mechanism, languages display vocalic agreement processes by means of the dominant influence of PEx.

To illustrate, Backley (1998: 116-7) cites the case of frontness harmony in native Finnish words (in which the front vowels *{*, *2* and *ü* and the back vowels *α*, *o*, and *υ* cannot co-occur, while *ι* and *ε* behave transparently). Here the value of α is [I] (palatality) in the generalised instruction ACTIVATE [α], which is specified as a word-level property. So the structure of *π2üτ{* + *στ{* ‘table (elative)’ is as follows.[5]

(20)



The representation in (20) shows [I]-activation extending throughout the prosodic word domain, highlighting the palatal alternations *2~o*, *υ~ü* and *α~{* observed in nuclear positions.

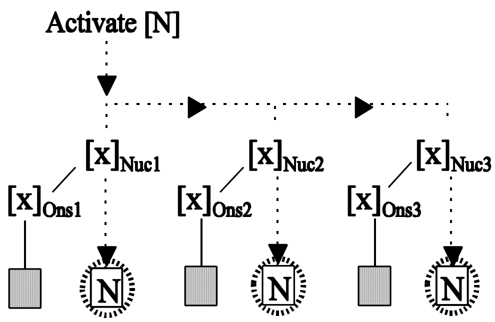
As (20) shows, the mechanism of vowel harmony involves only nuclear positions, which agree with their head position for a particular melodic quality. The relative importance of vowels within an account based on licensing paths seems empirically plausible, since nuclei provide the basic units of prosodic structure while non-nuclear categories are irrelevant at this level of structure.

4.2 Nasal harmony as inter-nuclear agreement

I assume that cases of nasal harmony receive a similar treatment to that of (20), the only difference being that the value of ACTIVATE [α] is [N] (nasality), rather than [I].

[5] In a context of element activation, Backley (1998: 117) assumes that Finnish allows [I] to license a [comp].

(21)



In order to capture the basic mechanism of nasal harmony using the structure in (21), I refer to the analysis of nasal harmony in Gokana[6] given in Nasukawa (1995b). The following data show the conditions which allow/disallow wide-scope nasalisation to take place in the morphemes of this language.

(22)	(a)	C Ṽ C̃	: *dɛ̃́m̃*	‘tongue’	**dɛ́m̃*	**dɛ̃́b*
		C Ṽ C̃ Ṽ	: *fĩ̀ñĩ̀*	‘monkey’	**fìnĩ̀*	**fĩ̀nì*
		C Ṽ Ṽ C̃ Ṽ	: *kṹṹñĩ́*	‘cooking stove’	**kṹṹní*	
					**kúṹní*	
	(b)	C̃ Ṽ	: *nũ*	‘thing’	**nu*	
		C̃ Ṽ C̃	: *nɔ̃m*	‘animal’	**nɔm*	
					**nɔ̃b*	
					**nɔb*	
		C̃ Ṽ C̃ Ṽ	: *mɛ̃́nɛ̃́*	‘chief’	**mɛ́nɛ́*	
					**mɛ̃́nɛ́*	
					**mɛ́lɛ́*	

[6]Spoken in eastern Nigeria, this Ogoni language belongs to the Benue-Congo branch of the Niger-Kordofanian family. According to Hyman (1982), lexical morphemes in Gokana conform to the template $C_1V_1(V)(C_2(V))$ (the symbols C and V stand here for any consonant and vowel, respectively).

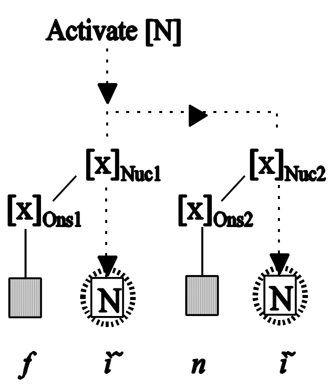
(c)	C V	: *lí*	‘root’	**lĩ́*
	C V C	: *zib*	‘thief’	**zĩm*
				**zim̰*
	C V C V	: *zárí*	‘buy’	**zání*
				**zánĩ́*

One fact concerning distribution emerges from the above data: if C_1 or V_1 is nasal, then all successive segments must also be nasal. In contrast, all successive segments must be oral if both C_1 and V_1 are non-nasal. In the case of an initial CV, the following distinctions are possible:

(23)	(a)	(b)	(c)
	$\mathbf{C_1 V_1} C_2 V_2$	$\mathbf{C_1 V_1} C_2 V_2$	$\mathbf{C_1 V_1} C_2 V_2$
		[N]	[N]

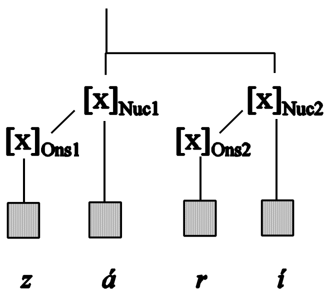
Let us first analyse Gokana nasal harmony using the word type given in (22b), e.g. *fĩ̀nĩ̀* ‘monkey’. Following the same line of argument given by Backley for vowel harmony, the lexical instruction ACTIVATE [N] is specified at the highest prosodic level. Then, [N]-activation extends throughout the prosodic word domain, targeting nuclear sites. This is represented as follows.

(24)



This procedure allows only nuclei to interpret nasality, as already discussed in the case of vowel harmony in (20). Accordingly, Ons_2 is thus represented as having no active [N]; yet, on the face of it, this position appears to receive nasality. Based on the assumption made in Nasukawa (1995b) — that a position such as Ons_2 may contain a nasal only when it lies within a nasal span — I shall claim that the nasality observed in Ons_2 in (24) does not result from the existence of [N] in that position but rather, that it is derived via phonetic interpolation through the entire ϖ~χϖ~ (cf. Cohn 1993). If Ons_2 is not an inter-nasal position, as in *b* in *zib* ‘thief’, it never shows any phonetic interpolation of nasality.

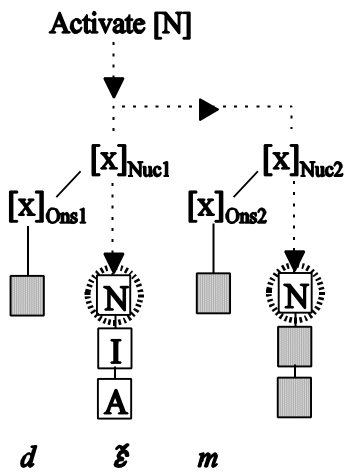
(25)



(25) represents the phonological structure of (23a), where no [N]-activation is involved. Here, Ons_2 finds no phonetic source for nasality.

The word type represented in (23b) includes not only strings such as *fì̃nĩ̀* in (24), but also lexical morphemes ending in a consonant, e.g. *dɛ̃́m* ‘tongue’. On the face of it, Ons_2 does not appear in a context where nasal interpretation is possible. However, I shall claim that, in phonological terms, this is indeed the configuration.

(26)

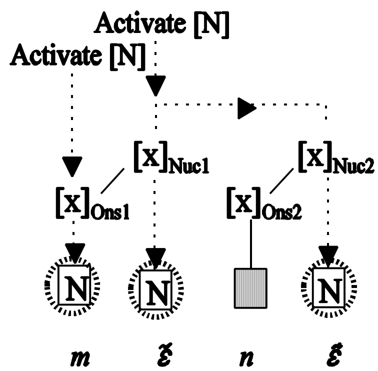


As illustrated in (26) above, one side of the position containing the nasal segment *m* is Nuc_1, which a-licenses [N] and the resonance elements [I] and [A], together interpreted as *ɛ̃*. On the other side is Nuc_2 which falls within the scope of [N]-agreement. Although [N], in the absence of other elements, is uninterpretable in this position, it contributes to a configuration in which the onset is subject to interpolation of nasality.

A similar analysis is found in Nasukawa (1998a), where the moraic/syllabic placeless nasal *N* in Japanese is treated as the phonetic manifestation of an onset, which a-licenses [N] and [?] (but no resonance element) followed by an empty nucleus. In this case, the empty nucleus contributes to the moraicity/syllabicity in the segment in question.

Next, I turn to the remaining word types in (23), and analyse (23c) under the inter-nuclear agreement approach to nasal harmony. An example word of the structure given in (23c) is *m̃ɛ̃ñɛ̃* 'chief', which employs a lexical instruction ACTIVATE [N] at Ons_1, which lies outside the expected harmony domain. However, in order to conform to PEx, Ons_1 must extend the lexical instruction. For the position in question, the only structurally-defined path is the licensing relation between its immediate head Nuc_1 and itself. Then, inheriting ACTIVATE [N] from its dependent position Ons_1, Nuc_1 becomes the source from which [N]-activation is extended throughout the domain. This mechanism is illustrated in the following configuration.

(27)



In addition, Ons_2 phonetically acquires nasality from its neighbouring nuclei without requiring an independent phonological specification for [N].

4.3 Opacity in inter-nuclear nasal agreement

On the basis of the above analysis of nasal harmony in Gokana, I now propose a treatment of harmonic opacity in the Type I system of nasal harmony. I assume that languages with segments that are opaque to wide-scope nasalisation exploit the same mechanism of harmony that operates in Gokana, but with the additional characteristic of allowing 'blocking' segments to interrupt the harmonic span. As most researchers have assumed (Piggott 1992, 1996; Walker 1998), the internal organisation of segments must play a central role in defining these opaque properties.

As discussed in §2, languages of Type I (which further divides into four sub-types) typically utilise fricatives and plosives as opaque segments in nasal harmony. Marked sub-types employ not only obstruents but also sonorants (Type IA) or only plosives (Type ID) as opaque segments. Here, I concentrate not on the parametric difference but on the most typical blocking process in nasal harmony — interruption by obstruents — since the primary focus of this paper is to reveal the prosody-driven mechanism of nasal harmony. For a detailed discussion of minor blocking processes and a parametric analysis of Type I nasal harmony, see Walker (1998).

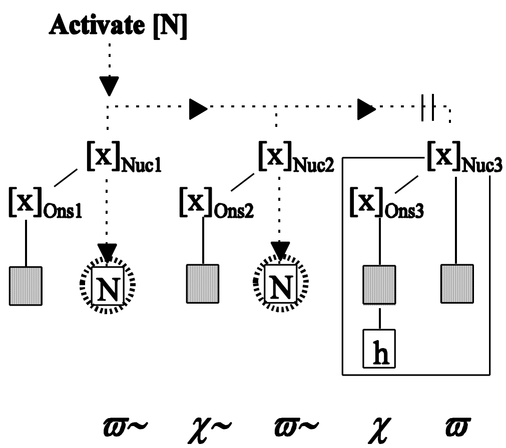
Now, we consider why obstruents are typical blockers in Type I nasal harmony. What prevents the progress of nasalisation can only be explained by reference to the structural component common to all obstruents. In element theory, obstruents require the presence of an active [h], which is absent from nasals/nasalised segments. This distributional restriction on [h] in relation to [N] is captured by the condition *[h, N].

(28) **Parameter *[h, N]**
[h] and [N] are mutually exclusive in melodic expressions

Example languages	Setting ON	OFF
The majority of languages	✓	
Fijian, Northern Tohoku Japanese, etc.		✓

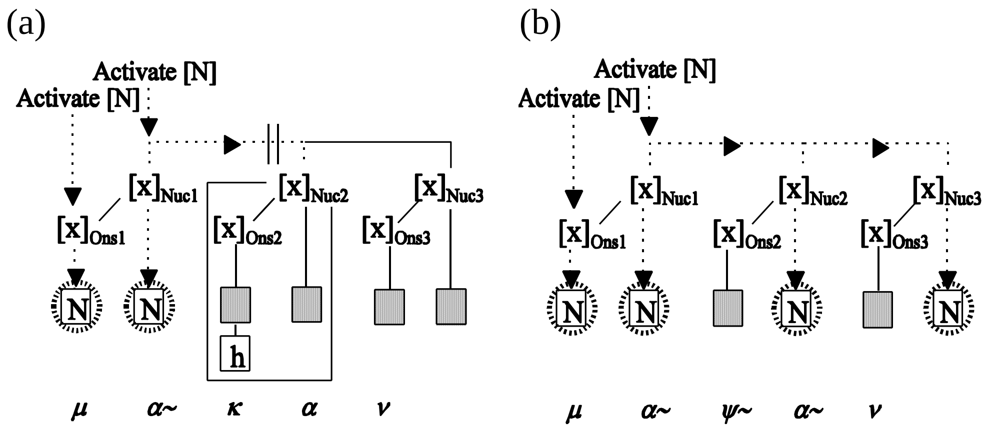
I claim that the ON mode of this constraint applies in all languages exhibiting nasal harmony (as well as most other languages): as a result of the constraint in (28), nasalisation is blocked if the target position lexically a-licenses [h]. Incorporating this view into an inter-nuclear analysis of nasal harmony allows the following possibility for investigating the overall agreement pattern in Type I systems.

(29) Type I agreement pattern



Targeting only nuclei, the configuration in (29) illustrates how the lexical instruction ACTIVATE [N] specified as a property of the ultimate head (prosodic word level) extends its influence across the word domain. Unlike the case of Gokana, however, [N]-activation fails to affect the entire harmonic span: in (29), Nuc_3 p-licenses Ons_3, where the latter a-licenses [h] and therefore prevents nasalisation from being sanctioned. Specifically, the constraint *[h, N] identifies a nucleus as a blocker if it p-licenses an onset position which a-licenses [h]. In other words, all elements contained within the domain of the target nucleus are subject to the element cooccurrence constraint: the existence of an active [h] below the nuclear level prevents the nucleus from becoming nasalised. In this case, even if another nucleus follows Nuc_3 in the same word, the extension of [N]-activation is halted since Nuc_3 cannot exist as an island/medium for transmitting the instruction ACTIVATE [N]. The following examples are taken from Malay.

(30) Malay nasal harmony



In (30a), PEx requires the lexical instruction ACTIVATE [N] to be extended throughout the given domain. However, the extension of [N]-activation is halted by the second minimal prosodic domain containing the noise element [h], which is incompatible with [N] owing to the requirement *[h, N]. As a result, only the first onset-nucleus sequence interprets nasality. In the case of (30b), on the other hand, [N]-extension is not interrupted. As a result, both positions in the first Ons-Nuc pair and also Nuc_2 and Nuc_3 receive active [N]. In this environment, Ons_2 and Ons_3 — which are flanked by positions carrying active [N] — acquire phonetic nasality via interpolation.

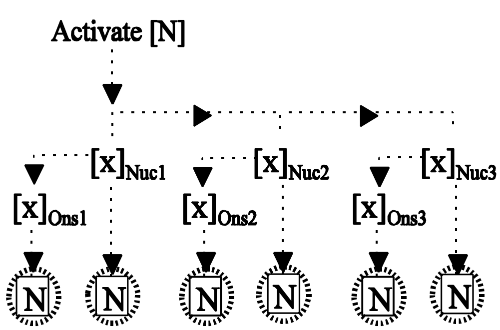
On the basis of these examples, it appears that the Type I pattern of nasal harmony differs from the generalised mechanism of vowel harmony only with respect to the domain where cooccurrence constraints operate. In the case of vowel harmony, constraints (such as *[I, U]: see Kaye, Lowenstamm & Vergnaud 1985, Harris 1994, Backley 1998) affect only nuclear sites. On the other hand, *[h, N] for nasal harmony functions only in non-nuclear sites (i.e. in onsets). This difference is reflected in the characteristics of the individual elements involved. In vowel harmony, we expect a cooccurrence restriction to refer only to resonance elements, which can be a-licensed in nuclear positions. These constraints do not therefore have any bearing on prosodic structure other than at the nuclear level. Similarly, [h] in *[h, N] for nasal harmony is a non-resonance element and is, as a result of the universal characteristics of this unit (which can be a-licensed only in non-nuclear positions), systematically absent from nuclear positions. Accordingly, *[h, N] affects only subordinate domains of nuclear positions where [h] can be realised. Elsewhere, the constraint is redundant, since the cooccurrence restriction involving [h] and [N] derives naturally from the absence of [h] in nuclei: because [h] never appears in nuclei, [N] is never active alongside [h] in these positions.

4.4 Transparency in inter-nuclear nasal agreement

We expect the Type II pattern of nasal harmony to be analysable using a mechanism similar to that suitable for vowel harmony and the Type I pattern, on the basis that the harmonic process is derived from inter-nuclear element agreement. However, vowel harmony and Type I are somewhat more prevalent in languages displaying harmonic agreement, leaving Type II under-represented cross-linguistically. In order to account for this markedness difference, linguists often utilise the notion of structural/functional complexity: the more complex a mechanism is, the more marked that mechanism is deemed to be. Following this line of argument, I assume that those rare languages exhibiting the Type II pattern exploit a more complex mechanism than is required for the other harmonic patterns. Specifically, two characteristics are worthy of closer scrutiny — the target of PEx and the role of *[h, N].

First, I assume that the target of PEx must be determined parametrically. As argued in §4.2, harmonic systems all employ PEx where the extending targets are nuclei. However, following Piggott & van der Hulst (1997), I assume that in the less common cases of nasal harmony — those that follow the Type II pattern — PEx targets non-nuclear positions, and in particular, onsets. This derives from the fact that, in Type II languages, both positions in a CV-sequence are uniformly oral or nasal, and never contain a sequence such as χϖ~ or χ~ϖ. That is, both positions in a minimal prosodic domain must agree for nasalisation/oralisation.

(31)



As illustrated in (31), if PEx targets onset positions, then the p-licensing nuclei of those onsets are also sanctioned to have an active [N]. This illustrates how nuclei are present as the driving force behind [N]-activation, serving the function of passing the instruction to their dependent onset positions.

In this case, unlike the Type I system, non-nuclear positions display prosodically-specified [N]-activation in order to conform to PEx, which has [N] as its variable. This parametric choice can be captured by the following formalism.

(32) **PEx ([α], {Nuc}/Non-nuc)**

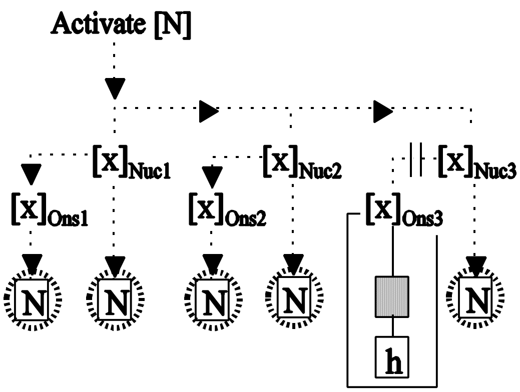
The formula in (32) contains two functional arguments: [α] and {Nuc}/Non-nuc. The first stands for any element which is extended to form wide-scope agreement. In the case of nasal harmony, as we have already seen in this paper, this variable is [N]. The other argument is a parametric choice to determine the element-extending target. In most cases, nuclei are regarded as the terminal positions to be specified for an active [N]. (The unmarked status of nuclei as a target is denoted by curly brackets in (32).) However, in rare cases, non-nuclear positions can be selected as a harmonic target instead. Type II languages, for example, are relatively marked because their second argument is Non-nuc. Accordingly, the constraint in (32) is described for nasal harmony as follows.

(33) (a) **PEx ([N], {Nuc}/Non-nuc)**
(b) **PEx ([N], Nuc/{Non-nuc})**

The function in (33a) describes Type I nasal harmony. If the first argument contains any resonance element, it causes vocalic harmony. On the other hand, in the marked case (33b) selects non-nuclear positions as the second argument to create the Type II system.

The way in which the constraint *[h, N] operates is similar in Types I and II, to the extent that it applies within the domain of a given harmonic target. However, in the case of Type II systems, unlike those of Type I, it is only onsets with an active [h] which are prevented from interpreting [N]. In contrast, their nuclei may interpret [N], since the domain affected by *[h, N] corresponds to a non-nuclear position which is targeted by the constraint in (33b).

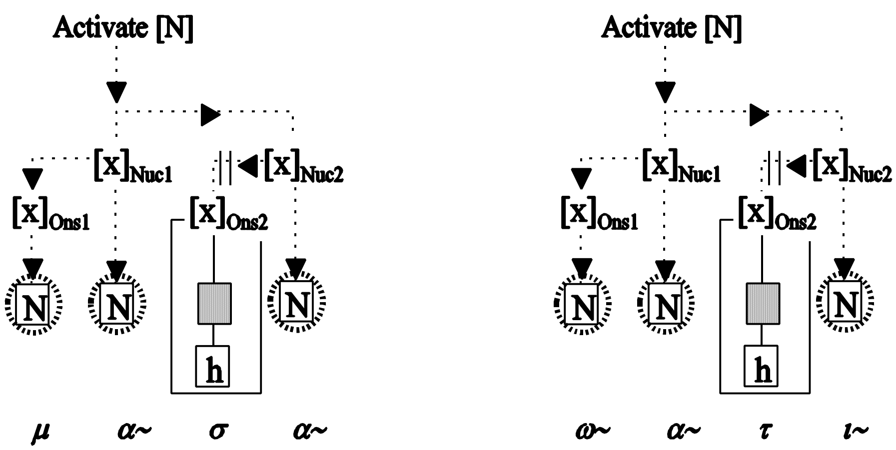
(34) Type II agreement pattern



The following examples from Southern Barasano illustrate this point.

(35) Southern Barasano nasal harmony

(a) (b)



Both structures in (35) show the same mechanism as (34): [N] is interpreted in all positions except Ons_2, since the latter complies with *[h, N] — if an active [h] is present then Ons_2 cannot interpret [N].

5 Summary

Let me summarise the discussion in this paper. Nasal harmony is a dynamic alternation involving the element [N]. In order to develop a treatment which mirrors that of vowel harmony, nasal harmony is regarded as an element agreement process which operates between nuclei and is driven by p-licensing paths. Both types of nasal harmony — Type I and Type II — come about when the two constraints *[h, N] and PEx ([N], Nuc/Non-nuc) are active. The difference between Type I and Type II lies in the parametric setting of the second argument of PEx: the former takes the default setting Nuc, whereas the latter takes the marked setting Non-nuc. One outcome of this approach is that non-nuclear positions — typically onsets — never receive the element [N] as a phonological property in the Type I pattern. However, we do nevertheless observe nasality being phonetically manifested in non-nuclear positions. In order to explain this using the distributional facts of nasality, I assume that it results from the phonetic interpolation of [N] from flanking nuclei.

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