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Historical transfer of nasality between consonantal onset and vowel: from C to V or from V to C?

Alexis MICHAUD, Guillaume JACQUES and Robert L. RANKIN

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Summary: Comparative data from several language families show that nasality can be transferred between a syllable-initial consonant cluster and the following vowel. The cases reported to date are summarized, and a new analysis is proposed for a set of Sino-Tibetan data. The evolution appears to go in both directions: from the consonantal onset to the following vowel in Tai-Kadai, Austroasiatic, Sino-Tibetan, Niger-Congo (Kwa) and Indo-European (Celtic), and from the vowel to the preceding consonant in Siouan. However, an examination of the conditions on these changes brings out an asymmetry. In most cases, transfers of nasality take place from a consonantal onset to a following vowel; the instances we found of a regular change in the opposite direction all come from languages where there is one of the following restrictions on nasal sounds: (i) nasal consonants are nonphonemic (contextually predictable), or (ii) the opposition between nasal and oral vowels is neutralized after nasal consonants (in favor of nasal vowels).

Zusammenfassung: Vergleichende Daten aus verschiedenen Sprachfamilien zeigen, dass Nasalität zwischen dem silbeninitialen Konsonantenbündel und dem nachfolgenden Vokal transferiert werden kann. Ausgehend von den bisher beschriebenen Fällen wird anhand sino-tibetischer Daten eine neue Analyse vorgeschlagen. Der Transfer scheint in beide Richtungen zu gehen: vom konsonantischen Anlaut zum nachfolgenden Vokal für Tai-Kadai, Austroasiatisch, Sino-Tibetisch, Niger-Kongo (Kwa) und Indogermanisch (Keltisch), dagegen vom Vokal zum vorangehenden konsonantischen Anlaut im Sioux. Eine genauere Untersuchung der Bedingungen dieser Nasalitätsveränderungen fördert jedoch eine Asymmetrie zutage. In den meisten Fällen verläuft die Richtung des Nasalitätstransfers vom konsonantischen Anlaut zum folgenden Vokal. Alle Fälle eines regulären Transfers in die entgegengesetzte Richtung kommen aus Sprachen, in denen die Nasallaute einer der folgenden Beschränkungen unterliegen: (i) Die Nasalkonsonanten sind nicht phonemisch (d.h. sie sind kontextuell vorhersagbar) oder (ii) die phonologische Opposition zwischen nasalen und oralen Vokalen ist nach Nasalkonsonanten aufgehoben, zugunsten von nasalen Vokalen.

Résumé : Des données comparatives de plusieurs familles de langues montrent l'existence de transferts de nasalité entre un groupe de consonnes en position initiale de syllabe et la voyelle qui suit. Le passage en revue des exemples décrits à ce jour est complété par une nouvelle analyse de données sino-tibétaines. De prime abord, il semblerait que ce transfert puisse s'opérer dans les deux sens : de l'attaque consonantique vers la voyelle suivante – en tai-kadai, austroasiatique, sino-tibétain, niger-congo (kwa) et indo-européen (celtique) – et de la voyelle à la consonnes précédente en sioux. L'examen des conditions d'apparition de ces changements révèle néanmoins une asymétrie. Le cas de figure le plus courant est que le transfert de nasalité s'opère de l'attaque consonantique vers la voyelle qui suit ; les cas que nous avons pu trouver d'un changement régulier dans la direction opposée proviennent tous de langues dans lesquelles les sons nasals connaissent l'une des restrictions suivantes : soit les consonnes nasales n'ont pas valeur de phonèmes (c.-à-.d. que leur apparition est

déterminée par le contexte), soit l'opposition entre voyelles orales et nasales est neutralisée après les consonnes nasales (en faveur de voyelles nasales).

Keywords: nasal onsets; nasal vowels; nasalization; consonant clusters; transphonologization; panchronic phonology; modeling of sound change

Introduction

A widely attested diachronic change is the creation of nasal vowels from nasal codas, the latter disappearing in the process. Examples are found in many unrelated languages, for instance from Proto-Romance, which did not have nasal vowels, to modern Romance languages (Sampson 1999); in French, the masculine form of "good", /bɔ̃/ (spelt *bon*), alternates with the feminine /bɔn/ *bonne*. This phenomenon figures prominently in discussions of universals of nasalization (e.g. Hajek 1997).

The historical transfer of nasality between a consonant and a following vowel is actually attested, though it is less common. For instance, the transfer of nasality from an intervocalic consonant to a following vowel – and sometimes also to a preceding vowel – is observable as a synchronic alternation in Yal: /tʰiŋi/ "shellfish, *Terebralia*" has an alternant [tʰiỹĩ], and /waŋa/ "manner, way" an alternant [wãỹã] (Ozanne-Rivierre 1995: 54; see also Ozanne-Rivierre and Rivierre 1989); the nasal consonant turns into a nasalized spirant in the process.

The present article focuses specifically on the transfer of nasality between a consonantal onset and a vowel, raising the issue whether the evolution can go in both directions: from C to V, and from V to C. Section 1 presents cases in which the transfer is from C to V. Although superficially similar, the facts in Siouan (section 2) actually reveal a reverse development: the spread of nasality in Siouan is from V to C. It thus seems as if the transfer of nasality could take place in both directions. However, the discussion (section 3) points to a structural condition on the transfer of nasality between a complex consonantal onset and a vowel: in view of the data available to us, it appears that this transfer only takes place from the onset to the following vowel – except in languages where there is one of the following restrictions on nasal sounds: (i) nasal consonants are nonphonemic (contextually predictable), or (ii) the opposition between nasal and oral vowels is neutralized after nasal consonants.

1. Vowel nasalization from a consonantal onset

This section reviews cases of vowel nasalization from a consonantal onset; in view of these well-attested cases, a similar analysis is then proposed for a set of Sino-Tibetan comparative data.

1.1. The simplification of stop+nasal *onsets in Kam-Sui (Tai-Kadai family, Southeast Asia)*

The Lakkia language (a.k.a. Lajia) provides crucial insights into the origin of nasal vowels in the Kam-Sui subgroup of Tai-Kadai. The correspondences in Table 1 point to earlier initial clusters.

Table 1. Some correspondences between Sui (dialect: Sandong 三洞) and Lakkia, after Ferlus 1996: 255.[1] Throughout the present article, bold type is used to draw attention to crucial examples.

Meaning	Sandong Sui	Lakkia	Reconstructed initial cluster
bear	ʔmui^{1}	**kũːi^{1}**	*km-
ditch	ʔmjeːŋ^{1}	**kõːŋ^{4}**	
face	ʔna^{3}	**kjɛ̃^{3}**	*kn-
maggot	ʔnun^{1}	**kjũːn^{1}**	
snow	ʔnui^{1}	**kjãi^{1}**	
thick	ʔna^{1}	**tsã^{1}**	*tn-
heavy	—	tsak^{7}	
urine	ʔniu^{5}	**kjĩːu^{5}**	*kɲ-
cold	ʔɲit^{7}	**kjĩːt^{7}**	

Sandong Sui lost the stop part of the original cluster: the *stop+nasal* clusters *km-, *kn-, *tn- and *kɲ- merged with the preglottalized *ʔm-, *ʔn- and *ʔɲ- initials. The latter are preserved in Sui, e.g. /ʔma^{1}/ "vegetables", /ʔma^{3}/ "flexible", both corresponding to a Proto-Kam-Sui * ʔm initial (Ferlus 1996: 251-252). Lakkia preserved the initial stop, while the nasal underwent lenition, nasalizing the following vowel in the process. Unexpectedly, the word "heavy" does not have a nasal vowel in Lakkia; such cases suggest that sporadic denasalizations took place after the creation of nasal vowels (Haudricourt 1967: 176).

Two Kam (a.k.a. Dong) dialects preserve forms that are very close to Lakkia – though without vowel nasalization – in the words "dog", "pig" and "flea": /kʰwa^{13}/, /kʰu^{53}/ and /kʰwat^{4}/ respectively in Sanjiang Kam (Solnit 1988a: 234). Lakkia syllables with an initial velar stop stand in a regular relation of correspondence with nasal-initial syllables in Kam and in Southwestern Tai dialects (Solnit 1988b: 232-234; Edmondson and Yang Quan 1988; Ferlus 1996: 239; on similar facts in the Kra subgroup: Ostapirat 2000).

Data from Kam and Mulao reveal another type of change: distinctive nasality can spread to a preceding consonant. In Kam, *kʰm- > /ŋw-/; in Mulao, *kʰm > /ʰŋw/ (Ferlus 1996: 239-240). This is a striking structural parallel to the correspondences between two Austroasiatic languages, Laven and Nha Heun: the *stop+nasal* initial

[1] The reconstruction concerns a hypothetical proto-Kam-Sui. The symbol / ʔ / stands for glottal constriction: see Smalley 1963: 389ff.

clusters of Laven correspond to *nasal+medial* in Nha Heun (Ferlus 1971). The evolution of medial nasals in Lakkia is summarized in Table 2.

Table 2. Evolution of medial nasals in Lakkia, after Ferlus 1996: 258.

Type of nasal consonant	Evolution in Lakkia
m	w
n	r (*further changing to* l *or* j)
ɲ	j
ŋ	j

The change found in Lakkia and Kam will be referred to below as *lenition of medials*, and the change in Sui as *loss of cluster-initial consonant*. Northern Sui dialects (Pandong 潘洞 and Yang'an 阳安) illustrate a possibility for the later evolution of *glottal+nasal* onsets: distinctive nasality is transferred onto the following vowel, and only the glottal remains, yielding [ʔṼ] or [h̰Ṽ]; the entire syllable is nasal, including the initial glottal sound (Haudricourt 1967: 176). The issue of the conditioning of the outcome of lenition (/h̰/ or /ʔ/) will be addressed in the general discussion, §3.3.2.

1.2. The simplification of **stop+nasal** *onsets in Goidelic and Breton*

The facts on vowel nasalization from an earlier TN or DN onset (where T =voiceless stop, D=voiced stop, and N=nasal consonant) are well established in the literature on Goidelic and Breton.

In some dialects of Breton, the transfer of distinctive nasality from the onset to the vowel is observed in words that are reconstructed as having initial clusters *tn- and *kn- in Proto-Breton, as pointed out by Jackson 1986: 801-803. Table 3 presents the two examples that he provides.

Table 3. Two examples of correspondences between Proto-Breton *TNV and Modern Breton TrṼ. After Jackson 1986: 801, §1142.

Meaning	Proto-Breton	Modern Breton
valley	***tnow**	*traoñ* (IPA: **/trãõ/** or /tʁãõ/) "the lower part"
nuts *(collective)*	*cnow (IPA: /***know**/)	*kraoñ* (IPA : **/krãõ/** or /kʁãõ/)

The nasal vowel in Breton /krãõ/ "nuts" cannot be ascribed to the influence of a following nasal consonant: the *-enn* suffix in the singulative form of the word, *kraoñenn*, cannot be the origin of the nasal vowel in the unsuffixed (collective) form of the word.

The change illustrated in Table 3 affected all Breton dialects except Vannetais, which stands apart from the other dialects in many respects. In Vannetais, the word for "nuts" (in the collective) is written *kanaou*. The nasal vowels resulting from this change are preserved in Léon and Cornouaille; in Tréguier, most words have

undergone denasalization since the change took place. Given the rarity of the clusters at issue in Proto-Breton, examples are scarce.

As noted by Jackson (ibid.), a striking coincidence with these Breton facts is seen in the Goidelic dialects of northern Ireland and Scotland, and in Manx, where /tn-/, /kn-/, /gn-/, and /mn-/ (a group not existing in Proto-Breton) became /tr-/, /kr-/, /gr-/ and /mr-/ with nasality of the following vowel. Table 4 provides examples from three dialects, one of which has lost nasality altogether.

Table 4. Some correspondences between Middle Irish and the Northern Irish dialect of Torr, illustrating the change from TNV and DNV to TrṼ and DrṼ, respectively. Data for the Torr dialect (and Old/Middle Irish) after Sommerfelt 1922: 154; Applecross Gaelic data (and Scottish Gaelic) after Ternes 2006.

Meaning	Middle Irish (unless otherwise specified)	Northern Irish dialect of Torr[2]	Applecross dialect of Scottish Gaelic
usual	**gná**thach	**grǣ**:(ə)χ	—
to gain	**gnó**thughadh *(from Dinneen's dictionary)*	**grõ**huw	—
complexion, countenance	**gnú**is	grũiſ (IPA: [**grũ**is])	—
grunt	**gnu**sachtach	**grũ**:saχt	—
hemp	**cná**ip	**krǣ**:b'ə	—
bone	*Old Irish* **cná**im; *Scottish* Gaelic cnàimh	**krǣ**:v	**kʰrã**:ɟ
hillock	*Scottish Gaelic* **cno**c	—	**kʰrɔ̃**xk
affair, matter	*Scottish Gaelic* **gno**thach	—	**krɔ̃**·x
a type of ball	**cna**c	**krã**g	—
skeleton	**cná**murlach	**krã**uwərLaχ	—
nut	**cnú**	**krõ**:	—
gathering	**cnu**asach	**krũ**:saχ	—
envy, jealousy	**tnú**th	**trũ**	—

Note that this phenomenon of medial lenition bears no relationship to the phenomenon known as "Celtic lenition", which results in synchronic consonantal alternations (see Martinet 1952 and Pilch 2001) that have no influence on the vowel, e.g. "sea" in Applecross is /mur/, lenited form /vur/ (Ternes 2006: 104).

[2] In the Northern Irish dialect of Torr, nasality is absent on some of the items where it would be expected: "to knock down" is /kraguw/, cp. Middle Irish *cnacad*; "heap of manure" is /krapw·y:lʹi/, cp. Middle Irish *cnap(p)*; and "button" is /krïpʹə/, cp. Middle Irish *cnaip*. This parallels observations on sporadic denasalization in Lakkia (§1.1), and has no bearing on the claims made in this article about transfers of nasality. Most dialects of Irish have lost nasality completely; this process began in the course of the 19th century and was completed by the mid-20th century.

The facts set out in the present section are close to those noted in Tai-Kadai (§1.1). However, the Tai-Kadai languages being monosyllabic, they do not provide any insights into the possible diachronic outcome of *stop+nasal* clusters in word-medial position. The Goidelic and Breton facts demonstrate that the transfer of distinctive nasality from a consonant cluster to a following vowel only takes place in the case of onsets, not in medial position within a polysyllable. The same sequences which yield TrṼ or DrṼ in initial position remain unchanged in medial position, as illustrated in Table 5. These data provide an argument for the following syllabic division: /tatʹ.Nʹuw/, /dam.Nuw/, /fʹɑm.Naχ/, and /kag.Nuw/, i.e. *stop+nasal* sequences constitute a cluster when in onset position, whereas they belong in different syllables when in medial position.

Table 5. Examples illustrating the preservation of the *stop+nasal* consonant sequences *tn, cn, mn* in word-medial position in the Northern Irish dialect of Torr. Data from Sommerfelt 1922: 39, 50.

Meaning	Middle Irish	Northern Irish dialect of Torr
to please	tai**tn**em	ta**t'N'**uw
condemnation	da**mn**ad	da**mN**uw
seaweed	fe**mn**ach	fʹɑ**mN**aχ
to chew	co**cn**am	ka**gN**uw

Appendix 1 presents additional evidence from Mon, Yao, Yi, and Tamang. The last example known to us is a change from *CVNV to CNV and finally to CṼ found in the Kwa branch of the Niger-Congo family (Hyman 1972; see also Williamson 1973). The change was under way in the Gwari language at the time when the data were collected: "For example, *kNU and *gNu are already pronounced [kŋu] and [gŋu], where the nasal release is not particularly pronounced. While I analyze both [CNV] and [CV] as /CNV/ in Gwari, the phonetic realization will depend in each case on the particular combination of C, N, and V. For example, /sNi/ is pronounced [sĩ]" (Hyman 1972: 176).

The Kwa facts, together with the Goidelic facts, contribute to a cross-linguistic model of vowel nasalization from a preceding consonant cluster by revealing that this phenomenon can involve clusters other than *stop+nasal*. This is confirmed below through the analysis of a new set of comparative data.

1.3. Vowel nasalization from a **fricative+nasal** *onset: new comparative data from Sino-Tibetan*

Fv-kho Naxi, Yongning Na and Laze are three closely related Sino-Tibetan languages (see Jacques and Michaud 2011 and references therein). They all possess nasal vowels, which look like secondary developments since nasal vowels only occur as part of /h̃Ṽ/ syllables (with some marginal cases of /ʔṼ/). This situation is exactly parallel

with cases described in §1.1 where nasal vowels are only found after a glottal onset, i.e. in /ɦṼ/ or /ʔṼ/ syllables.

The Naxi, Na and Laze data are compared here with the Japhug variety of Rgyalrong (Jacques 2004, 2008): see Table 6. Superscript letters indicate tones: L(ow), M(id), H(igh) and combinations thereof. In the syllables transcribed with nasal vowels, nasalization actually lasts throughout the syllable: [ɦĩ], [ɦỹ], etc.

Table 6. Comparative vocabulary for five words in Rgyalrong and in Naxi, Na and Laze, pointing to the diachronic development of distinctive nasality on vowel rhymes in Naxi, Na and Laze from earlier /*rN-/ onsets.

	red, 红	stand, 站	person, 人	hair (body hair), 毛	to stir-fry, 炒	two, 二
Japhug dialect of Rgyalrong (嘉绒语茶堡话)	ɣɯ**rn**i	**rm**a *("stay at s.o.'s place")*	tɯ-**rm**e	tɤ-**rm**e	**rŋ**u *(loan from Tibetan)*	ʁnɯs <*qnis
Fv-kho Naxi (峰科纳西语)	hỹ^{L}	hỹ^{LM}	hĩ^{M}	hỵ̃^{H}	—	ŋi^{LM}
Yongning Na (永宁纳语)	hỵ̃^{L}	hĩ^{MH}	hĩ^{H}	hỵ̃^{H}	hỵ̃^{M} hỵ̃^{M}	ŋi^{H}
Laze (木里水田话/拉热话)	—	hĩẽ^{H}	hĩ^{M}	hỵ̃^{L}	—	ŋi^{M}

As seen in Table 6, Rgyalrong has some initial clusters; indeed, it is the only language in this part of Sino-Tibetan that preserves a broad range of initial clusters. Rgyalrong provides more relevant evidence than Written Tibetan: taking the third word in Table 6 as an example, Written Tibetan does not have an initial cluster in the word for "person" *(mi)*, whereas Rgyalrong has /rme/.

Table 6 brings out a correspondence between the /ɦṼ/ syllables of Naxi, Na and Laze and etyma with initial /rm-/ or /rn-/ in Rgyalrong.[3] (The meaning of Rgyalrong /rma/, "to stay at someone's place", must be considered to be a development from the meaning "to stand".) On the analogy of the cases described above, we conclude that these /ɦṼ/ syllables do not simply result from rhinoglottophilia (a term coined by Matisoff 1975 to refer to "an affinity between the feature of nasality and the articulatory involvement of the glottis"), but that they originate in earlier *CNV syllables. This analysis seems almost trivial in view of the wealth of examples from various languages set out above; it nonetheless constitutes a less than trivial contribution to the study of nasal vowels in Sino-Tibetan. The hypothesis that the nasal vowels found in some Sino-Tibetan languages could be attributed to the

[3] The backdrop to this comparison is the hypothesis that there exists a Burmo-Qiangic subgroup within Sino-Tibetan, containing Lolo-Burmese and Qiangic (which includes Rgyalrong) together with the Naish languages, the latter being defined as including Naxi, Na and Laze (Jacques and Michaud 2011).

influence of syllable-initial nasals was already expressed by Huang Bufan 1991; on the other hand, no hypotheses had been proposed heretofore as to which specific sequences of phonemes were involved in the change.[4]

The last example in Table 6, "two", illustrates the preservation in Naxi, Na and Laze of nasals that originate in onsets other than /*rN-/. It appears reasonable to hypothesize that the *CN- onsets that led to vowel nasalization all went through a /*sN-/ stage; indeed, sN-initial cognates are observed in Tibetan for some of these items. (For general phonetic reflections on this topic see Ohala and Ohala 1993: 233 and references therein: "children learning English sometimes pronounce target *sm* and *sn* clusters as voiceless nasals".) Some further details on nasal vowels in Naxi are provided in Appendix 2.

As a conclusion to section 1, all observed cases of nasalization from a consonantal onset are recapitulated in Table 7. The presentation adopted in Table 7 is not intended to suggest that the transfer of nasality to the vowel in CNV sequences begins as a consequence of a consonant shift: it is in fact plausible that the vowel becomes nasalized first, e.g. (taking up the first Lakkia example in Table 7) *TmV>****TmṼ**>TwṼ.

Table 7. A recapitulation of cases of vowel nasalization from a consonantal onset. T=unvoiced stop, D=voiced stop; N=nasal consonant; V=vowel, Ṽ=nasal vowel; and C=obstruent consonant.

Lakkia	*__Tm__V > TwṼ; *__Tn__V > TrṼ; *__Tɲ__V, *__Tŋ__V > TjṼ
Breton	*__Tn__V > TrṼ
Goidelic	*__TN__V > TrṼ; *__DN__V > DrṼ; *__mn__V > mrṼ
Kwa	*CVNV > __CN__V > CṼ
Photharam Mon	__tŋ__V > n̪w̃Ṽ
Northern Sui	__ʔN__ > ʔṼ or n̪Ṽ
Naish	*__sm__V > n̪Ṽ
Miên, Yi/Lolo	*__N̥V__ > n̪Ṽ, *__NV__ > ɳ̪Ṽ
Tamang	__NV__ *in free variation with* ɳ̪Ṽ

[4] The analysis of nasal vowels as originating in initial clusters cannot be extended across-the-board to all the languages cited by Huang Bufan 1991 (Southern Nu, Namuyi, Shixing and Pumi). For instance, in Pumi (a.k.a. Prinmi) and Shixing, nasal vowels are more widespread than in the Naish languages, some of them originating in nasal codas.

2. A reverse development: the transfer of nasality from a vowel to a preceding consonant in Siouan[5]

At first blush, the same phenomenon whereby nasal vowels develop from preceding *obstruent+nasal* consonant clusters would appear to be found in Siouan languages – in virtually all subgroups. A correspondence such as Winnebago /-pãnã/ vs. Chiwere /-blã/ ("ten"; full forms: Winnebago /kerepãnã/, Chiwere /greːblã/) looks like another case of transfer of nasality from a TN- onset, suggesting a reconstruction as *-pna. (Note that the disyllabic structure observed in Winnebago is an innovation: Proto-Siouan consonant clusters are broken by the insertion of a svarabhakti vowel in Winnebago [Dorsey 1885].) It would appear reasonable to extend to such cases the argument made by Hyman 1972: 176 about Kwa: "it seems much more natural to speak of the nasality as having shifted from the consonant to the vowel, i.e. [CNV] becomes [CṼ]. The reverse (with denasalization of V) would be very strange indeed." However, advances in the reconstruction of Proto-Siouan lead to the conclusion that the change was in fact the reverse: consonant nasalization from a following nasal vowel. The word for "ten" is actually to be reconstructed as *-wrã, not *-pna.

Given the complexity of these facts, the present section is entirely devoted to their analysis. The general discussion (section 3) will then address the general issue of the modeling of the transfer of nasality between a consonantal onset and a following vowel, suggesting a link between the direction of this transfer and the phonemic status of nasal consonants.

The Siouan language family includes more than a dozen languages spread across the central and eastern parts of the United States and the prairies of Canada. There are four major subgroups, outlined below:

I. Missouri River Siouan (*Crow, Hidatsa*)

II. *Mandan*

III. Mississippi Valley Siouan

Dakotan (*Santee-Sissiton, Yankton-Yanktonais, Teton Lakhota, Assiniboine, Stoney*)

Chiwere-Winnebago (*†Ioway, †Otoe, †Missouria, Winnebago*)

[5] Amerindianist phonetic transcriptions have been converted to IPA throughout, using the tilde for nasality (/ĩ/ instead of /į/) and indicating stress before the syllable instead of by an acute accent on the stress-bearing vowel.

Dhegiha (*Omaha, Ponca, †Kansa, †Osage, †Quapaw*)

IV. Ohio Valley Siouan (*†Tutelo, †Saponi, †Moniton, †Occaneechi, †Biloxi, †Ofo*)

In this paper we will not deal with Ohio Valley Siouan as the available data were recorded over a century ago and cannot be verified. There is no reason to believe that they behaved any differently from their more westerly siblings, however.

Nasality is a distinctive feature of vowels in all but two of the sixteen or more languages. On the other hand, in some Siouan languages (certainly Mandan and probably Tutelo) nasality in consonants always depends on an environment adjacent to nasal vowels. Thus, while nasality must be considered phonemic for vowels, the same is not true for consonants. In two Siouan languages, Crow and Hidatsa, there are no longer either nasal vowels or phonemic nasal consonants; nasality has simply ceased to have a phonological role in these languages. (For reasons of space, the Crow and Hidatsa data will not be set out here, but see Graczyk 2007 and Boyle 2007.) In the other Siouan languages the synchronic situation is often mixed but, as we shall see, it is clear that nasality has been passed historically to sonorant consonants from nasal vowels.

Siouan languages typically have a five-vowel oral system with a subset of at least two and most often three nasal vowels. In most languages something close to the reconstructed Proto-Siouan system is retained. Common Siouan vowels may be either long or short. The nasal subset has either two or three members with the rounded vowel being phonetically either high or mid, depending on the language:[6]

i	u	ĩ	(ũ *or* õ)	
e	o			
a		ã		

A number of both root and inflectional morphemes in nearly every Siouan language consist solely of a nasal vowel or a nasal vowel preceded by a boundary-marking glottal stop. For example Lakhota /ʔĩ/ "wear about the shoulders", /ʔũ/ "use", "be", "wear" (three homophones); Kansa and Osage /ĩː/ "wear about the shoulders", /õː/ "be, do"; Ponca /ʔĩ/ "pack on the back", /ĩ/ "wear clothing", /-ĩ/ "an irrealis modal enclitic", /ã/ "wear as a ring" and /ã/ "do, be". There are cognates for most of these roots in most if not all Siouan languages. So nasality must be a distinctive feature of vowels in these languages, as there are no nasal consonants in the example morphemes to provide an assimilatory environment. Hollow (1970: 19ff.) presents evidence why, in a generative phonological analysis, nasal vowels in Siouan cannot be considered to result from an abstract VN sequence.

The other side of the coin is that in most Siouan languages there are no nasal consonants unless followed by a nasal segment, normally a vowel, historically (and

[6] In Mandan, Dakotan, Chiwere (Ioway and Otoe), Winnebago and Tutelo the rounded nasal vowel is usually high, [ũ], while in Dhegiha (Kansa, Osage and Quapaw), Biloxi and Ofo it is normally mid, [õ]. In the Omaha and Ponca Dhegiha dialects *õ and *ã have merged unconditionally as [õ], transcribed *ã*.

usually synchronically). In conservative languages like Mandan the nasal sonorants [n] and [m] may stand only before nasal vowels, and their oral counterparts, reflexes of *r and *w may stand only preceding oral vowels (Mixco 1997).[7] Thus in Mandan there are no phonologically nasal consonants at all; consonant nasality is always assimilated from a following vowel. There are active morpho-phonological alternations that illustrate these processes. A normally oral inflectional prefix, such as /wa-/ "1st sg. agent", nasalizes completely to [mã] if a nasal sonorant follows, as in (1) (after Hollow 1970: 22):

(1) /wa- rãte -oʔʃ/
[mã- nãte -ʔʃ]
1SG stand.up MALE DECLARATIVE
"I stand up"

This example also shows that the nasalization rule iterates from right to left. The /ã/ of /rãte/ nasalizes the preceding /r/, the resultant [n] nasalizes the preceding /a/ of /wa-/, and the resultant [ã] nasalizes the preceding /w/. Hollow (1970: 22-23) gives an example of nasal spread across multiple syllables and several morpheme boundaries. The seventh commandment as translated by a fluent Mandan speaker is provided in (2). There are vowel epenthesis and consonant cluster simplification rules at work in this verb phrase also, but they have no bearing on our topic. We adopt Hollow's analysis of the grammatical morphemes in the utterance.

(2) /ˈwa- ˈwa- ra- rũr -rĩx -rĩ -kt -oʔʃ/
[ˈmã- mã- nã- nũn ĩx -ĩ-nĩs -t -oʔʃ]
NEG_1 ABSOLUTIVE 2SG abduct NEG_2 2PL POT MALE DECLARATIVE
[mãmãnãnũnĩxĩˈnĩstoʔʃ] "Thou shalt not commit adulterery"

Additionally, a morpheme with an underlying nasal vowel and a phonetically nasalized consonant, e.g., /rũ-/, phonetically [nũ], "1st person pl." fails to nasalize the sonorant if the nasal vowel undergoes coalescence with a verb-initial oral vowel in a conjugated stem, and the necessary nasalizing environment disappears. This rule, $V_1V_2 > V_2$, is common to every Siouan language. The Mandan verb "forget" illustrates this process:

1sg		ˈi-	**wa**	**-**kihãːxik
2sg		ˈi -	**ra**	-kihãːxik-oʔʃ
3sg		ˈi -		-kihãːxik-oʔʃ
1pl	**r-**	ˈiː-		-kihãːxik-oʔʃ

[7] In most published Dakota and Lakhota dictionaries the nasalization diacritic on vowels is omitted following an *m* or *n*. This, of course, is just the opposite of the historical direction of nasalization.

Note that, while first and second person agent prefixes are found between the instrumentive prefix, /i-/, and the verb root, the first plural prefix always precedes instrumentive and most other prefixes. This is an idiosyncrasy of most other Siouan languages also. In this paradigm /rũ-/ "1st pl.", normally [nũ], appears in its oral allomorph, [r-], because the /ũ/ is typically lost preceding an oral vowel, [riː- < nũ+i-]. This is further evidence that the underlying state of the sonorant consonant in [nũ-] "1st pl." is the non-nasal /r/.

The nearly pan-Siouan rule that emerges from the many examples of this sort is shown in (3). In Mandan this rule might be phrased as a constraint on entire syllables, but in most Siouan languages there are exceptions that will cause the rule to be phrased as it is here.

(3) [+sonorant] > [+nasal] / __[+nasal]

Mandan, with its productive rule of iterative leftward nasal spread, must be quite close to the original Proto-Siouan state of affairs. Most of the other Siouan languages show this same rule to be more or less applicable. In the Mississippi Valley Siouan languages, including Lakhota/Dakota, Ioway-Otoe, Winnebago, Omaha-Ponca, Kansa, Osage and Quapaw, there is clear evidence for the rule, though there are exceptions in each language introduced in particular phonological environments and also in derivational morphemes that have been recently affixed to stems. These latter cases show that the Siouan nasalization rule, although formerly completely regular, has ceased to spread across morpheme boundaries in some innovated constructions.

There are also at least some exceptions to the above rule in the widely-spoken Dakotan languages due to dialect mixture and/or denasalization of certain vowels. These factors have introduced an opposition between nasal and non-nasal sonorants in most of the languages. Thus in Lakhota (Ullrich 2008), the Teton dialect of Dakotan, we find such sets as /mã/ "look!" (women's speech), /mã-/ "1sg. patient" and /wã/ "arrow"; /mĩ/ "mine, my", /wĩ/ "female" and /wi/ "sun, moon".

Two of these instances, /wĩ/ "female" and /wã/ "arrow", illustrate a special set of circumstances that require comment. These morphemes are reflexes of Proto-Siouan lexemes in which the sonorant+nasal vowel sequences were followed by /h/. There are several other such cases. In precisely these cases *j, *w and at least once *r preceding a nasal vowel fail to nasalize in Lakhota and often in Winnebago and Osage, as shown in Table 8.

Table 8. Examples where sonorants fail to nasalize preceding a nasal vowel + /h/.

Meaning	Proto-Siouan	Lakhota	Winnebago	Osage	Kansa
arrow, chert	*ˈwãːhe	ˈwã	ˈmãː	ˈmãː	ˈmãː
back, spine	*i-ˈrãːhe	ʧʰãˈkʰahu	nãːˈke	nãhˈka	nãkˈka
buy	*ˈwĩhe	—	ruˈwĩ	ðywĩ	jyˈmĩ
swim, paddle	*i-ˈwãhe	nũˈwã (niˈwã)	nĩːˈwã	nĩmã	nĩˈmã
shiver, shake	*jãˈjãːhe	ʧʰãˈʧʰã	—	ʒãʒã	ʒãʒã
female	*wĩhe	ˈwĩjã	-wĩ	-wĩ	-mĩ

There is an apparent exception: "breathe" is *ˈrĩː-ha(-he) in Proto-Siouan, /nĩˈja/ in Lakhota, /nĩːˈha/ in Winnebago, /ˈnĩ/ in Osage and /ˈnĩ/ in Kansa. Note also that the lack of nasal spread when the nasal vowel is followed by *h seems to be rather regular; we do not have an explanation for this observation.

As in Mandan, the Mississippi Valley Siouan subgroup also shows right-to-left iteration of the nasalization rule for sonorants, at least to a degree, but usually affecting only the immediately preceding phoneme. In Dakotan dialects iteration extends somewhat farther. Table 9 shows the correspondences for sonorant clusters preceding a nasal vowel.

Table 9. Examples illustrating leftward nasal spread in the correspondences resulting from Proto-Mississippi Valley Siouan (MVS) *wr clusters preceding a historically nasal vowel. Data are from the *Comparative Siouan Dictionary*, hereafter CSD (Carter, Wesley Jones et al. in preparation).

Meaning	Lakhota (Ullrich 2008)	Quapaw (Rankin 1972)	Osage (Rankin 1980; Quintero 2004)	Kansa (Rankin 1974-78)	Proto-MVS (CSD)
satisfied, enough	ˈi**mn**ã	—	i**br**ã	—	*ˈiː**wr**ã
smell	ˈ**mn**ã	ˈ**bn**ã	ˈ**br**ã	ˈ**bl**ã	***wr**ã
three	ˈja**mn**ĩ	ˈdaː**bn**ĩ	ˈðaː**br**ĩ	ˈja**bl**ĩ	*ˈraː**wr**ĩ
ten	wikˈʧe**mn**ã	kˈdeː**bn**ĩ	ˈleː**br**ã	ˈleː**bl**ã	*ˈkjeː**wr**ã
turn	-**mn**ĩ	ˈ**bn**ĩ	ˈ**br**ĩ	ˈ**bl**ĩ	*-ˈ**wr**ĩ
warped, twisted	peˈ**mn**ĩ	ˈbe**bn**ĩ	ðyˈpe**br**ĩ	be**bl**ĩ	*-**wr**ĩ
spread out to dry	ˈ**mn**ĩ	ˈaːka**bn**ĩ "cover"	—	**bl**ĩ	*-**wr**ĩ

Osage /ˈbraːska/, Lakhota /blaska/, Kansa /ˈblaːska/, Omaha-Ponca /ˈbðaːska/ and Quapaw /ˈbdaːska/ "flat" illustrate the oral outcome of the Proto-Siouan *wr- cluster. Other *stop+rṼ and *stop+wṼ clusters are affected in Siouan languages. Reflexes of these are presented in Table 10. Note that Lakhota /g/ cannot function as a sonorant obstruent the way that /b/ and /d/ in Table 9 do because all instances of Lakhota /g/ go back to the Proto-Siouan obstruent *k and have a very different distribution overall, whereas Lakhota /b/ goes back to *w, and /l/ goes back to *r, both sonorants. In the D-dialects of Dakota, Proto-Siouan *r has the oral reflex /d/, which also functions as a sonorant even though it is phonetically an obstruent. In some Siouan languages, e.g., Crow and Hidatsa, [w, b, m] are all allophones of /w/ and [r, l, d, n] are allophones of /r/. For a more thorough discussion of *sonorant obstruents*, see Rice 1993; we believe that the Siouan data presented in this paper substantially support her conclusions.

Clusters involving velar obstruents followed by /r/ appear to resist nasalization preceding nasal vowels in most, but not all, Siouan languages. These include *kr and *xr clusters, but not *sr or *ʃr clusters, both of which nasalize, sometimes even spontaneously. There do not seem to be any Proto-Siouan *pr or *tr clusters, nor *obstruent+w* clusters. Therefore there are no native nasalized *obstruent+m* outputs from the nasalization rule, although a few instances of Algonquian borrowings with /kwṼ/ yield Lakhota /gm/ and Chiwere /dw/, see discussion of "squash", below. Most Lakhota /gm/ clusters lack Proto-Siouan etymologies.

Table 10. Obstruent + sonorant clusters in several Siouan languages.

Meaning	Lakhota (Ullrich 2008)	Quapaw, (Rankin 1972)	Osage (Rankin 1980; Quintero 2004)	Kansa (Rankin 1974-78)	Proto-MVS (CSD)
cold	ˈ**sn**i	**sn**ĩ	nĩ	**hn**ĩ	*s**r**ĩ
habitually	**ʃn**ã	-ˈ**hn**ã	nã	-ˈ**hn**ã	*ʃ**r**ã
dive	kiˈ**gn**ũka	—	ˈlãke	ˈlãge	*ˈ**kr**ũke
revile	iˈ**gn**ũ	ˈ**kn**õ	ˈlõː	ˈlõː	*ˈ**kr**ũ
strike sparks, fry, burn	-**xn**ĩ	ˈ**xn**ĩ	ˈ**xl**ĩː	ˈ**xl**ĩː	*ˈ**xr**ĩː
migrate	—	kaˈ**xn**ã	kaˈ**xl**ãː, kaaˈlãː	gaˈ**xl**ã	*kaˈ**xr**ãː
bobcat *(loan)*[8]	iˈ**gm**ũ	—	iˈlõka	iˈlõga	*iˈ**tm**ũ (?)

Although earlier generations of Siouanists (Wolff 1950: 175, Matthews 1958, 1970: 107) reconstructed the superficial *bl, *br, *pr or *mn clusters in Proto-Siouan for

[8] This term for "bobcat" has look-alikes all across eastern North America including both Iroquoian languages and Tunica. It is probably unwise to posit a proto-Mississippi Valley Siouan reconstruction for the term even though there are at least some apparent cognates. The prototype for the terms apparently had a /tr/ or a /tw/ cluster however, and this is the closest we get to a /tr/ cluster in Siouan.

cognate sets such as those presented above, a more careful examination of the grammars of the Siouan languages enables us to correct these earlier reconstructions. Although all of the Mississippi Valley Siouan languages share the initial /b/ or /m/ of these clusters, it is important to consider the morphological source of these consonants in the proto-language. All of these instances of /b/ and /m/ have a source in one of two Proto-Siouan prefixes, either /wa-/ "inanimate classifier" or /wi-/ "animate classifier", thus the initial member of virtually all of the /bl/, /br/, /bn/, /bð/, and /mn/ clusters in the several languages goes back to Proto-Siouan *w (with regular syncope of the old initial syllable vowel). Understanding of the earlier morphology of these words reinforces our conclusion that nasalization has progressively been assimilated from right to left. The *wr clusters failed to assimilate nasalization in Osage and Kansa, partially assimilated it in Quapaw, and underwent complete nasalization in Lakhota.

Synchronic morpho-phonological examples also exist to illustrate iterative nasal assimilation in Lakhota. In Dakotan languages, we find nasalizing morphemes such as /-ktA/ "potential mode". (The reason for the peculiar nasalizing nature of this morpheme lies in the fact that an additional element has been lost in Dakotan. The missing /-ĩ/ "irrealis" is preserved in Omaha and Ponca. The entire construct in preserved in Winnebago where the potential mode marker is /-ĩkʤe/.) The synchronic effect of these morphemes on a preceding syllable coincides precisely with the diachronic change postulated in the *Comparative Siouan Dictionary*. In verb phrases stem-final oral vowels nasalize when followed by /-ktA/, and sonorants preceding these vowels also become nasalized, as in example (4):

(4) /b-le/ [ble] "I go" + /kte/ "potential mode" → [ˈmnĩ̃kte] "I will/would go" (Rankin, Boyle et al. 2003).

Our analysis receives additional support from the treatment of borrowings, e.g. the word for "squash, pumpkin", Lakhota /waˈgmũ/, Chiwere /waːˈdwã/, Winnebago /wiʧãˈwã/, which according to the *Comparative Siouan Dictionary* is borrowed from the Algonquian word for "squash" (Proto-Algonquian *eːmehkwaːni), apparently from a language where final *i had dropped, such as Menomini /ɛːmɛkwan/. The Chiwere/Winnebago forms have to be explained by supposing a dissimilation: *kwan > *kwã > *twã, while the Lakhota form would result from assimilation: *kwan > *kwã > *kwũ > *kmũ [gmũ]. "Cat" is another diffused term that provides an *obstruent+w* cluster, although the source language is hard to identify in this case (see Table 10 and accompanying footnote). The interested reader is referred to Appendix 4 for further details about nasality in Dakotan and newly formed nasal consonants in Ponca.

Summary of the Siouan facts

We will not discuss here other phenomena pertaining to nasalization in Siouan, such as the nasalization of syllable-final stops in modern Lakhota, and the absence of any phonological feature of nasality in Crow and Hidatsa: those fall outside the scope of the present article. To summarize the facts presented above: we have seen that in the

Siouan language family the spread of nasality from vowels to consonants and from consonants to vowels has taken place differently at different times in different subgroups and languages:

Period 1: Early Siouan, probably around 3,000 years B.P. (Rankin 2006). The pattern was right-to-left nasalization: a sonorant preceding a nasal vowel was affected if it was not preceded by another consonant and if the nasal vowel was not followed by /h/. This change affected all Siouan languages.

Period 2: Nasalization spread to preceding sonorants in consonant clusters when the initial member of a cluster was /s/ or /ʃ/ but not /k/ or /x/. This change affected all Mississippi Valley Siouan languages and Mandan, e.g. MVS *snĩ "cold", Mandan /ʃnĩ/.

Period 3: Nasal assimilation extended to clusters of *velar* + **r*. The change /kr, xr/ > /kn, xn/ preceding a nasal vowel took place in Mandan, Dakotan and Quapaw separately, since these three languages do not form a subgroup together. Iteration extended to both members of *wr clusters preceding a nasal vowel in Dakotan and Mandan, again separately. Iteration stopped at cluster boundaries in Dakotan but proceeded leftward in Mandan until an obstruent or word boundary was reached, Dakotan /ˈjamnĩ/, Mandan /nãːmĩnĩ/ "three" (note vowel epenthesis), both from *ˈraːwrĩ, from a single nasal vowel in word-final position.

Period 4: MVS borrowings of "bow" and "beans" (see Tables 14 and 15 in Appendix 4), between the fifth and tenth centuries, included left to right nasalization of vowels following a nasal consonant, i.e., oral vowels following a nasal consonant in the source languages were interpreted by Siouan speakers as nasal vowels (this is structurally similar to the situation observed in Maxacalí: see Wetzels 2009).

Period 5: After the relatively recent breakup of common Dhegiha Siouan into Omaha-Ponca, Kansa, Osage and Quapaw, Omaha and Ponca developed new /m/ and /n/ from older, apparently oral sonorant clusters. These new nasal consonants can appear preceding oral vowels, e.g., /ˈme/ "spring" (the season), /ppaˈmu/ "down hill", /nu/ "man", /ˈnegi/ "mother's brother", /ˈneːʒe/ "urine" (Shea and Williams 2009; other examples are found in Table 13 of Appendix 4). As these examples show, the new nasals are not restricted to appearing preceding the peripheral vowels /ĩ/, /ã/ and /õ ~ ũ/. In Dakotan and most other Siouan languages /e/ and /o/ raise to /ĩ/ and /ũ/ when they assimilate nasalization.

Period 6, very recently: Modern Ponca extends nasalization from the new /m/ and /n/ to following /i/ or /a/. It is notable that this nasalization only affects the two vowels that can normally be nasal vowels in Ponca. Reflexes of the two mid vowels, /e/ and /o/, remain oral (Omaha and Ponca /u/ is the regular reflex of Proto-Siouan *o).

3. General discussion

3.1. Theoretical background: The search for panchronic laws of sound change

The method applied in the case studies presented above is none other than the classical method of historical phonology. However, beyond case studies, one of the goals of comparative linguistics is to assemble data that lead to an inventory of the common types of sound change and to an improved understanding of the conditions under which they occur; it appears useful to clarify how we aim to contribute to that inventory and understanding. We will present our theoretical backdrop, Panchronic Phonology, through a brief discussion of Evolutionary Phonology and structural approaches to diachronic phonology.

Evolutionary Phonology, building on Ohala 1989, considers phonetic variation as the primary source of phonological change (Blevins 2004, Blevins and Wedel 2009; see also Smith and Salmons 2008). This emphasis on the phonetic bases of change encourages a continuous dialogue between experimental phonetics and historical phonology which is definitely profitable to both. However, the role played by phonetic factors may be slightly overestimated by this approach. Let us take nasality as an example. The temporal extension of nasality typically exceeds the duration of one single segment in ordinary speaking style: from a phonetic point of view, nasality tends to spill over neighboring segments. Velum lowering tends to be anticipated, and nasal airflow tends to extend beyond the nasal segment. The aerodynamic study of the variability of nasal sounds in spontaneous speech brings out numerous cases of anticipation and carryover of nasal airflow, including an overwhelming proportion of cases of nasal carryover in NV sequences (Basset, Amelot et al. 2001 on French). There is no reason to think that nasal consonants were any less phonetically variable in the past history of the Romance languages; however, despite the considerable potential for change revealed by phonetic studies, initial nasals are stable throughout their recorded history.

Hypothesized universals of language change based on phonetic properties seldom stand close scrutiny. Let us take as an example the hypothesis that distinctive nasalization develops preferentially in the context of low vowels (see Hombert 1986: 360 and references therein). A survey shows that low vowels are preferentially nasalized in some languages, and high vowels in others (Hajek and Maeda 2000). There exist competing phonetic tendencies; they do not have explanatory or predictive power when it comes to individual cases (Labov 1994: 601; see also the critical assessment of Evolutionary Phonology by Andersen 2006: 168-171). Clearly, the existence of a pool of phonetic variation is only part of the thoroughly complex story of diachronic sound change.

Structural approaches to diachrony study the way in which phonological systems respond to the causes of change (see in particular Martinet 2005). A major source of change is the constant competition between the tendency towards phonological integration and the tendency towards phonetic simplicity. Phonological economy

tends to fill structural gaps in phonological systems, and phonetic economy tends to create phonological gaps. A simple example can be drawn from phonemic inventories: having a contrastive nasal counterpart to each oral vowel is phonologically economical (as the feature of nasality is used to the greatest possible extent) but phonetically uneconomical, because the distinction between a large number of nasal vowels is perceptually difficult (see Appendix 3 for a brief review of phonetic facts).

Out of the pool of potential changes, the actual direction of evolution observed in a given language depends in part on the state of its phonological system, e.g. – again taking nasality as an example – which nasal phonemes it possesses (among consonants and vowels), which phonotactic constraints they are subject to, and what functional load they have in the system.[9] For instance, the change from /m/ to /m͡b/ and finally to /b/ is found only in languages that have distinctive nasal vowels: a NV-vs.-NṼ opposition may evolve to N͡DV-vs.-NṼ and then to DV-vs.-NṼ, e.g. /na/ vs. /nã/ changing to /n͡da/ vs. /nã/ (and eventually /da/ vs. /nã/). The insertion of an oral stop blocks the propagation of nasality from N onto the following vowel, a propagation which would threaten the opposition between NV and NṼ (Haudricourt 1970); this has been described as "perceptual reinforcement of the orality of a neighboring vowel" (Hyman 1975: 256, 259; on the creation of contour consonants out of nasal ones, see Wetzels 2008, 2010).[10]

The recognition of the relevance of structural facts to phonological change has a bearing on long-term research perspectives, such as the elaboration of a database of sound changes. From a structural perspective, such a database should contain detailed information on the state of the phonological system before and after each sound change, including an inventory of phonemes and quantified information on their functional load, as well as a phonotactic description. What is needed is an approach that attempts to formulate generalizations about sound change that are independent of any particular language or language group. Haudricourt (1940, 1973) labels such an approach Panchronic Phonology (see also Hagège and Haudricourt 1978). Panchronic laws are obtained by induction from a typological survey of precise diachronic events whose analysis brings out their common conditions of appearance. In turn, they can be used to shed light on individual historical situations. Let us consider two examples of panchronic regularities. The first is from Haudricourt's programmatic 1940 article: there is a potential for the change from word-initial /st-/ to V(owel)+/st-/ when the following four conditions are met: (i) initial /st-/ is not significantly more frequent than V+/st-/; (ii) V+/st/ is allowed in word-final position;

[9] We hasten to add that the emphasis on structural factors by no means implies a lack of interest in social factors (as studied by Labov 2001), from language contact (e.g. Weinreich 1953, Trudgill 1986) down to the level of individual, stylistic choices (Fónagy 1983, 2001).

[10] This phenomenon of diachronic transphonologization (restructuring of a system) is to be distinguished from cases of synchronic variation, as reported e.g. in Central Rotokas (Firchow and Firchow 1969; see also Robinson 2006) and Pirahã (Everett 1986), which have neither nasal consonants nor nasal vowels in their extremely small inventory of phonemes.

(iii) there is no word-initial stress; (iv) if the word where the change is to occur has N syllables, words with N+1 syllables must be allowed in the language. The second example is the modeling of the transphonologization of the voicing opposition among initial consonants (Haudricourt 1965, Ferlus 1979). After evolving into an opposition between phonation types on the following vowel (breathy voice vs. modal voice), this opposition becomes tonal if the language already had tones (creating a split in the tone system); otherwise it becomes a vowel quality opposition, creating a two-way split in the vowel system. This model is verified in numerous East and Southeast Asian languages; it has recently been applied to the reconstruction of Old Chinese, supplementing the model to include oppositions between single and geminate onsets as another diachronic source for phonation-type register oppositions (Ferlus 2009).

We adopt the term 'panchronic' to describe our approach because we consider that the explicit research program defined by Haudricourt holds promise of an increasing degree of precision and explicitness in modeling historical change. The aims and methods of many researchers in historical phonology are actually close to this program. (For a detailed epistemological discussion, see Mazaudon and Michailovsky 2007.) Labov's generalization that "In chain shifts, peripheral vowels become more open and nonperipheral vowels become less open" (1994: 601) can be considered as a panchronic statement, as can several of the generalizations about nasal states and nasal processes proposed by Hyman 1975: they aim to explain synchronic states in terms of the processes that lead up to them, and to arrive at general laws of sound change. We believe that, in practice, these common goals are more important than theoretical differences.[11] From the data and analyses in sections 1 and 2, practitioners of Panchronic Phonology, Evolutionary Phonology or other approaches to historical phonology would draw essentially the same conclusions – to which we now proceed.

3.2. Conditions on the transfer of nasality from a vowel to a preceding consonant

The case studies presented in this paper show that the transfer of nasality between a complex consonantal onset and a vowel can take place in both directions – from C to V, but also from V to C. This implies that, given a correspondence such as (C)NV :: (C)CṼ between two languages (where C stands for a non-nasal consonant), one cannot immediately assume that (C)NV is more conservative. The possibility that nasality could come from the vowel has to be considered.

[11] Here is an example of a seemingly irreducible theoretical difference which is in fact of little consequence. In Evolutionary Phonology, phonological categories are considered to belong to a universal grammar (Blevins 2004: 55), whereas under a structural-functional approach such as Panchronic Phonology, phonological categories are considered to be shaped by the set of relations within the language's system, and by usage, and are thus 'emergent' in the sense of Bybee 2001. In practice, however, the notion of emergence arguably plays a more prominent role than universally-defined categories in research conducted in the framework of Evolutionary Phonology.

However, it appears possible to determine the direction of evolution on the basis of the combinatorial properties of nasal sounds in the languages at issue. The hypothesis that we propose in light of the history of nasality in Siouan is that the change CṼ > NṼ only occurs in languages without an opposition between NV and NṼ. This offers a means of discriminating between three scenarios (1a, 1b, and 2) which are illustrated by Breton, Sino-Tibetan and Siouan, respectively.

Scenario 1a: both languages have nasal vowels and oppositions between NV and NṼ syllables. The proto-language likewise had nasal vowels and an opposition between NV and NṼ syllables.

	language 1	language 2	proto-language
Correspondences	(C)NV	(C)RṼ	*(C)NV
	CṼ	CṼ	*CṼ
	NṼ	NṼ	*NṼ
	NV	NV	*NV

Scenario 1b: nasal vowels are absent from one of the two languages, and highly restricted in the other. The proto-language did not have nasal vowels.

	language 1	language 2	proto-language
Correspondences	(C)NV	(C)RṼ	*(C)NV
	CV	CV	*CV
	NV	NV	*NV

Scenario 2: neither of the two languages has an NV-vs.-NṼ opposition (except marginally: in loans, in expressive words, or in morphologically restricted contexts). The proto-language lacked NV-vs.-NṼ oppositions, or lacked nasal consonants altogether.

	language 1	language 2	proto-language
Correspondences	CV	CV	*CV
	CṼ	NṼ	*CṼ
	NṼ ~ NV	NṼ	*NṼ

Under the most extreme version of scenario 2, the proto-language lacks contrastive nasal consonants altogether. This should be viewed as an extreme along a

continuum, not as one of two terms within a binary opposition.[12] Languages without phonemic nasal consonants all have synchronic rules of consonant nasalization from a neighboring nasal vowel in the first place. The statement that a language does not have phonemic nasal consonants is an abstract one: "A vowel system can be contrastive for nasality only if there are output nasal consonants" (Hyman 2008: 101). The transfer of distinctiveness from a nasal vowel to a preceding consonant is structurally easy in such a system; the existence of simple paths towards the emergence of nasal consonants as distinct phonemes (as illustrated by some Siouan languages) goes some way towards explaining why languages with nasal vowel phonemes and without nasal consonant phonemes are fairly rare: only sixteen are listed in the UPSID database (Maddieson 1984).[13]

A less extreme version of scenario 2 involves languages with nasal consonants but without NV-vs.-NṼ oppositions. This situation is illustrated by Lakhota: recall from example (4) in section 2 that nasalization spreads regressively in stem-final position within a verb phrase. While the regressive spread of phonological nasality in Lakhota does neutralize some contrasts between CṼ and NṼ, its consequences remain limited because Lakhota does not contrast e.g. /mĩ/ and /mi/. Other examples include the Hare dialect of Slave (Athabaskan family), where the phonemes analyzed as /m/ and /n/ denasalize in front of oral vowels, except for three prefixes (Rice 1989: 60-61). This results in the quasi-absence of /NV/ sequences (where V is an oral vowel), at least in the surface forms. Given such a configuration, the field of allophonic phonetic dispersion of /NṼ/ sequences can safely range into the empty phonetic slot, viz. *nasal consonant+oral vowel* (Rice 1989: 148).[14]

The hypothesis underlying the distinction between scenarios 1a-b and 2 can be formulated as follows: the change CṼ > NṼ can only take place after the neutralization of nasality oppositions in nasal-initial syllables, NV and NṼ. (A brief phonetic discussion of this topic is proposed in section 3 of Appendix 3.) This means

[12] A special configuration is that of languages where the domain of nasality is the morpheme. All the examples known to us are from Native American languages: see Gomez-Imbert 1980, Peng 2000, Rose 2008, Wetzels 2009 and Epps 2008: 86 (which presents some comparative reflections on this topic) on Amazonian languages, Harms 1985 on Epena Pedee (Choco family, Colombia) and Marlett 1992 on Mixtec. Cayuvava, an extinct language of Bolivia, also appears to belong to this type, as far as one may judge from the description by Key 1961. In addition to Key's observation of a pervasive tendency "for nasalization to spread over some of the adjacent segments" (p. 147), there are two structural arguments: (i) the language has [k] but neither [g] nor [ŋ], as predicted by the hypothesis that nasals and voiced stops are allophones; and (ii) any oral vowel has a nasal counterpart, which is unusual in languages where nasality is a feature of segments (see Appendix 3).

[13] The case of Ikwere is especially well-documented (Clements and Osu 2005); see also the cross-language discussions of nasal harmony by Piggott 1997, Walker 1998, and Clements and Osu 2003. A limitation of statistics based on UPSID or similar databases is that there exist several options for the interpretation of the phoneme system of languages that have no opposition between voiced stops and nasal consonants, especially in languages of the Americas.

[14] Other examples of this type include Yoruba (as analyzed by Pulleyblank 1988: 258-259), which has CV, CṼ, NṼ but no NV.

that, in a language that contrasts /b/ and /m/, and /a/ and /ã/, a confusion between /bã/ and /mã/ could only take place after the confusion of /mã/ with /ma/. The confusion of CṼ and NṼ would entail large-scale lexical confusions; such a change, though not impossible, can be predicted to require highly specific conditions, such as intense language contact. Note that this generalization concerns regular phonetic change, not morphosyntactically conditioned alternations, which can constitute special cases.

Needless to say, this empirical generalization, based on the languages that we were able to take into account, needs to be verified (and refined) in light of the greatest possible number of attested cases of nasalization.

3.3. Conditions on the transfer of nasality from a complex consonantal onset to a following vowel

This last part of the discussion recapitulates some structural observations about the processes studied in section 1.

3.3.1. Two paths of lenition of *obstruent+nasal* initial clusters

When an *obstruent+nasal* onset simplifies, either the initial obstruent or the medial nasal can undergo lenition. This phenomenon of lenition tends to affect all the *obstruent+obstruent* and *obstruent+nasal* clusters in the language.

Two pathways of lenition can be distinguished.

Process 1: lenition of medial nasal. If lenition affects medials, /m/ and /ŋ/ change to /w/, and /n/ changes to /r/ (itself often turning to /l/ or /j/ in a later evolution), distinctive nasality being transferred either to the following vowel or to the preceding obstruent.

Process 2: lenition of cluster-initial C. The lenition of the initial consonant in a CN cluster results in the creation of devoiced nasals.[15] It can be followed by (i) the transfer of distinctive nasality from the consonant to the following vowel, yielding /hṼ/, or (ii) by a merger of devoiced nasals with voiced nasals, as in English. *Stop+nasal* initial clusters in English are only found in rare loanwords such as *tmesis, Pnyx* and *Pnom Penh*. Middle English /kn-/ and /gn-/ simplified to /n-/ in most dialects (there were no /km-/, /kŋ-/, /gm-/ or /gŋ-/ clusters); *know* is homophonous with *no* /nəʊ/, *gnat* with *Nat* /næt/, etc. Dialectal evidence suggests that the change

[15] While this process of lenition is the most common origin of voiceless nasals, there also exists a second trajectory leading to voiceless nasals. In Siouan, nasalization goes in the opposite direction: Kansa /hnĩ/ [n̥nĩ] < /snĩ/ < *srĩ "cold". (The actual articulation in Kansa is a voiceless nasal – the air is expelled through the nose.) The conditioning of the direction of change lies in the phonotactic restrictions on nasal sounds, as discussed in §3.2. Interestingly, fricative-plus-/r/ sequences (*sr, *ʃr + Ṽ) are the clusters that nasalize most consistently in Siouan. No Siouan language has a non-nasal reflex of *r after /s, ʃ/ and preceding a nasal vowel. As noted in section 2, the *xrṼ cluster is different, and often fails to nasalize the /r/. Data on more languages will be necessary to analyze the difference in evolutionary potential between these two types of clusters.

was either /kn/ > /kn̥/ > /tn̥/ > /n̥/ > /n/ or, more directly, /kn/ > /kn̥/ > /n̥/ > /n/ (Jespersen 1928:352).

Returning to the lenition of the initial consonant in a CN cluster, some differences are expected for *fricative (or trill)+nasal* and for *stop+nasal*. In the former case, the outcome is expected to be a devoiced nasal (sometimes called 'preaspirated nasal'). In the latter case, the outcome of lenition appears to depend on the type of C-to-N transition, as explained below.

3.3.2. The phonetic transition from oral obstruent to nasal and the outcome of lenition: /h/ or /ʔ/

The lenition of *obstruent+nasal* initial clusters as illustrated by the Sui language (§1.1) yields ᴳN, where ᴳ stands for a glottal articulation: either an unvoiced fricative /ʰ/ or a glottal constriction /ˀ/, so that ᴳN means either of {ʰN, ˀN}. What are the factors conditioning one or the other type of glottal articulation? Both developments are attested across languages – indeed, sometimes within the same language – so that neither of the two treatments can be considered exceptional.

A hypothesis based on suggestions by Michel Ferlus and Larry Hyman (p.c.) is that the direction of evolution (towards either aspiration /ʰ/ or constriction /ˀ/) is determined by the timing of the gestures for the obstruent and the nasal, in particular the timing of the onset of voicing. There can be a voiceless interval between the release of the initial obstruent and the oral closure for the nasal, causing the initial obstruent to become slightly aspirated phonetically (phonetic approximation: [CʰN], where C stands for an obstruent); or the transition between the obstruent and the nasal can be voiced (phonetic approximation: [CN] or [CᵊN]). These two types of transitions can be viewed as two extremes along a continuum of voice onset time (on this notion, see Lisker and Abramson 1964 and Cho and Ladefoged 1999). The two types are not expected to contrast with each other: at any given time, a given language has one type of transition. If the language has an unvoiced transition at the stage when the lenition of the initial occurs, the result is /ʰN/. If it has a voiced transition (shorter voice onset time), the result is /ˀN/ – an evolution which is reminiscent of the cross-linguistically common change from a voiceless stop coda to a glottal stop. Under this hypothesis, the presence of both /hṼ/ and /ʔṼ/ in the same language implies that the two sets developed at different times.

Support for the hypothesis of the existence of two types of transitions, and for the possibility of a rapid diachronic change from the one to the other, comes from Old Khmer. The initial clusters transcribed as T+N (*km-*, for instance) in pre-Angkorian Khmer inscriptions are transcribed as Tʰ+N (for example: *kʰm-*) by the stage of Angkorian Khmer; a likely interpretation is that the phonetic articulation of these T+N clusters was 'schwa-like' at the former stage, and 'fricative-like' at the latter. This phonetic evolution is reflected in the transcriptions because the authors of the transcriptions based themselves on Sanskrit, which has both unaspirated stops and

unvoiced aspirated stops: they chose the symbols that corresponded most closely to the phonetic realizations in Khmer.

Conclusion

From the point of view of specific language groups, the above developments make a contribution to the study of nasality in Siouan and in a subgroup of Sino-Tibetan.

From the point of view of general models of sound change, they suggest an answer to the initial research issue, namely whether transfers of nasality between a consonant and a following vowel could work from C to V and from V to C. There are quite a few well-attested cases of nasalization of a vowel from a preceding cluster containing a nasal; the nasalization of a consonantal onset from a following nasal vowel is less frequent. Our interpretation of these changes is based on considerations of distributional constraints on nasal phonemes and of their functional load. Structural gaps in a system create a potential for transphonologization. In languages without phonemic nasal consonants, /CṼ/ > [NṼ] is a ubiquitous synchronic rule. In languages that have phonemic nasal consonants but no oppositions between /NṼ/ and /NV/, the change from /CṼ/ to /NṼ/, despite resulting in the neutralization of some oppositions, is not unheard of; however, it is usually restricted to specific morphological contexts. Finally, no case of spreading of distinctive nasality from a vowel to a preceding consonant has been found so far in languages that have an opposition between /NṼ/ and /NV/.

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Appendix 1. Data from Mon, Yao, Yi, and Tamang.

The Kam-Sui facts (§1.1) illustrated several aspects of the processes under study; Goidelic and Breton data (§1.2) provided additional insights concerning phonotactic restrictions on these processes, showing that they only take place in word-initial position. The present Appendix presents additional evidence from all the other languages where comparable developments are reported: Mon, Yao, Yi, and Tamang.

1. From dental stop+nasal *cluster to nasal rhyme in Mon (Austroasiatic family)*

Literary Mon and Middle Mon possess complex initials composed of an obstruent followed by a nasal, e.g. "day" *tṅay* (approximation in IPA: /tŋaj/). In modern dialects, the obstruent part has generally disappeared without compensation: "day" is /ŋoa/ in Modern Mon (Shorto 1962: 90). However, the reflex /n̰õa/ is observed in a Mon dialect of the East bank of the Meklong (Province of Rajburi, District of Photharam, Thailand; personal communication from Christian Bauer, who collected data on this dialect in 1978 from an informant aged over 70). The diachronic change leading up to /n̰õa/ can be hypothesized to be the following: (i) the obstruent in /tŋaj/ devoiced the nasal, yielding /ʰn̰oa/; (ii) distinctive nasalization was transferred onto the vowel while the initial simplified to /n̰/. Note that the entire syllable is phonetically nasal: the change from /ʰn̰oa/ to /n̰õa/ consists simply in the loss of the oral closure for the initial /ŋ/ (Christian Bauer, p.c.).

2. From nasal consonant to glottal fricative+nasal vowel: n̥V > /hṼ/, NV > /ɦṼ/

The evolution from a phonologically voiceless nasal to /h/ with nasalization of the following vowel is not uncommon. Some cases are observed in the Miên (a.k.a. Yao) group of languages (Michel Ferlus, p.c.). Data from the Nosu and Phunoi languages (Yi-Burmese; Sino-Tibetan) lead David Bradley to reconstruct a historical change from a devoiced nasal consonant / n̥ / to /h/, by loss of the oral closure, followed by the loss of nasality (Bradley 1979: 150, 265). Synchronic variation can sometimes be observed between ʰNV and hṼ: in the Sandong dialect of Sui, "dog", /ʰmɑ^{1}/, can be realized either [ʰmɑ^{1}] or [hwã^{1}] (Wei and Edmondson 2008: 592).

A related phenomenon is observed in Tamang (Sino-Tibetan; Martine Mazaudon, p.c.): on words carrying tone 4, initial /ŋ/ freely alternates with a voiced glottal fricative /ɦ/, in which case the entire syllable is nasalized. There exist only two words of this phonemic composition: "to call" /^{4}ŋot-pa/ (sometimes realized as [^{4}ŋot-pa], sometimes as [^{4}ɦõt-pa]), and "to sleep" /^{4}ŋu-pa/ ([^{4}ŋu-pa]~[^{4}ɦũ-pa]). This is not an instance of nasal devoicing: following the merger of the voiced and unvoiced series of initials, which resulted in the present-day system of four tones (1 and 2 in the High series, 3 and 4 in the Low series), there is no voicing opposition on initials in Tamang. The synchronic alternation at issue may have to do with the general laxness accompanying tone 4, which is realized with whispery phonation and with some

allophonic variation of the initial consonant (Mazaudon 1973; for experimental evidence, see Mazaudon and Michaud 2008).

This synchronic alternation between /NV/ and /ɦṼ/ in Tamang contributes to a general model of the transfer of nasality to a following vowel: it shows that the presence of a preceding obstruent is not a necessary condition on the transfer of nasality from a consonant to a following vowel. The consonantal onset involved can be either a cluster or a single nasal consonant.

Appendix 2. Additional information about nasal vowels in Naxi

Comparison across dialects of Naxi reveals a tendency for vowel nasality to become lost altogether: for instance, the variety of Naxi spoken in the town of Lijiang, which is officially considered as the standard variety (He Jiren and Jiang Zhuyi 1985: 130), lacks nasal vowels altogether. Interestingly, the lexical distinctions at issue are partly preserved in some dialects that have lost nasal vowels: a transfer of distinctiveness back to the initial consonant has taken place. Table 11 sets out correspondences between the Naxi dialects spoken in the villages of Fv-kho and A-sher, and in the city of Lijiang (a.k.a. Dayanzhen).

Table 11. Correspondences between the Naxi dialects of Fv-kho, A-sher, and Lijiang City, illustrating the loss of nasal vowels in A-sher and Lijiang City, and the transformation of the opposition attested as /hỹ/-vs.-/hy/ in Fv-kho into an opposition between /hy/ and /ɕy/ in A-sher.

	red, 红	tired, 累	person, 人	paddy, 稻子	body hair, 毛	saw, 锯
Fv-kho Naxi (峰科)	h**ỹ** ^{L}	hy ^{L}	h**ĩ** ^{M}	hi ^{M}	h**ỵ̃** ^{H}	hy̩ ^{L}
A-sher Naxi (金山文化村)	hy ^{L}	ɕy ^{L}	hi ^{M}		hy̩ ^{M}	
Lijiang City Naxi (大研镇)	hy ^{L}		hi ^{M}		hy̩ ^{M}	

These correspondences shed light on the marginal phonemic contrast between initial /ɕ/ and /h/ in Lijiang Naxi, an opposition which is only found in front of /y/, e.g. /hy ^{L}/ "red" vs. /ɕy ^{L}/ "tired, disheartened". Table 11 illustrates the correspondence between /hy/ in A-sher Naxi and /hỹ/ in Fv-kho Naxi; as for A-sher Naxi /ɕy/, it corresponds to Fv-kho Naxi /hy/. Thus, while nasal vowels have entirely disappeared in A-sher Naxi, some of the lexical distinctions that relied on the feature of nasality have been preserved by a further transfer of distinctiveness – back to the initial consonant. (A brief discussion of the phonetic bases of this change is proposed in Michaud 2006: 28-29.) In the case of rhymes /i/ and /ɥ/, the opposition is lost altogether.

The functional yield of the nasal-vs.-oral opposition over vowels appears to play a role in the evolution of the system: nasality over vowels is subject to sporadic loss in languages where its functional yield is low. This is evidenced by the complete lost of nasality in Lijiang Naxi, and by the sporadic denasalization observed in Lakkia.

Aramaic can be considered as an example where vowel nasalization failed to become phonemic – or soon disappeared without leaving any traces – in the course of the simplification of *Cn- initial clusters: Proto-Semitic *n becomes Aramaic *r* when it is the second element of an initial consonant cluster, without leaving any nasality on the vowel (Testen 1985); the absence of nasal vowels either in Aramaic or in neighboring languages with which it was in contact probably played a role in the complete loss of the feature of nasality in this process. Breton (§1.2) illustrates the opposite situation: it can safely be hypothesized that nasal vowels already existed before new nasal vowels were introduced, resulting in a relatively higher functional yield of nasal vowels, which probably contributed to their preservation.

Appendix 3. Brief review of some phonetic facts about nasal sounds

1. Why nasal vowels tend to be fewer in number than oral vowels

The formant structure of nasal vowels is unlike that of oral vowels: coupling with the nasal cavity introduces poles and zeroes, with the result that formant bandwidth in nasal vowels cannot be deducted from formant frequency (Vaissière 2007). This acoustic characteristic, while it efficiently sets nasal vowels apart from oral vowels, makes it more difficult to distinguish between nasal vowels than between oral vowels. Nasality makes a vowel's exact height difficult to perceive; it has the acoustic-perceptual effect of lowering non-low vowels and raising low vowels, resulting in a smaller vowel space than for oral vowels (see the results reported by Ohala 1975: 294, 302, and the review by Kingston 2007: 417-417). This sheds light on the typological observation that phonemic nasal vowels tend to be fewer in number than oral vowels.

2. Phonetic observations on **obstruent+nasal** *initial clusters*

From an articulatory point of view, there is a conflict between obstruents and nasals, which goes a long way towards explaining the evolutionary potential of CN- initial clusters, as well as the synchronic fact that, in systems with nasality harmony, a phoneme's resistance to nasalization corresponds to its position along an obstruence scale (Clements and Osu 2003). Obstruents require a high intra-oral pressure, whereas intra-oral pressure drops as soon as the velic valve opens: "an open velic valve bleeds buccal obstruency and its concomitant turbulence" (Ohala and Ohala 1993: 228; see also Shosted 2006 and Solé 2007). The low intra-oral pressure for nasals, which is an articulatory consequence of the open velic valve, is an articulatory requirement for the realization of voicing; fricatives are antagonistic with voicing, since the former require a high intra-oral pressure to create friction, and the latter a low intra-oral pressure creating a drop of pressure across the glottis (Ohala 1975: 295, Ohala and Ohala 1993: 227). The conflict may be resolved at the expense of the voicing of the nasal consonant: there is thus a pressure, in *fricative+nasal* sequences, (i) for nasals to

become devoiced, and (ii) for fricatives to become continuants of the type that Martinet (1981, 1985) calls 'spirants'.

Since nasality is barely perceptible over unvoiced segments, the devoicing of (the first part of) the nasal will tend to lead to vowel nasalization as a contextual variant,[16] paving the way for a possible transphonologization, creating distinctive nasal vowels (see, again, Ohala 1975).

From a perceptual point of view, among CN- sequences, *nasal+nasal* and *stop+nasal* in initial position are less robust perceptually than *fricative+nasal*. This is because information on the place of articulation is present throughout a fricative (friction noise being continuous) whereas the place of articulation of stops is mostly evidenced through their burst, which can be compromised by a following nasal (if the opening of the velic port is anticipated). *Nasal+nasal* sequences are not problematic from an articulatory point of view but are perceptually fragile: the cues to the place of articulation of an initial nasal are mainly found in the formant transitions into the following segment; if that segment is not a vowel, the cues are difficult to retrieve from the acoustic signal.

3. Why a confusion between /bã/ *and* /mã/ *would happen only after a confusion of* /mã/ *and* /ma/

In section 3.2 (“Conditions on the transfer of nasality from a vowel to a preceding consonant”), we hypothesize that a confusion between /bã/ and /mã/ may only happen after a confusion of /mã/ and /ma/. This calls for some comments, insofar as it could seem surprising that the vocalic opposition (that between /a/ and /ã/ in /ma/ and /mã/) is more confusable than the consonantal opposition.[17] However, the opposition between a nasal vowel and an oral vowel is fragile in the context of nasal consonants. Conversely, the difference between an oral obstruent and a nasal stop is acoustically strong. The hypothesis therefore appears to have a reasonable phonetic basis.

Appendix 4. Additional data on nasality in Siouan.

1. Nasalization in Dakotan

The modern details of nasalization in Dakotan are complex. There has been extensive contact among speakers of different dialects, and with speakers of English and

[16] If this statement appeared teleological ("vowel nasality develops *in order to* avoid lexical confusions"), it could easily be replaced by a non-teleological formulation in the spirit of Labov (2001: 21): the following vowel tends to become nasalized for purely phonetic reasons of timing of velar movements; productions in which nasality is weakest would have a greater tendency to be misunderstood than those with stronger nasalization. As a result the mean number of tokens in the materials to which the learner is exposed would be shifted in the direction of greater nasalization, and the field of dispersion of the phoneme would expand in that direction. (See also Martinet 2005: 2-3, 123.)

[17] This paragraph is based on comments by Rachel Walker (p.c. 2011).

French. There has been a certain amount of spontaneous denasalization of vowels following nasal consonants, but determination of exactly what environments are involved will require considerable dialectological fieldwork. The situation is complicated by the fact that many dictionary authors have simply chosen not to mark nasalization on vowels following an *m* or *n* in their practical orthographies. At least one set of exceptions is reported by Rood and Taylor 1996 (§2.2.1), who assert that a marginal opposition between nasal and oral vowels after nasal consonants exists in some varieties of Dakotan languages: "Speakers who have phonemic contrast after nasal consonants probably continue an earlier pattern in the language whereby there was full phonemic contrast in oral and nasal vowels after nasal consonants. That this is not an idiosyncratic feature of some persons' speech is shown by their agreement with speakers of other Sioux dialects such as Nakoda, where full contrast is found after nasal consonants." Table 12 provides examples.

Table 12. Three minimal pairs establishing the presence of a contrast between oral and nasal vowels after nasal consonants in Lakhota, after Rood and Taylor 1996 (§2.2.1).

nasalized vowel		oral vowel	
mãˈka	"I sit"	**ma**ˈka	"skunk"
ˈ**gmũ**za	"slimy"	ˈ**gmu**za	"closed, as the fist"
nĩˈjã	"cause to live"	**ni**ˈja	"to breathe"

However, David Rood (p.c. 2009) mentions that the Lakhota speaker who served as a language consultant was influenced by the Nakhota variety, in which Proto-Mississippi Valley Siouan **Hr* becomes /n/ instead of /l/. In Nakoda (Yankton-Yanktonais), a genuine constrast exists between oral and nasal vowel after /n/, but it is clearly secondary. Thus, the minimal pairs in Table 12 do not actually contradict our analysis of Proto-Siouan nasalization.

2. *Newly formed nasal consonants and subsequent* NV > NṼ *in modern Ponca*

In the Omaha and Ponca languages certain Proto-Siouan primary or secondary sonorant clusters have spontaneously nasalized reflexes. These innovated /nV/ and /mV/ sequences in Omaha and Ponca, where the following vowels are oral, have introduced nasal consonants into the language that were never followed by nasal vowels. This fact was noted by James Owen Dorsey, a linguist for the Bureau of American Ethnology who worked among the speakers of Dhegiha Siouan languages in the 1880s and 1890s. It was also noted in Omaha by John Koontz (p.c.) in the 1980s. But in modern Ponca recordings made in 2008 and 2009 (Kathy Shea, p.c.), the historically oral peripheral vowels /i/, /a/, and /u/ following the innovated nasals have, in fact, nasalized. So while nasality has historically involved assimilation leftward from a nasal vowel, modern Ponca (as opposed to Omaha) shows nasal assimilation in the opposite direction, from left to right. Lakhota and Kansa cognates are included in

Table 13 for reference. Note that the non-peripheral oral *e* of "lake" maintains its non-nasal status; only peripheral vowels in Siouan have nasal counterparts.

Table 13. Peripheral oral vowels after neo-nasals nasalize only in modern Ponca.

Meaning	Proto-Siouan (CSD)	Lakhota (Ullrich 2008)	Kansa (Rankin 1974-78)	Omaha (Dorsey 1890)	Ponca (Shea and Williams 2009)
	w_r or ***Hr***				
male	*wiˈro:ka	ˈbloka	ˈ**do**:ga	ˈ**nu**:ga	ˈ**nũ**:ga
ripe	*ˈHru:te[18]	ˈluta	ˈ**ʤy**:ʤe	ˈ**ni**:de	ˈ**nĩ**:de
beg	*Hˈrahe	ˈla	ˈ**da**	waˈ**na**	waˈ**nã**
by heat	*aˈHra:-	—	ˈ**da**:-	ˈ**na**:-	ˈ**nã**:-
lake	*waˈHre	ˈble ~ ˈmde	ˈʤe	ˈne	ˈne
	w_w or ***w?***				
blood	*waˈʔi(re)	ˈwe	waˈ**bĩ**	waˈ**mi**	wa**mĩ**
boat	*ˈHwa:te	ˈ**wa**ta	**ba**:ˈʤe	**ma**:ˈde	**mã**:ˈde
cottonwood	*waˈwa:xʔe	ˈ**wa**ɣa	ˈ**ba**:kʔa	ˈ**ma**:ʔa	ˈ**mã**:ʔa
hail	*ˈHwa:su	**wa**ˈsu	ˈ**bo**:sy	ˈ**ma**:si	ˈ**mã**:si

Although recent developments in Omaha and Ponca allow sequences of (neo) nasal consonants followed by oral vowels (with subsequent vowel nasalization in Ponca), such was not always the case. The terms for "bow" and "beans" in Mississippi Valley Siouan languages illuminate yet another chapter in the convoluted history of nasal spread in Siouan.

Bow. All of the MVS "bow" terms are borrowings from Algonquian languages (with possible intermediate transmission via other Siouan languages), as shown in Table 14. In the donor languages all of the terms begin with a nasal, /m/, followed by an oral vowel, yet in the recipient languages the terms all have nasal vowels following the initial /m/. So at the time these terms were borrowed, probably around the sixth century A.D., nasalization, at least in the MVS languages, spread from right to left in native vocabulary but could also spread from left to right, as it does in these borrowings. The date ranges for the borrowing of "bow" and "beans" come from archaeological evidence. The bow first appears in the Mississippi Valley between the 4th and 6th centuries A.D., while beans are imported from Mexico into the Mississippi

[18] The *H in these reconstructions, *Hr and *Hw, represents a proto phoneme of unknown quality. Since all of the cases in which the identity of the initial member of the cluster is transparent involve sonorant+/r/ or sonorant+/w/, e.g. /**w**iˈ**r**o:ka/ "male", /**w**aˈ**w**axʔe/ "cottonwood" (with syncope of initial syllable vowels in Mississippi Valley Siouan resulting in a /ww-/ cluster), we believe that *H was probably a sonorant glide, either *h or *ʔ, but there is little to no direct evidence for a specific identity for this phoneme in this Siouan version of "laryngeal theory".

Valley around the 11th century. The Algonquian source for "bow" was first noted by John Koontz (1986).

Table 14. BOW. Terms borrowed from neighboring Algonquian languages.

Language	Form	Comments
Lakhota	iˈtazipa	Pre-Lakhota *(m)iˈta (+ zipa "shoot")
Dakota	mitanazipa	"my bow"
Winnebago	mãːʧˈgu	Proto-Winnebago-Chiwere *ˈmãːtku
Chiwere	ˈmãːhdu	From a prototype like *mætku
Omaha	ˈmãde	From a prototype like *mæte
Ponca	ˈmãde	From a prototype like *mæte
Kansa	ˈmĩʤe	From a prototype like *mite
Osage	ˈmĩtse	From a prototype like *mite
Quapaw	ˈmãtte	From a prototype like *mæte
Tutelo	ˈmĩkte	"Gun". From a prototype like *mitke

According to Aubin 1975 the term is reconstructible as Proto-Algonquian **me'tekwa* "animate wood". Although the Siouan terms look a lot alike, no proto term is reconstructible to Proto-Mississippi Valley Siouan. Rather, it appears that the terms were borrowed in slightly different forms from different Algonquian languages, and it is difficult to determine which Algonquian dialects contributed them. The Chiwere/Winnebago (and Tutelo) terms, with their internally reconstructible /tk/ consonant cluster (with regular metathesis) and rounded vowel, look most like Miami /mitäkopa/ or Menominee /mæʔtekuap/ (Rankin 2006).

Dakota and Lakhota only borrowed the first two syllables of the Algonquian term, but then lost the initial consonant when speakers apparently interpreted /miˈta/ "bow" as a possessed form (/miˈtʰa-/ marks certain first person singular possessed nouns). The Dhegiha languages also show reflexes of only the first two Algonquian syllables, so identifying the donor language is difficult. In addition, Omaha, Ponca and Quapaw have /mã-/ as an initial syllable, perhaps from a language like Menomini with an initial /mæ-/. Osage and Kansa, with initial /mĩ-/, share a term from a source language with initial /mi-/, perhaps one of the Illinois Algonquian dialects. Except for Dakotan, the entire initial syllable of these terms is nasalized throughout MVS.

Beans. "Bean" is another borrowed term in which one or more vowels have nasalized following a nasal consonant. Beans appear in the archaeological record in about the eleventh century. Geographically contiguous Siouan languages have very similar terms for "bean". The words have irregularities, however, that suggest that the term diffused within Siouan and had its origins elsewhere. John Koontz (p.c.) has found

similar-looking terms for "bean" in several Uto-Aztecan languages spoken from the Rockies and Great Basin southward into Meso-america.

The similar Siouan terms appear to be tri-morphemic historically. The initial morpheme had the prototype /hũːˑ/ (meaning unknown). It is separable on the grounds that it is distinct from the middle section of the word that has analogs in Yuman and Uto-Aztecan languages and also on the grounds that it occurs without that middle section in Chiwere. The suffix, /-ke/, is a common Siouan derivational suffix.

The middle section of the term has the prototype /mVni/ or some similar sequence of labial and dental sonorants with nasality. It is this portion that coincides with a cluster of Uto-Aztecan (and Yuman) language terms for "bean" (Miller 1967: 107). What is important here is that the vowels in the Uto-Aztecan (and Yuman) prototypes are oral, but the vowels assimilated into Siouan have nasalized. This nasalization has to have its origin in the original preceding consonant(s). Beyond this, little can be said about the precise source of the loan or its diffusion across Siouan. Each Siouan language has assimilated the vowel and preceding consonant cluster according to the pattern prevailing in that language. Compare, in Table 15, the middle portion of the following Siouan terms with the various Uto-Aztecan terms that follow.

Table 15. BEAN(S) in Siouan, and in Uto-Aztecan (unrelated to Siouan).

Siouan	
Mandan	ˈoːˑ-mĩnĩ-ke (phonemically ˈoːwrĩke in modern Mandan)
Lakhota	o- ˈmni-ʧa
Winnebago	hũːˑ- ˈnĩ-k
Chiwere	ũ-ˈɲũ -ge
	ˈũ- -ŋe
Omaha	hĩ- ˈbðĩ-ge
Ponca	hĩ- ˈbðĩ-ge
Kansa	hõ- ˈblĩ-ge
Osage	hõ- ˈbrĩ-ke
Quapaw	hõ- ˈbnĩ-ke

Uto-Aztecan	
Mayo/Sonora	muːni
Mayo/Sinaloa	ˈmuːni-m
Guarijío	muˈni
O'odham	muːni
Hopi	mo ri
S. Paiute	muːtiː
Huichol	ˈmuːme
Cora	ˈmuhme