A dependency-based typology of nasalisation and voicing phenomena

Bert Botma and Norval Smith University of Leiden/LUCL / University of Amsterdam/ACLC

1. Introduction

In earlier work (see e.g. Botma 2004, Botma & Smith 2006) we have argued that there are good grounds to assume that distinctive voicing and nasalisation are in complementary distribution; the former is a property of obstruents, the latter of sonorants. In our dependency-based approach we formalise this in terms of a dependent element |L|, whose interpretation depends on whether it is linked to an obstruent or sonorant manner component. Dependent |L| is interpreted as voicing in obstruents, and as nasalisation in sonorants.

In this paper we evaluate this hypothesis against the behaviour of voicing and nasalisation in domains like the syllable and the word. The behaviour of voicing and nasalisation in these domains appears at first sight to be problematic for our approach, since cross-linguistic evidence indicates that they display asymmetric behaviour; while there are languages with long-distance nasal harmony, there do not seem to be any languages with long-distance voicing harmony (by 'longdistance' we mean that the targets are not necessarily adjacent on the segmental level). Rather, long-distance voicing relationships appear to be dissimilatory in nature. Our research shows that this asymmetry is part of a general asymmetry between sonorants and obstruents: long-distance laryngeal assimilation targets sonorants and leaves obstruents unaffected; long-distance laryngeal dissimilation targets obstruents and leaves sonorants unaffected. Our interpretation of this asymmetry is motivated by the idea that long-distance assimilation is regulated by syllabic heads, i.e. projections of nuclear positions.¹ Given that nuclei contain sonorants, and given that dependent |L| in sonorants denotes nasalisation, we predict the possibility of long-distance nasalisation, and rule out the existence of long-distance voicing. Therefore, the hypothesis that voicing and nasalisation are represented by a single element, viz. [L], can be maintained.

This paper is organised as follows. First, in §2, we provide a brief outline of the theoretical background. Next, in §3, we offer a number of arguments for the

dual representation of voicing and nasalisation in terms of dependent |L|. In §4 we discuss the asymmetric behaviour of voicing and nasalisation in assimilation and dissimilation phenomena. §5 concludes our paper.

2. Representational assumptions

We assume that subsyllabic constituents have the general structure in (1), where 'O', 'N' and 'C' are short for onset, nucleus and coda, and 'x' represents the skeletal level. Subsyllabic constituents have a maximum of two x-positions, a 'head' and a 'dependent'. In this paper we restrict our attention to constituents with a single x-position.

(1) {O, N, C} x phonation | {|',H,L|} manner {|',H,L|} | place {|A,I,U|}

In (1) the manner and place components together form what may be termed the segmental 'core'. The phonation component forms a dependent of this core. This is in line with the observation that it is unmarked for a segment to be specified for manner and place, but marked for a segment to be specified for phonation.

For the purposes of this paper, two aspects of (1) require further comment. The first is the location of the phonation component, which, following Kehrein (2002) and Kehrein & Golston (2004), we take to be a dependent of a subsyllabic constituent (rather than of individual segments, as is traditionally assumed). This predicts that subsyllabic constituents can have at most one laryngeal contrast. The phonetic implementation of this contrast is language-specific. For instance, a contrastively aspirated /p/ can be realised as pre- or postaspirated. However, (1) predicts that no language contrasts /^hp/ with /p^h/, at least not in the same syllabic position. We refer the reader to the sources cited for discussion of this and related issues. What is relevant for our purposes is that laryngeal assimilation minimally applies between subsyllabic constituents, as there are no phonologically relevant laryngeal distinctions below this level.

The second aspect concerns the interpretation of the elements |?|, |H|, and |L|, which represent both the manner and the laryngeal properties of segments. The articulatory and acoustic interpretations of |?,H,L| are given in (2).

(2)		Articulatory interpretation	Acoustic interpretation
	s :	complete closure	energy reduction
	H:	close approximation	aperiodicity
	L :	open approximation	periodicity

The corresponding manner and laryngeal interpretations are given in (3).

(3)		Manner interpretation	Laryngeal interpretation		
	s :	plosive	glottal constriction		
	H :	sibilant/fricative	glottal widening		
	L :	vowel	voice/nasalisation		

The interpretation of $|^{2}$,H,L| thus depends on their position in the phonological structure. A case in point is the element |L|. If |L| occurs as a manner element, i.e. as (part of) the head, the segment is identified as a sonorant. If |L| occurs as a phonation element, i.e. as the dependent, its interpretation is variable; |L| denotes nasalisation if there is also an |L| in the head, and voicing if there is no |L| in the head. Phonologically, nasalisation is therefore a laryngeal property.² Consider the examples in (4).



(4a) represents the high-back vowel /u/. The manner component of /u/ consists of |L|, which is dominated by the nucleus and itself dominates the place element |U|. In (4b), nasalised / \tilde{u} / has an additional dependent |L|; since there is also an |L| in the manner component, this dependent |L| denotes nasalisation. (4c) represents a 'plain' labial plosive /p/. (4d), which represents /b/, has an additional dependent |L| which denotes voicing, since there is no |L| present in the manner component.

The context-sensitive interpretation of |L| embodies the claim that voicing and nasalisation are in complementary distribution. We discuss this claim in more detail in §3.

3. The dual interpretation of dependent |L|

There are a number of arguments in favour of the dual interpretation of dependent |L| as voicing and nasalisation. One is that it obviates the need for cooccurrence restrictions between sonorancy and voicing, and obstruency and nasalisation.³ Cross-linguistic evidence shows that languages neither have distinctively voiced sonorants nor distinctively nasalised obstruents.⁴

The dual interpretation of dependent |L| also permits a natural interpretation of postnasal voicing. Postnasal voicing is a cross-linguistically common process in which a voiceless stop is realised as voiced under the influence of a preceding nasal. In our approach this can be represented as spreading of dependent |L| from the nasal (in our view, a 'nasalised sonorant stop'; see Botma & Smith 2006) to the dependent position of the stop. This is shown in (5), where the nasal 'N' and the voiceless stop 'C' form a coda–onset sequence.

(5) C O

$$x L x$$

 $| | |$
 L
 $?$
 $/NC/ \rightarrow [NC]$

The mirror image of this process, i.e. 'stop-induced nasalisation', is unattested. Apparently, dependent |L| can spread from a sonorant to an obstruent but not vice versa. At present, we have no explanation for this asymmetry.

Perhaps the most compelling support for the dual interpretation of dependent |L| comes from processes which trigger either voicing or nasalisation, depending on whether the target is an obstruent or a sonorant. One such process is found in Navajo. As Rice (1993) observes, the Navajo perfective is signalled by voicing of stem-final fricatives (6a) and by nasalisation of stem-final vowels (6b).

(6) a.	Imperf Perf			b.	Imperf	Perf		
		-?aał	-?aal	'chew, eat'		-bí	-bī́	'swim'
		-?aa∫	-?aa3	'few go'		-?á	₋?ấ́	'cl. small object'
		-lóós	-lóóz	'lead'		-ka	-kã	'cl. contained object'

These surface manifestations can be accounted for if the perfective morpheme is analyzed as |L|, which links to the dependent position of the stem-final segment. Botma (2004) discusses a number of similar processes from Irish, Maukakã and Sambú.

The evidence reviewed above suggests that there are good grounds to assume that distinctive voicing and nasalisation are represented by a single element, viz. dependent |L|. In the remainder of this paper we will evaluate this hypothesis against the asymmetric behaviour of voicing and nasalisation in domains such as the syllable and the word.

4. Voicing and nasalisation: Typological observations

In this section we offer an overview of assimilation and dissimilation processes that involve nasalisation and voicing. Before doing this, it is important to make explicit a number of terms. We interpret assimilation in standard autosegmental terms, i.e. as spreading of a dependent element from some trigger to some target (as is exemplified in (5), for instance). We assume that all spreading is local, in the sense that it takes place between adjacent constituents (see also Walker 2000 and references there). This implies that a spreading analysis of long-distance assimilation, where segmental trigger and target are apparently not adjacent, can be maintained only if we assume that spreading takes place at some higher level in the phonological structure. In §4.2 we will see that this is the case in long-distance nasalisation, which, we argue, is local on the level of syllable heads.

We assume that laryngeal dissimilation involves the deletion of a dependent element, forced by the presence of an identical dependent element in the same domain. A hypothetical input to dissimilation is given in (7), which shows a word with two voiced obstruent stops in onset position. If a language does not tolerate such sequences, dissimilation may apply to remove one of the two offending |L|s.



Note, incidentally, that a representation in which the two voiced stops are linked to a single dependent |L| would violate locality, and is therefore impossible.

With this background, we now turn to an overview of voicing and nasalisation processes. In §4.1 we consider processes that are local on the subsyllabic level; we term these 'adjacent' processes. In §4.2 and §4.3 we focus on processes that are not local on the subsyllabic level; we term these 'long-distance' processes.

4.1 Adjacent nasalisation and voicing

As regards adjacent assimilation, we find cases of both voicing and nasalisation in coda–onset clusters. (Nuclei are never targeted by voicing assimilation, since nuclei contain sonorants, where dependent |L| denotes nasalisation.) In (8ab) we give two examples of coda-induced assimilation (in both examples the following onsets are prefix-initial).

(8)		Process	Language	Example	Source
	a.	Voicing	Oromo	$/b-t/ \rightarrow [bd]$	Lloret (1995)
	b.	Nasalisation	Yakut	$/m-l/ \rightarrow [mn]$	Stachowski & Menz (1998)

We analyze Yakut /l/ in (8b) as a sonorant stop, i.e. as a segment with a manner component that consists of |L| and |2|. This /l/ is targeted by the dependent |L| of the preceding nasal, turning it into a nasalised sonorant stop, i.e. [n], as in (9).

(9)	С		Ο
	\sim]
	х	L	х
	L		L
	\$		\$
	U		Ι
	/m-	$l \rightarrow [n]$	nn]

We will see in \$4.3 that sonorant stops are the universally unmarked nasalisation target.

Conversely, there do not appear to be any adjacent dissimilation processes that involve nasalisation or voicing. Note that there are languages which denasalise the second nasal in a nasal cluster (i.e. $/NN/\rightarrow[NC]$), such as Fore (Scott 1978). However, this process involves dissimilation of manner rather than of phonation; the change from a nasal to a voiced (obstruent) stop involves deletion of |L| from the *manner* component of the affected nasal.

4.2 Long-distance voicing

The asymmetry between voicing and nasalisation becomes apparent when we consider long-distance assimilation. Long-distance nasalisation is well-attested, but the status of long-distance voicing is dubious. Some researchers accept it as a possibility (see e.g. Walker 2000), while others explicitly reject it (see e.g. Gafos 1998). In any case, it would appear as though all reported cases of long-distance voicing assimilation are also open to alternative interpretations.

In recent work on voicing agreement, two general patterns of long-distance voicing agreement are recognized (see e.g. Walker 2000, Rose & Walker 2004, Hansson 2001, 2004). In the first, voicing agreement is part of a more general identity requirement on consonants. This may involve other phonation types, as in Aymara and Chaha, but also supralaryngeal aspects such as place (see Rose & Walker 2004 for a typological overview). This type of consonant agreement is at best infrequent. Walker (2000:533) claims that it is found in Ngbaka, which has roots of the kind in (10ab), but not (10c).

(10)	a.	tita	'grandparent'	b.	bata	'three'	с.	*tida
		pepu	'vent'		duka	'shoulder'		*dita
		babã	'companion		tolo	'strike'		*pɛbu

The data cited by Walker reflects only a subset of the cooccurrence restrictions in Ngbaka. Wescott (1965:346) notes that a disyllabic word with a voiced obstruent cannot also contain its prenasalised counterpart, and that a disyllabic word with a prenasalised obstruent cannot also contain its 'plain' nasal counterpart. Hence, it would seem as though Ngbaka imposes a general ban on segments that are too much alike. This suggests that an OCP-based approach to the Ngbaka restrictions is more appropriate (as in, for instance, Mester 1986 and van de Weijer 1996).

The second pattern of long-distance agreement involves an inter-dependence between voicing and low tone. Hansson (2001, 2004) argues that in such cases voicing agreement can be seen as a by-product of low-tone spreading and toneinduced voicing. This is arguably also the case in Kera, the only language where voicing agreement –apparently– results in overt alternations. Pearce (2006) has recently argued that the Kera voicing facts result from spreading of low tone, and that the language in fact lacks distinctive voicing altogether.⁵

We conclude from these observations that voicing generally does not display long-distance assimilation. Rather, all long-distance voicing effects that we are aware of involve dissimilation. Examples include Lyman's Law in Japanese (Itô & Mester 1986), Dahl's Law in a number of East African Bantu languages (Davy & Nurse 1982) and Thurneysen's Law in Gothic (Mossé 1956). We will not offer an analysis of any specific voicing dissimilation process here. Such processes can in principle be handled by a ban on multiple occurrences of dependent |L| in obstruents in a particular domain, as was outlined in (6) above.

4.3 Long-distance nasalisation

Long-distance nasalisation is well-attested, and forms part of a phenomenon that is referred to as 'nasal harmony'. One type of long-distance nasalisation is found in a number of Amazonian languages, including Southern Barasano. In Southern Barasano nasalisation is an underlying property of some vowels. From these it spreads rightwards to the end of the word, skipping voiceless obstruents. Any consonant preceding a nasalised vowel also surfaces as nasalised, except when that consonant is a voiceless obstruent. Consider the forms in (11), taken from Smith & Smith (1971).

(11)	kãmõkã	'rattle'	wãtĩ 'demon'		hati-ãmĩ	'he sneezes'	
	mãsã	'people'	rimã	'poison'	hiamãkõnõ	'ten'	

In Southern Barasano (and in many other Amazonian languages) the voiced stops [b,d,g] are in complementary distribution with the nasals [m,n,n]; the former precede oral vowels, the latter nasalised vowels. This leads Botma (2004) to treat /b,d,g/ as *sonorant* stops, which, like other harmonic targets, surface as nasalised through association with dependent |L|. The advantage of this account is that it limits the set of nasalizable segments in Southern Barasano to sonorants.

Botma (2004) further assumes that, underlyingly, nasalisation is a property of the syllable, rather than of the vowel that this syllable dominates (see Piggott & van der Hulst 1997 and Nasukawa 2005 for similar approaches). Specifically, his claim is that |L| is a dependent of the syllable node N¹, itself a projection of the nucleus N⁰. This makes it possible to analyze rightward spreading of nasalisation as local on the syllabic level, as is illustrated in (12) for the word [w̃atĩ].



Since Southern Barasano does not allow codas, we assume that it lacks a nuclear projection equivalent to the level of the rhyme. N^1 is equivalent to the syllable level; the projection N^2 incorporates the harmonic element |L|.

Our account of Southern Barasano nasalisation essentially extends Kehrein's (2002) prosodic theory of laryngeal contrasts to include the level of the syllable. Indeed, there is reason to believe that |L| can also occur as a dependent in even larger domains. For instance, Piggott (1996) argues that nasalisation in Kikongo is bound by the foot, while in Amazonian languages such as Tuyuca and Yuhup nasalisation is a property of entire words (see e.g. Botma 2004). In each of these domains |L| can be viewed as an underlying dependent of a particular syllable head (and therefore ultimately as a dependent of a sonorant manner component), and in each of these domains spreading of |L| can be viewed as applying at the level of syllable heads. This ensures, then, that dependent |L| will always be interpreted as nasalisation at the syllabic level. Thus, the asymmetric behaviour of voicing and nasalisation in long-distance phenomena does not force us to reject the hypothesis that both are represented by |L|. Indeed, aside from being restrictive, an account in terms of a context-sensitive element |L| explains why we find long-distance nasalisation, but no long-distance voicing. Compare this to a traditional feature-based approach, in which it must be stipulated that some features, e.g. [+nasal], can be harmonic, while others, e.g. [+voice], cannot.

A comment is in order regarding the phonetic implementation of dependent |L| in languages like Southern Barasano. As the data in (11) shows, nasalisation targets all sonorants in the harmonic domain. This suggests that in nasal surface forms, all |L|-headed segment types contain dependent |L|.⁶ But since dependent |L| can in principle also be linked to obstruents, we must restrict its association in Southern Barasano to the set of sonorants. Adopting a term from Piggott & van der Hulst (1997), Botma (2004:140) proposes that the dependency relation of a harmonic element in a prosodic domain must be 'consistent'. We formalise this in terms of the principle in (13).

(13) Principle of Consistent Dependency Relations

In a harmonic domain N^n , where N^n is a projection of N^0 , and N^n is specified for a dependent element X, X can be implemented only on heads of the same type as N^0 .

(13) predicts that long-distance nasalisation never triggers voicing of obstruents. Processes which involve both voicing and nasalisation, such as postnasal voicing and Navajo perfective formation, always take place at the subsyllabic level.

To conclude this section, we briefly consider another type of long-distance nasalisation. This concerns the consonant nasalisation process that is found in a number of Bantu languages. The basic pattern is displayed by Lamba. As Odden (1994:325) observes, Lamba has oral and nasal suffix allomorphs, depending on whether the preceding stem-final consonant is oral (14a) or nasal (14b). (14c) shows that the nasalisation process may have more than one target.

(14)	a.	pat-ile	'scold-perf'	(*pat-ine)
		mas-ile	'plaster-perf'	(*mas-ine)
	b.	uum-ine	'dry-perf'	(*uum-ile)
		nw(a)-ine	'drink-perf'	(*nw-ile)
	с.	mas-ulul-a	'un-plaster'	(*mas-unun-a, *mas-ulun-a, *mas-unul-a)
		min-unun-a	'un-swallow'	(*min-ulul-a, *min-ulun-a, *min-unul-a)

We analyze the target of nasalisation, i.e. /l/, as a sonorant stop, similar to what we proposed for Yakut in (8b).

The Lamba facts appear to be problematic for the account suggested above. If, as we claim, long-distance nasalisation involves spreading at some projection of N^0 , then how can we explain that harmonic nasalisation is not implemented at N^0 itself? In other words, if dependent |L| in Lamba is an underlying property of the stem-final syllable, then why is |L| realised only on the suffix consonant, and not on the preceding suffix vowel?

We suggest that the answer to this question lies in the relative markedness of nasalisation targets. Typological research has shown that there is an implicational hierarchy in the compatibility of segments with nasalisation (see Walker 1998 and references there). Walker (1998:34) proposes the following harmony scale.⁷

```
(15) sonorant stop > vowel > glide > liquid > fricative > obstruent stop
```

This hierarchy is implicational in the sense that if, say, in some language glides are targets for nasalisation, then vowels and sonorant stops will also be targets. Hence, (15) reflects the fact that of all segment types, sonorant stops are best compatible with nasalisation. This is corroborated by the observation, made by Maddieson (1984), that a language which has contrastively nasalised segments minimally has nasals — i.e., nasalised sonorant stops. Notice also that the relative unmarkedness of nasals seems feasible on phonetic grounds, since nasalisation is perceptually most salient in nasals.

In Walker's Optimality-Theoretic approach, the scale in (15) is formalised as a set of intrinsically ranked markedness constraints, as in (16).

(16) *NasObsStop >> *NasFric >> *NasLiq >> *NasGli >> *NasVow >> *NasSonStop

Walker formalises spreading of nasalisation in terms of NASSPREAD constraints. This generates a typology of nasal harmony processes, including one in which the harmonic targets are restricted to just sonorant stops (the appropriate ranking has the NASSPREAD constraint ranked between *NASVOW and *NASSONSTOP). This, we suggest, is the type of nasal harmony that operates in Bantu languages such as Lamba. The phonetic realisation of harmonic forms in Lamba creates the impression that the nasal spreading is non-local. However, this is only apparent, since the process operates at the level of syllable heads, where it is local.

Reasons of space preclude a detailed analysis of Bantu consonant nasalisation, but the contours of such an analysis will by now be clear.⁸ In Lamba, as in all languages with long-distance nasalisation, dependent |L| is underlyingly linked to a syllable head. The surface manifestation of nasalisation is regulated by the interaction between spreading and markedness constraints. As to the latter, we will have to reformulate the constraints in (16) in terms of our dependency-based representations. For instance, in our model it seems to be the case that dependent |L| is best compatible with manner structures containing the element $|^2|$, either in isolation (in which case dependent |L| denotes voicing), or in combination with |L|(in which case dependent |L| denotes nasalisation). Dependent |L| is less compatible with manner structures containing the markedness of such segment types as nasalised liquids and glides. We leave the formalisation of these constraints for future research.

5. Conclusion

In this paper we have shown that there is an asymmetry between long-distance voicing and nasalisation: the former is dissimilatory, the latter is assimilatory. We have argued that this asymmetry receives a principled answer if (1) voicing and nasalisation are represented by dependent |L|, and (2) long-distance nasalisation is regulated by prosodic heads, i.e. projections of nuclei. The fact that dependent |L|, when linked to a syllable head, is interpreted as nasalisation explains why we find long-distance nasal harmony, but no long-distance voicing harmony. Hence, the asymmetry of voicing and nasalisation in long-distance phenomena does not undermine an approach in which they are represented by the same element, viz. dependent |L|.

One question that is raised by our account is to what extent the behaviour of dependent |L| is representative of laryngeal contrasts in general. As we intimated above, we suspect that the asymmetry between voicing and nasalisation reflects a general asymmetry between obstruents and sonorants. All the cases of laryngeal dissimilation known to us target obstruents, and leave sonorants unaffected. An uninteresting reason for this asymmetry would be that laryngeal contrasts are on the whole much less frequent in sonorants. In that case, laryngeal dissimilation of sonorants would be unattested simply because laryngeal contrasts in sonorants are very rare to begin with. However, a more interesting reason would be that only sonorants are capable of projecting prosodic heads, so that, as a result, only sonorants can take part in long-distance assimilations. The asymmetry between obstruents and sonorants could then be attributed to the fact that their laryngeal dependents occupy different structural positions, and therefore display different

behaviour. Some support for the latter position comes from Spokane, where we find a process of long-distance glottalisation which targets sonorants and skips intervening obstruents (see Carlson 1980). We hope to address the Spokane facts in a future paper.

Notes

1. For a similar approach to vowel harmony, see van der Hulst & van de Weijer (1995).

2. The Government Phonology model of Nasukawa (2005) also assumes a single element representing voicing and nasality.

3. In feature theories [voice] is usually underspecified in sonorants. For an approach in which [nasal] is limited to segments specified for SV (i.e. sonorants), see Rice (1993).

4. This implies that pre- and postnasalised stops, which are potentially contrastive, cannot be analyzed as single nasalised stops but must be treated as NC clusters. See Downing (2005) for a recent account along these lines.

5. In our account there is a natural relation between voicing and low tone, in that both are expressed by the dependent low-tone element |L|. We leave the specific representation of low tone, and its interaction with voicing, for further research, however.

6. We assume that all sonorants in the harmonic domain 'inherit' an |L|-specification from the syllable-level specification.

7. Contrary to what we claim, Walker assumes that obstruents are potential nasalisation targets. This does not affect the point at issue, however.

8. It should be noted that Bantu languages differ in the kind of NASSPREAD constraints that are active. Compare Hyman's (1995) description of Yaka, for instance.

References

Botma, Bert 2004. *Phonological aspects of nasality: an element-based dependency approach*. Ph.D. diss., University of Amsterdam (published by LOT, Utrecht).

Botma, Bert & Norval Smith. 2006. "A dependency account of the fortis–lenis contrast in Cama". *Linguistics in the Netherlands 2006* ed. by Jeroen van de Weijer & Bettelou Los, 15–27. Amsterdam/Philadelphia: John Benjamins.

Carlson, Barry. 1980. "Spokane -e-". International Journal of American Linguistics 46.78-84.

- Davy, John & Derek Nurse. 1982. "Synchronic versions of Dahl's Law: the multiple applications of a phonological dissimilation rule". *Journal of African Languages and Linguistics* 4.157–195.
- Downing, Laura. 2005. "On the ambiguous segmental status of nasals in homorganic NC sequences". *The internal organization of phonological segments* ed. by Marc van Oostendorp & Jeroen van de Weijer, 183–216. Berlin: Mouton de Gruyter.

- Gafos, Adamantios. 1998. "Eliminating long-distance consonantal spreading". *Natural Language and Linguistic Theory* 16.223–278. New York: Garland.
- Hansson, Gunnar. 2001. Theoretical and typological issues in consonant harmony. Ph.D. diss., University of California, Berkeley.
- Hansson, Gunnar. 2004. "Long-distance voicing agreement: an evolutionary perspective." *Proceedings of the 30th Annual Meeting of the Berkeley Linguistics Society* ed. by Marc Ettlinger *et al.*, 130–141. Berkeley: Berkeley Linguistics Society.
- Hulst, Harry van der & Jeroen van de Weijer. 1995. "Vowel harmony". *The handbook of phono-logical theory* ed. by John Goldsmith, 495–534. Oxford: Blackwell.
- Hyman, Larry. 1995. "Nasal consonant harmony at a distance: the case of Yaka". *Studies in African Linguistics* 24.5–30.
- Itô, Junko & Armin Mester. 1986. "The phonology of voicing in Japanese: theoretical consequences for morphological accessibility". *Linguistic Inquiry* 17.49–73.
- Kehrein, Wolfgang. 2002. Phonological representation and phonetic phasing: affricates and laryngeals. Ph.D. diss., University of Marburg.
- Kehrein, Wolfgang & Chris Golston. 2004. "A prosodic theory of laryngeal contrasts". *Phonology* 21.325–357.
- Lloret, Maria-Rosa. 1995. "The representation of glottals in Oromo". Phonology 12.257-280.
- Maddieson, Ian. 1984. Patterns of sounds. Cambridge: Cambridge University Press.
- Mester, Armin. 1986. Studies in tier structure. Ph.D. diss., University of Massachusetts.
- Mossé, Fernand. 1956. *Manuel de la langue gotique: grammaire, textes, notes, glossaire*. Paris: Aubier, Éditions Montaigne.
- Nasukawa, Kuniya. 2005. A unified approach to nasality and voicing. Berlin: Mouton de Gruyter.
- Pearce, Mary. 2006. Evidence against voicing spread in Kera. Paper presented at the 14th Manchester Phonology Meeting, May 2006, Manchester.
- Rice, Keren. 1993. "A re-examination of the feature [sonorant]: the status of 'sonorant obstruents". *Language* 69.308–344.
- Rose, Sharon & Rachel Walker. 2004. "A typology of consonant agreement as correspondence". Language 80.475–531.
- Odden, David. 1994. "Adjacency parameters in phonology". Language 70.289-330.
- Piggott, Glyne. 1996. "Implications of consonant nasalization for a theory of harmony". *Canadian Journal of Linguistics* 41.141–174.
- Piggott, Glyne & Harry van der Hulst. 1997. "Locality and the nature of nasal harmony". *Lingua* 103.85–112.
- Scott, Graham. 1978. The Fore language of Papua New Guinea. (Pacific Linguistics B–47). Canberra: Australian National University.
- Smith, Richard & Connie Smith. 1971. "Southern Barasano phonemics". Linguistics 78. 80-85.
- Stachowski, Marek & Astrid Menz. 1988. "Yakut". *The Turkic languages* ed. by Lars Johanson & Éva Csató, 417–433. London: Routledge.
- Walker, Rachel. 1998. Nasalization, neutral segments, and opacity effects. Ph.D. diss., University of California at Santa Cruz.
- Walker, Rachel. 2000. "Long-distance consonantal identity effects". WCCFL 19.532-545.
- Weijer, Jeroen van de. 1996. Segmental structure and complex segments. Tübingen: Niemeyer.
- Wescott, Roger. 1965. "Review of J.M.C. Thomas (1963) Le parler Ngbaka de Bokanga phonologie, morphology, syntax". Language 41.346–347.