Nasal harmony in Hoocąk and Mandan*

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Abstract: This paper lays out the conditions in which nasal harmony occurs in both languages. Hoocąk and Mandan share a common set of natural impediments to the spread of nasal harmony: supralaryngeal stops and mid vowels. Nasal harmony spreads unidirectionally until it meets one of these two blocking elements. The major distinction between these two languages is that nasal harmony is progressive in Hoocąk and regressive in Mandan. The difference between how Hoocąk and Mandan handle nasal harmony is not restricted to merely in which direction nasal harmony moves, but also onto which kinds of sonorants it may move. Previous research on Hoocąk, including Garvin & Hartmann (n.d.), Helmbrecht & Lehmann (2006), and Lipkind (1945) among others, has touched on the boundaries of nasal harmony, but has not detailed the specific morphophonological environments in which it occurs. Likewise, Hollow's (1970) account of regressive nasal harmony in Mandan is insufficient to account for the many instances where nasal harmony is expected to occur, but is absent.

Keywords: Hoocąk, Mandan, morphology-phonology interface, nasal assimilation, nasal harmony

1. Introduction

Rankin et al. (1998:366) reconstruct a phonological system of Proto-Siouan that features nasal vowels but no nasal consonants. All modern Siouan languages have surface nasal consonants due to the assimilation of nasal features from a following nasal vowel, as seen in Table 1.

Table 1: Reconstruction of Proto-Siouan *awąą(-re) 'bird > game bird, turkey'

Proto-Siouan	*awąą(-re)	'bird > game bird, turkey'
Hidatsa	wáaraa (idáakubee)	'dove' ['dove' + 'owl']
Mandan	mą́ąre(k)	'large bird'
Chiwere	(waayį́k'ų́ų)mą	'bird's nest'
Hoocąk	mąą	'nest'
Quapaw	mą	'crow'
Biloxi	mą́ąni	'turkey'
Ofo	amą́	'turkey'
Tutelo	mąné (asą́)	'duck, goose'

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Across the board, the underlying nasal vowel *ą in the stem above causes nasal assimilation of the preceding *w in all modern languages, except for Missouri Valley languages like Hidatsa, where nasal vowels merged with oral vowels and all nasalization is absent on vowels. However, in some languages, like Biloxi and Tutelo, the reflex of the *r in the stem augment *-re also assimilates the nasal feature of the adjacent nasal vowel. That is to say, it seems that the historical nasal harmony we observe in Proto-Siouan may not be as clearly delineated as described in Rankin et al. (1998:370).

What is not clear in the literature is whether the emergence of surface nasal consonants happened once over the development of various daughter languages from Proto-Siouan or whether there are have been multiple instances where nasal consonants have become reanalyzed as an underlying phoneme rather than a nasalized allophone. Furthermore, research into how languages synchronically handle nasal assimilation is quite limited. This paper offers a remedy to this by looking at nasal assimilation in two Siouan languages: Hoocąk and Mandan.

In §2, we examine some typological characteristics of nasal harmony in other languages. This overview helps to contextualize the kinds of nasal harmony we witness in Hoocąk and Mandan in §3. Section §4 describes the conditions under which nasal harmony occurs in both languages and some differences between them. In §5, we discuss the data and show that both share a common feature in Siouan to universally turn *r into [n] before a nasal vowel but that Mandan extends this process to universally converting *w to [m] while Hoocąk does not. We then conclude with some general observations about nasal harmony in Siouan in general and potential avenues of future research.

2. Typological characteristics of nasal harmony

Nasal harmony involves vowel-consonant harmony where one segment assimilates nasal features from another, either from vowel to consonant or from consonant to vowel (Rose & Walker 2011:245). We can divide harmonies into two categories. If the [+nasal] feature is spread from left to right, it is referred to as **progressive** harmony, while spreading the [+nasal] feature from right to left is **regressive** harmony.

This consonant to vowel harmony is a productive feature in the South American language Warao. In this instance of progressive nasal harmony, a nasal consonant will spread [+nasal] across superlaryngeal voiced segments (i.e., vowels and glides but also including /h/). We can see this behavior in (1a) through (1d).

(1) Progressive nasal harmony in Warao (Osborn 1966:111-112)

a.	/moau/	→	[mõãũ]	‘give it to him!’
b.	/nao/	→	[nãõ]	‘come!’
c.	/inawaha/	→	[inãwãɦã]	‘summer’
d.	/mojo/	→	[mõjõ]	‘cormorant’
e.	/naote/	→	[nãõte]	‘he will come’
f.	/mehokohi/	→	[mẽɦõkohi]	‘shadow’
g.	/panapana hae/	→	[panãpanã ɦãẽ]	‘it is a porpoise’

This **long-distance** (or **non-local**) nasal harmony takes place across syllable and word boundaries, so long as the phonetic conditions exist to permit its spread in Warao. This progres-

sive nasal harmony can take place beyond what is immediately adjacent to the original nasal, permitting the [+nasal] feature to be spread rightward until coming into contact with a voiceless superlaryngeal obstruent. This pattern appears in (1e) through (1g), where nasal harmony moves rightward until abutting against a voiceless stop. In (1g), we see nasality spread across a word boundary from /panapana/ 'porpoise' onto the following word, the copular /hae/, creating nasalized segments on the verb despite its own lack of underlying nasal segments.

While English does not have phonemic nasal vowels, we do have a kind of regressive nasal harmony in the form of anticipatory nasal assimilation. In the English examples below in (2), an underlying nasal consonant triggers nasal harmony with a preceding vowel. This process is **strictly local**: i.e., its effects are restricted to immediately adjacent segments. This behavior is evidence in (2a) through (2f). This nasal harmony likewise is blocked by any intervening non-vocalic segments between the vowel and nasal, as we see in (2g), where the /ɹ/ blocks the spread of nasal harmony onto the preceding vowel, even though there is a nasal element present in the coda of that syllable. Nasality is also localized to the domain of the syllable, as (2h) shows two individual nasal segments, /m n/, where only the /n/ triggers nasal harmony because it is tautosyllabic with the vowel /ɑ/ and has no intervening segments. Even though the /ə/ precedes a nasal consonant, it does not because nasalized because it does not share a syllable with /m/.

(2) Regressive nasal harmony in English (using General American English pronunciations)

a.	/dʒæm/	→	[dʒæ̃m]	'jam'
b.	/ɹum/	→	[ɹũm]	'room'
c.	/stɪnt/	→	[stĩnt]	'stint'
d.	/sʌn/	→	[sʌ̃n]	'sun'
e.	/bɑnd/	→	[bɑ̃nd]	'bond'
f.	/sɔŋ/	→	[sɔ̃ŋ]	'song'
g.	/ɑɹm/	→	[ɑɹm], *[ɑ̃ɹ̃m]	'arm'
h.	/kəmɑn/	→	[kʰəˈmɑ̃n], *[kʰə̃ˈmɑ̃n]	'c'mon!'

Languages have a variety of ways to handle blocking mechanisms for nasal harmony (Walker 2011:1838). In addition to contrasting regressive and progressive nasal harmonies, there is another kind of nasal harmony. **Bidirectional** nasal harmony occurs when a language simultaneously has possessive and regressive harmony, causing the [+nasal] feature to spread both leftward and rightward in a word.

The Applecross variety of Scottish Gaelic is one example of a language that features simultaneous regressive and progressive nasal harmonies. In this variety, nasal harmony is blocked by oral stops but not oral fricatives. We can see this behavior below.

(3) Bidirectional nasal harmony in Applecross Scottish Gaelic (Ternes 1973:134-135)

a.	/frĩa·v/	→	[fr̃ĩã·ṽ]	'roots'
b.	/ʃɛ̃nɛ·var/	→	[ʃɛ̃nɛ̃·ṽãr̃]	'grandmother'
c.	/ʟãːj/	→	[ʟ̃ãːj̃]	'hand'
d.	/ãhuç/	→	[ãh̃ũç̃]	'neck'
e.	/sŋã·nʲdʲan/	→	[s̃ŋã·nʲdʲan]	'thread'
f.	/tʰãhusk/	→	[tʰãh̃ũs̃k]	'fool'
g.	/strãi·ɣ/	→	[str̃ãĩ·ɣ̃]	'string'
h.	/kʰɔ̃ispaxk/	→	[kʰɔ̃ĩs̃paxk]	'wasp'

In (3a) through (3d), we can see that the bidirectional nasal harmony has spread from the underlying nasal vowel to both word edges. In (3e), we see the regressive harmony continue all the way to the left edge of the word, but rightward spread has been blocked by the /dʲ/. Likewise, the bidirectional spread in (3f) and (3h) is blocked at the edges of the word by voiceless stops, while (3g) sees its progressive nasal harmony make it to the right edge of the word, but is blocked in its regressive path by a voiceless oral stop.

In the languages heretofore discussed, each kind of nasal harmony has worked uniformly, even a language like Scottish Gaelic with bidirectional nasal harmony. Nasal harmony in both directions have the same blocking conditions and spreading conditions. This uniformity is not universally required of nasal harmony systems, however. The Tupian language Guaraní of South America features nasal harmony. This phenomenon in Guaraní has generated a large amount of descriptive literature (Gregores & Suárez 1967; Rivas 1975; Walker 1999, 2011; Rose & Walker 2011, Thomas 2014, *inter alios*).

In this literature two patterns emerge. First, Guaraní features iterative regressive nasal harmony before prenasalized consonants. Second, underlying nasal vowels spread the [+nasal] feature onto voiced segments (i.e., vowels, glides, and voiced obstruents) bidirectionally. The only blocking mechanism observed is an oral vowel bearing primary stress. A nasal vowel bearing primary stress still participates in nasal harmony. Secondary stress does not block nasal harmony.

The data below demonstrates the behavior of the first of these two types of nasal harmony: nasal harmony involving prenasalized consonants.

(4) Guaraní regressive nasal triggered by prenasalized consonant

a.	/ᵐbeⁿdaˈre/	→	[mẽⁿdaˈre]	‘widow(er)’	(G & S 1967:69)
b.	/ⁿdereˈᵐbe/	→	[nẽr̃ẽˈᵐbe]	‘your lips’	(G & S 1967:69)
c.	/gʷeˈᵐbe/	→	[ŋʷẽˈᵐbe]	‘type of plant’	(Thomas 2014:81)
d.	/tataeˈⁿdɨ/	→	[tãtãẽˈⁿdɨ]	‘lamp’	(Thomas 2014:81)
e.	/araˈⁿdu/	→	[ʔãr̃ãˈⁿdu]	‘knowledge’	(Thomas 2014:81)

In each of the examples in (4) a prenasalized consonant triggers leftward nasal harmony, causing vowels and approximants to become nasalized and voiced consonants to acquire a nasal place of articulation. Nasality is restricted to phonological material to the left of the prenasalized consonant. Underlying prenasalized consonants involved in this nasal harmony become fully nasal, though the original prenasalized consonant does not.

The second type of nasal harmony, which is bidirectional, originates from an underlying nasal vowel and then spreads towards both edges of a word. Examples of this process appear below.

(5) Guaraní bidirectional nasal harmony triggered by nasal vowel

a.	/iᵈjaˌkãraˈku/	→	[ʔĩɲãˌkãr̃ãˈku]	‘is hot-headed’	(G & S 1967:69)
b.	/ɕeˌkʷãɣʷaˈsu/	→	[ɕẽˌkʷãɣ̃ʷãˈsu]	‘my thumb’	(G & S 1967:69)
c.	/ⁿdo-roi-ⁿduˈpã-i/	→	[nõr̃õĩnũˈpãĩ]	‘I don’t beat you’	(Rivas 1975)
d.	/paɨˈrã/	→	[pãɨ̃ˌr̃ã]	‘to tinge’	(Thomas 2014:78)
e.	/oro-maˈʔẽ/	→	[õr̃õmãˈʔẽ]	‘I watch you’	(Thomas 2014:84)

In (5a) through (KL5c), we see a nasal vowel near the center of the word trigger the spread of nasality. In (5a) and (5b), specifically, we see the spread of the [+nasal] feature blocked by an

oral vowel bearing primary stress. In the remaining examples, the primary stress is on a nasal vowel, which them emanates to both edges of the word given the lack of blocking conditions.

Rose & Walker (2011) note in their discussion of the typology of harmony systems that bidirectional harmony can have different blocking conditions for different directions. Certainly, it appears that such systems might really be just separate nasal harmonies, similar to the two described above in (4) and (5): the prenasal consonant regressive nasal harmony is blocked from moving rightwards by the prenasalized consonat of origin; nasalization can move from right to left, but never left to right. The same is not true for the nasal harmony caused by underlying nasal vowels, where the only blocking mechanism is an oral vowel in a syllable bearing primary stress. Both nasal harmonies are non-local, and are able to spread very far from their original nasal-triggering segment, as seen in the example below. Nasal harmony is emphasized in bold.

(6) Long-distance nasal harmony in Guaraní

[la	ɕeraˈʔɨ	**ʔĩŋ̃ã̤kãxãˈtã**	**ĩtẽˈ**rei	la	eˈkʷela pe]
/la	ɕe-raʔɨ	iᵈj-akã-hatã	iterei	la	ekʷela pe/
the	1-child(of.father)	3-head-a.lot	just.too	the	school to

‘my child (father speaking) is just too stubborn at school’ (Gregores & Suárez 1967:69)

The word ‘be stubborn’ is a compound that contains two underlying nasal vowels. Either of these vowels could be generating the bidirectional harmony, which envelops the whole word. To the right, the progressive nasal harmony continues until it encounters a blocking element: i.e., a syllable with an oral vowel that bears primary stress. No nasality spreads regressively from ‘stubborn’ due to the fact that ‘my child’ ends in a stressed oral vowel, thus preventing any nasalization. In Guaraní, not only does nasal harmony take place within the domain of a word, but it can move past word boundaries until some featural element impedes it.

The various systems of nasal harmony that appear above in Guaraní, Scottish Gaelic, English, and Warao all serve to highlight an important fact about nasal harmony: there is no singular kind of nasal harmony. Each language has a different approach, and some languages employ multiple approaches unto themselves. This section serves to provide an overview of the many ways nasal harmony can function in other languages, and to contextualize how nasal harmony in Hoocąk and Mandan fit within the typology.

3. Nasal harmony in Hoocąk and Mandan

3.1. Previous work on nasality in Siouan

With the exception of Missouri Valley languages (i.e., Hidatsa and Crow), all Siouan languages have nasal vowels (Parks & Rankin 2001:103). Repeatedly throughout Rankin et al. (2015), we can see that surface nasal consonants in modern languages can be reconstructed back to a *r and *w following nasal vowel. Diachronically, some kind of regressive local nasal harmony must have taken place in order for these sonorants to become nasals: e.g., PSi *wątho ‘bear’ > pre-Proto-Mississippi Valley |w̃ãtʰo| > Proto-Mississippi Valley **mątho > Lakota *matȟó* [maˈtˣo].

Michaud et al. (2012:209) note that several other Siouan languages have some form of nasal harmony. This observation points to the fact that nasal harmony is also a synchronic phenomenon in Siouan and is not just relegated to the historical development of these languages.

The vast majority of phonetic studies on nasality in a Siouan language has involved Lakota, as it has a large speaker pool from which to draw data. James (1983:6-7) gives the following examples of nasal spread in Lakota:

(7) Nasality in Lakota

a.	*lowáŋ*	'sing'	/lɔwã/	→	[l̃ɔ̃.ˈw̃ə]
b.	*lená*[1]	'these'	/lɛna/	→	[l̃ɛ̃.ˈnə̃]
c.	*akáŋl*	'on top'	/akãl/	→	[a.ˈkə̃l̃]
d.	*nážiŋ*	'stand'	/ˈnaʒĩ/	→	[ˈnə̃.ʒ̃ĩ]

All of the data in (7) involves nasality spreading bidirectionally from its source. Scarborough et al. (2015) do not find such a prolific pattern of nasal harmony, showing instead a pattern of coarticulation with carryover nasality being more noteworthy than anticipatory coarticulation.

To date, no comprehensive study of nasal harmony across the Siouan language family has been done. This paper represents the first look at nasality as a synchronic phenomenon in a Siouan language that is not Lakota. The content below describes the systems of nasal harmony for both Hoocąk and Mandan.

3.2. Hoocąk nasal harmony

Prior research on the phonology of Hoocąk, including Garvin & Hartmann (n.d.), Helmbrecht & Lehmann (2006, 2010), and Lipkind (1945), among others, has touched on the boundaries of nasal harmony. The harmony is progressive and affects vowels /a/, /i/, and /u/, as well as the consonant /r/. The vowels are nasalized when they occur after another nasal vowel or nasal consonant (/m/ or /n/), and the /r/ consonant becomes /n/ when following a nasal vowel. Whether that vowel is underlyingly nasal or nasalized by a proceeding vowel or consonant is inconsequential. This rule is summarized in (8) below:

(8) Progressive nasal assimilation rule in Hoocąk

$$\left\{\begin{matrix} a \\ i \\ u \\ r \end{matrix}\right\} \rightarrow [+\text{nasal}] \quad / \quad [+\text{nasal}]\_$$

Both examples in (9) demonstrate the results of the application of this rule:

(9) Nasal harmony in Hoocąk

a. *nąąpąą ųį̨nera*
nąąpąą ʾųų-ire=ra
basket make-PL=DEF
'[that] they made baskets' (Lipkind 1945:40)

[1]This word should have no underlying nasal vowels, but the description by James (1983) in working with younger speakers of Lakota suggests that either there is an underlying nasal vowel present or that there is some other source of the nasalization: i.e., the /n/. Another possibility is that this process is a newer phenomenon, given that it is sparsely attested. In addition, it is not clear if all nasalization is created equal in is example; it is possible that there is a distinction between weak nasalization due to anticipatory articulation versus a stronger nasalization conditioned by phonology. Additional research is needed to see how prevalent words without nasal vowels in Lakota participate in nasal harmony.

b. *nąą'ap*
nąą-aap
tree-leaf/sheet
'leaf' (Helmbrecht & Lehmann 2010:158)

In (9a), the long /ą/ vowel following the /n/ in *nąąpąą* 'basket' is automatically nasalized due to its position following the nasal consonant. Meanwhile, the second long /ą/ in *nąąpąą* 'basket,' as well as the long /ų/ in *'ųų* 'make or do,' are underlyingly nasal. The /ų/ affects both the following nasalizable vowel /i/ and nasalizable consonant /r/ in the plural subject *-ire* suffix, producing [į] and /n/, respectively. The following vowel /e/ can not be nasalized in Hoocąk, and so the spread ends upon reaching it.

The example word *nąą'ap* 'leaf' in (9b) is composed of two morphemes: *nąą*, which has many translations in English, among them, 'tree,' and *'aap*, which is descriptive of the thin or sheet-like nature of a leaf. In this example, nasalization from the inherently nasal quality present in *nąą* does not carry over to the /a/ vowel in *'aap*. This spread is prevented by the glottal stop.

The above examples demonstrate that nasality may not spread past stop consonants or mid-vowels /e/ or /o/ (which are never nasalized in Hoocąk). These blocking elements will be further discussed in §4.1. Nasality may spread across consonants /h/ and /w/, however, though there are discrepancies in previous descriptions of the nature of that spread. Helmbrecht & Lehmann (2010:7) assert that nasality spreads across eligible vowels whether there is an /h/ between them or not, and that it may optionally spread through /w/. Conversely, Garvin & Hartmann (n.d.:18) note that nasality spreads to subsequent vowels "sometimes" through /h/, and "usually" through /w/. Examples demonstrating nasal spread across /h/ and /w/ are provided in (10) and (11):

(10) a. Nasal harmony crossing /h/
mįąnąk
mįį<ha>nąk
<1E.A>sit
'I sit' (Helmbrecht & Lehmann 2010:7)

b. *nąįžą*
nąą-hižą
tree-one
'a tree' (Helmbrecht & Lehmann 2010:7)

c. Nasal harmony not crossing /h/
hiicąwą *haara*
hiicąwą <ha>hii=ra
brother.in.law <1E.A>be.related=DEF
'my brother-in-law' (DoBeS Archive 2016)

d. *pejąhu*
pejąhu
sandhill.crane
'sandhill crane' (DoBeS Archive 2016)

(11) a. Nasal harmony crossing /w/

Važątire	*waanįwįną*	*coire*
važątire	<ha>hanį-wi=ra	coo-ire
car	<1E.A>have-PL=DEF	blue/green-PL

'the cars we have are blue/green' (DoBeS Archive 2016)

b. *ha'ųwį*
ha-'ųų-wi
1E.A-do-PL
'we [exclusive] do' (Helmbrecht & Lehmann 2010:8)

c. Nasal harmony not crossing /w/
hįwus
hį-wus
1E.U-dry
'I [my skin] am dry' (Helmbrecht & Lehmann 2006:73)

We postulate that the reason for the nasality spreading across /h/, as in (10a) and (10b), or not, as in (10c), relates to word boundaries. Though examples (10a) and (10c) both contain the first person actor prefix *ha-*; in (10a), it is prefixed to the verb *mįįnąk* 'to sit' in primary derivation, and is therefore treated as word-internal. In contrast, (10c) consists of two prosodic words, with *ha-* in word-initial position. If nasalization consistently spread across /h/ as well as syllable or word boundaries, as claimed byHelmbrecht & Lehmann (2010:7), we would expect nasalization to spread to all eligible consonants and vowels to form **hiicąwą hąąną* for 'my brother-in-law.' The word boundary likely prevents nasal spread onto the eligible vowels and consonant. Example (10d) shows an environment in which nasalization does not spread past /h/ to the nasalizable vowel /u/. This may be due to the same sensitivity to word boundaries, as *pejąhu* 'sandhill crane' is a rare compound word, composed of *peeją* 'crane' and *huu* 'leg.' Nasal spread across compound words is further discussed in §4.3.

When it comes to nasality crossing or not crossing /w/ (as seen in (11a) through (11c)), we support the generalizations made in previous research: that it is common, but not obligatory, for nasalization to spread in environments with /w/.

The only consonant which takes on a nasal quality through nasal spread in Hoocąk is /r/. The /r/ which becomes /n/ in environments in which it follows a nasal vowel. This nasalization frequently occurs when attaching the definite determiner =ra to a noun ending in a nasal vowel, as in (12):

(12) Nasalization of determiner =*ra*
wanįną
wanį=ra
meat=DEF
'the meat' (Helmbrecht & Lehmann 2006:80)

In summary, given the proper conditions, the nasalization rule may apply to numerous nasalizable vowels and consonants until it reaches either a stop consonant, a mid-vowel /e/ or /o/, or the rightward edge of a word.

3.3. Mandan nasal harmony

The first description of the sound system of Mandan appears in Kennard (1936). Kennard's account of the phonology of Mandan does not address allophony, and he describes the voiced segments [ɾ n ⁿd] and [w m] as individual phonemes. However, throughout his glosses, he frequently remarks in footnotes that [ⁿd] becomes [ɾ] when word-internal, and that [w] can alternate with [m] when word-initial. There is no mention of nasal harmony in his analysis of Mandan grammar, but there are instances where nasal harmony is documented but not described.[2]

(13) Nasal harmony in Kennard (1936)
máamakįmaaxaani érehini [ˈmãː.mã.kĩ.mãː.xa.ːnĩ ˈe.ɾe.hʲnĩ]
waa-wą-kiwąąxE=rį e-reh=rį
UNSP-1S-ask=SS PV-want=SS
'she was just going to ask me something and...' (Kennard 1936:30)

In the data above, we can see a long nasal vowel in *kįmáaxe* 'ask', which causes the underlying /i/ to become nasalized. Furthermore, the underlying /ã/ in the first person stative marker *ma-* causes the preceding /w/ to become [m], as well as continue spreading leftwards to the edge of the word. Hollow (1970:18) is the first to recognize that the coronal voiced consonants and the bilabial voiced consonants are actually allophones. In his analysis of Mandan phonology, Hollow posits that all surface nasal consonant occur when followed by a nasal vowel: e.g., [n] can only occur when an underlying /ɾ/ precedes a nasal vowel. Similarly, [ⁿd] only occurs in word-initial environments, and even then, it can still appear as [ɾ] when phrase-internal.[3]

(14) Hollow's (1970:22) Regressive Nasal Assimilation Rule
$$\left\{\begin{matrix}\text{Resonant consonants}\\ \text{Apex vowels}\end{matrix}\right\} \rightarrow \text{[+nasal]} \quad / \quad \_\text{[+nasal]}$$

The rule above in (14) causes any non-vocalic voiced consonant (i.e., /w/ and /ɾ/) and non-mid vowels (i.e., /a i u/) to become nasalized when the following segment is nasalized. Kasak (2019) likewise supports this analysis of voiced consonants in Mandan. We can see this rule at work in the data below.

In (15), we see that /w/ is [w] when word-initial or word-internal and is followed by an oral vowel. This behavior is clear in (15a) through (17c). We can contrast the behavior of /w/ in the first person active marker *wa-* with what we see in (15d) through (15f), where /wa/ becomes [mã] due to the presence of an underlying nasal vowel in the following syllable.

[2]Note that surface nasal vowels do not contain a nasal hook if preceded by a nasal consonant in the orthography used here: e.g., ⟨máahe⟩ 'bow and arrow' is really pronounced [ˈmãːhe]. Nasal hooks are only marked when there is no preceding nasal consonant: e.g., ⟨xtą́ąte⟩ 'thunder' is still pronounced [ˈxtãːte].

[3]Mandan exhibits sensitivity to prosodic domains (i.e., word-level versus phrase-level). After pauses or when there is an intonational break, /w ɾ/ appear as nasals [m n] without the presence of an underlying nasal vowel. The presence of a nasal consonant without a subsequent nasal vowel is one indicator of a change in topic or focus within a Mandan sentence. For addition discussion of phrase-sensitive allophony, see Chapter 2 of Kasak (2019), as the issue of prosodically sensitive allomorphy is beyond the scope of the present paper. It is possible that other Siouan languages possess similar sensitivities to prosodic environments with respect to nasal consonants, and this is a topic for future research.

(15) Bilabial /w/: [w] versus [m]

a. *warópxe'sh* [wa.ˈɾo.pxeʔʃ]
wa-ropxE=o'sh
1A-enter=IND.M
'I entered' (Hollow 1970:247)

b. *waréeho'sh* [wa.ˈɾeː.hoʔʃ]
wa-rEEh=o'sh
1A-go.there=IND.M
'I went there' (Hollow 1970:175)

c. *ówati* [ˈo.wa.ti]
o-wa-ti
PV.LOC-1A-dwell
'my home' (Hollow 1970:251)

d. *maná'ko'sh* [mã.ˈnãʔ.koʔʃ]
wa-wą'k=o'sh
1A-be.standing=IND.M
'I stood up' (Hollow 1970:22)

e. *maníiro'sh* [mã.ˈnĩː.ɾoʔʃ]
wa-rį̨į̨=o'sh
1A-walk=IND.M
'I walked' (Hollow 1970:182)

f. *ímaminixo'sh* [ˈi.mã.mˈĩnĩ.xoʔʃ]
i-wa-wrį̨x=o'sh
PV.INS-1A-play
'I am play' (Hollow 1970:305)

We can see the behavior of nasal harmony shown explicitly below, with an underline emanating from the origin of the nasality and spreading leftward.

(16) Regressive nasal harmony in Mandan in (15d)
maná'ko'sh [mãˈnãʔkoʔʃ]
wa-wą'k=o'sh
1A-be.standing=IND.M
'I stood up' (Hollow 1970:22)

In the data in (15), the nasal harmony is purely regressive in nature; no nasal harmony moves rightward from a nasal vowel. We can see this same pattern repeated for the coronal voiced segments below.[4]

(17) Coronal /ɾ/: [ɾ] versus [n] versus [ⁿd]

a. *rópxe'sh* [ˈⁿdo.pxeʔʃ]
ropxE=o'sh
enter=IND.M
'he/she entered' (Hollow 1970:247)

b. *rarópxe'sh* [ⁿdaˈ.ɾo.pxeʔʃ]
ra-ropxE=o'sh
enter=IND.M
'he/she entered' (Hollow 1970:247)

c. *órati* [ˈo.ɾa.ti]
o-ra-ti
PV.LOC-1A-dwell
'your home' (Hollow 1970:251)

d. *naníiho'sh* [nã.ˈnĩː.hoʔʃ]
ra-rį̨į̨h=o'sh
2A-breathe=IND.M
'you breathed' (Hollow 1970:181)

e. *namáahąte'sh* [nã.ˈmãː.hã.teʔʃ]
ra-wąąhątE=o'sh
2A-groan=IND.M
'you groaned' (Hollow 1970:267)

f. *ónamiho'sh* [ˈo.nã.mĩ.hoʃ]
o-ra-wį̨h=o'sh
PV.LOC-2A-point.at=IND.M
'you pointed at it' (Hollow 1970:286)

Using the second person active marker *ra-* to in a variety of environments in (17), we can see that /ɾ/ is only [ⁿd] when word initial before an oral vowel. Word-internally, /ɾ/ remains [ɾ]. However, if the following syllable contains a nasal vowel, nasality will spread leftward over each voiced element.

[4]Note that in this orthography, unlike Kennard (1936), the word-initial allophone [ⁿd] is written ⟨r⟩.

In Mandan, this regressive nasal harmony is able to spread over great distances. Hollow (1970:22) himself notes an impressive example involving the spread of nasality leftward from the verb stem across three prefixes, though it is not alone in having long-distance harmony. This nasal spread is depicted with an underline.

(18) Long-distance regressive nasal harmony in Mandan

a. *máamananuunixinisto'sh* [ˈmãː.mã.nã.nũː.nĩ.xⁱnĩ.sto?ʃ]
waa-wa-ra-rųų=rįx=rįt=(k)t=o'sh
NEG-UNSP-2A-abduct=NEG=2PL=POT=IND.M
'thou shalt not commit adultery' Hollow (1970:22)

b. *máamanaraxikanashinito'sh* [ˈmãː.mˆãnã.ɾa.xi.kˆãnã.ʃˆĩnĩ.to?ʃ]
waa-w-rą-ra-xik=rąsh=rįt=o'sh
UNSP-1S-2A-INS.MTH-be.bad=ATT=2PL=IND.M
'you (pl.) ruined it all for me' (Trechter 2012:154)

This nasal harmony targets only voiced consonants and non-mid vowels. Thus, so long as all prefixes before a syllable bearing a nasal vowel has both of these prerequisites, there is no hard limit on the distance within a word that regressive harmony can travel.

3.4. Comparison of both systems

Despite moving in different directions, both Mandan and Hoocąk have a few similarities in how vowel harmony works. For both languages, the /r/ universally participate in nasal harmony and become [n] when involved. Similarly, only non-mid vowels can participate in vowel harmony.

(19) Nasal harmony for /r/

a. Hoocąk (→)
hįnągíkarahe [hĩ.nã.ˈgi.kᵃra.he]
hį-ra-gikarahe
1S-2A-invite
'you invite me' (Helmbrecht & Lehmann 2006:17)

b. Mandan (←)
ónanapo'na? [ˈo.nã.nã.po?.nã]
o-ra-rąp=o'rą
PV.LOC-2A-find=INT.F
'did you find it?' (Kennard 1936:20)

In (19a), the first person object marker *hį-* causes nasality to travel rightward, spreading the [+nasal] feature onto the /r/, making it [n] and carrying [+nasal] onward to the /a/. Similarly, in (19b), the nasality spreads leftwards from the /ã/ in the stem, onto the preceding /ɾ/, and then likewise continues spreading towards the left edge of the word onto each available segment (i.e., onto non-mid vowels and voiced consonants).

The other consonant that participates in nasal harmony in both languages is /w/. In Mandan, when /w/ is involved in nasal harmony, /w/ becomes [m]. However, in Hoocąk, /w/ allows nasal harmony to pass onto the following vowel without fortifying to [m]. We can see this behavior in the data below.

(20) Nasal harmony for /w/

a. Hoocąk (→)
nąąžį<u>wį</u>ne [nã:.ˈʒĩ.wĩ.ne]
nąąžį-wi-re
stand-PL-IMP
'stand (pl.)!' (Lipkind 1945:8)

b. Mandan (←)
<u>mamána</u>pe'sh [mã.ˈmã.nã.peʔʃ]
wa-wa-rąpE=o'sh
UNSP-1A-dance=IND.M
'I danced' (Hollow 1970:167)

The data in (20a) is peculiar in that /w/ seemingly participates in nasal harmony in Hoocąk but does not become [m] in the same way /r/ becomes [n]. It is possible that the /w/ is actually [w̃], but no phonetic studies have been done on nasality in Hoocąk to date to confirm this nasal articulation. In the DOBES corpus, when /w/ is involved with nasal harmony, it is still transcribed as ⟨w⟩. This contrasts with the treatment of /r/ to [n], where such instances are depicted as ⟨ń⟩ in Lipkind (1945) and ⟨ň⟩ in Helmbrecht & Lehmann (2006) to distinguish this [n] from underlying /n/.

The important finding of looking at nasal harmony in both Hoocąk and Mandan is that they are remarkably similar despite being part of disparate branches of the language family. Both languages allow for long-distance nasal harmony, and both languages involve the same segments in that harmony. The major difference between these two languages is the directionality of the nasal spread, with Hoocąk having only progressive harmony, while Mandan has only regressive. Hoocąk likewise is distinct from Mandan in that /w/ does not fully assimilate to a nasal stop, but it does permit nasal spreading to pass through onto following segments.

4. Conditions for nasal harmony

The data presented in §3.2 serve to show the ways in which nasal harmony in both languages work. We know that both languages involve the sonorants /w/ and /r/ in nasal harmony, as well as the non-mid vowels /a i u/. The description that follows highlights the blocking conditions for nasal harmony in both languages, and it raises questions for what patterns might exist in nasal harmony across the language family.

4.1. Blocking environments for Hoocąk

As demonstrated in §3.2, nasalization spreads across vowels /a/, /i/, /u/, and consonant /r/. The spread is blocked by stop consonants (including the glottal stop), mid-vowels, and right-edge word boundaries. Examples (21a)-(21c) showcase these blocking environments:

(21) Nasal harmony blocking in Hoocąk

a. *nąą'ap*
nąą-'aap
tree-leaf/sheet
'leaf' (Helmbrecht & Lehmann 2010:158)

b. *waamįnąkra*
waamįnąk=ra
chair=DEF
'the chair' (Helmbrecht & Lehmann 2010:254)

c. *nąąpąą ųįnera*
nąąpąą 'ųų-ire-ra
basket make-PL-REL
'[that] they made baskets' (Lipkind 1945:40)

d. *mąą hijąhį*
mąą hijąhį
land different
'different countries' (Helmbrecht & Lehmann 2010:87)

In (21a) (repeated from (9b)), nasal spread to the nasalizable vowel /a/ is blocked by the glottal stop. In (21b), spread to the nasalizable consonant /r/ is blocked by the stop consonant /k/. In (21c) (repeated from (9a)), the mid-vowel /e/ prevents spread to the /r/. Finally, in (21d), the word boundary prevents spread to the nasalizable vowel /i/. Because we have established that /h/ does not block spread across eligible vowels, we conclude that it is the word boundary that is preventing the spread in this case.

4.2. Blocking environments for Mandan

The description of nasal harmony in Mandan throughout §3.3 shows that Mandan robustly allows for long-distance regressive nasal harmony, so long as the following conditions are met:

(22) Nasal harmony spreads leftward in Mandan if...

a. The nasal element is preceded by a voiced consonant (i.e., /w/ or /ɾ/), or

b. The nasal element is preceded by a non-mid vowel (i.e., /a i u/).

This set of conditions conforms the description of nasal harmony that Hollow (1970) puts forth. We can see examples of blocking in the data below.

(23) Blocked nasal harmony in Mandan

a. *óminik* [ˈo.mⁱnĩk], *[ˈõ.mⁱnĩk]
o-wrįk
PV.LOC-be.a.bean
'bean' (Hollow 1970:132)

b. *komíihąka* [ko.ˈmĩː.hã.ka], *[kõ.ˈmĩː.hã.ka]
ko-wįįhą-ka
3POSS.PERS-be.a.female.grandchild-HAB
'her grandchild/sister-in-law' (Hollow 1970:287)

c. *émahekere're* [ˈe.mã.he.kᵉɾeʔ.ɾe], *[ẽ.mã.he.kᵉɾeʔ.ɾe]
e-wą-he=krE=o're
PV-1S-say=3PL=IND.F
'they said it to me' (Hollow 1973a:189)

d. *wíiratąąre* [ˈwiː.ɾa.tãː.ɾe], *[mĩː.nã.tãː.ɾe]
wiiratąą=E
enemy=SV
'enemy' (Hollow 1970:292)

In each of the examples above, regressive harmony has been blocked by a mid-vowel or a voiceless consonant. However, there are example in the Mandan corpus where nasal harmony is expected to occur but does not.

(24) Unexpected blocking of nasal harmony in Mandan

a. *ímanapshe'sh* [ˈi.mᵃ̃nã.pʃeʔʃ], *[ˈĩ.mᵃ̃nã.pʃeʔʃ]
i-w-rą-pshE=o'sh
PV.INS-1S-2A-bother=IND.M
'you bother me' (Hollow 1973b:133)

b. *káare ótaamaharaata!* [ˈkaː.ɾe ˈo.taː.mã.hᵃɾaː.ta], *[ˈkaː.ɾe ˈo.tãː.mã.hᵃɾaː.ta]
kaare o-taa#wą-hrE=ta
NEG.IMP PV.LOC-be.facing#1S-CAUS=IMP.M
'don't point it at me!' (Hollow 1973a:167)

c. *Núu'etaamiihseena* [ˈnũː.ʔe.taː.mĩː.hseː.nã], *[ˈnũː.ʔe.tãː.mĩː.hseː.nã]
rųų'etaa#wįįh=s=ee=rą
Mandan#woman=DEF=DEM.DIST=TOP
'that Mandan woman there' (Hollow 1973b:89)

d. *míihkanatka* [ˈmĩː.hka.nã.tka], *[ˈmĩː.hkã.nã.tka]
wįįh=ka#rąt=ka
woman=HAB#be.in.the.middle=HAB
'lizard [lit. 'female's heart']' (Hollow 1970:286)

The data above illustrates one clear reason why nasal harmony does not continue moving leftward when there are not featural impediments: word boundaries. In the case of the causative construction in (24b) and the compound nouns in (24c) and (24d), there is a word boundary between a nasal element and a non-nasal element that should otherwise be able to participate in nasal harmony. Thus, we can see that word boundaries are a third blocking environment for nasal harmony. Unlike Guaraní, as seen in (6), nasal harmony in Mandan appears to be strictly word-internal.

With this third condition in mind, we can say that causative constructions like the on in (24b) involves an incorporated verb, thus explaining the word boundary and lack of nasal harmony onto the [aː] in *ótaa* 'be facing' near to the nasal [m]. However, this word boundary condition does not seem to apply to the data in (24a), where we do not see multiple words combined into a larger morphological word. The instrumental preverb *i-* is not its own word, so we should not expect to see word boundary-type blocking here.

A central argument in Kasak (2019) is that word boundary-type blocking is exactly what is happening in Mandan. Helmbrecht (2008:139) posits that preverbs in Siouan are diachronically the result of grammaticalized postpositional elements in Proto-Siouan or pre-Proto-Siouan that became reanalyzed as being integral parts of the verb. These elements lost their wordhood over time, leading these former free postpositions to become bound preverbs. Kasak (2019) builds upon Helmbrecht's (2008) hypothesis in how the structure of Siouan verbs came to be by employing Anderson's (1992) notion of a **composite** word: i.e., a word that has internal structure. In a composite, there is a word couched inside of a greater word, where there is additional morphological material outside the bounds of that head word. This evolution is illustrated step-by-step below.

(25) Evolution of free postpositions into preverbs in composites

a. Stage 1: Free postpositions
[[N][P]] [V]

b. Stage 2: Prosodic association of postposition with verb in SOV
[N] [[P][V]]

c. Stage 3: Loss of wordhood for postposition and erasure of brackets
[N] [P[V]]

Stage 1 in (25a) involves a typical postposition following its nominal complement to the left of a verb. This is a typical structure for a head-final language with SOV sentence order. There is nothing typologically marked about this stage. However, as we proceed to Stage 2, we can see in (25b) that the postposition has become reanalyzed as being associated with the verbal element rather than the nominal element. This postpositional element still has some degree of wordhood, perhaps similar to particle verbs in Germanic languages, which means that the postpositional element still has some prosodic and/or morpho-syntactic autonomy.

Stage 3 in (25c) represents the kind of structure that Kasak (2019) proposes for Mandan and other Siouan languages: where the postpositional element in previous stages has become fully reanalyzed as being a part of the same word as the verb, but not a word unto itself. It is part of the verb, but not integral to the verb in the same way as affixes are.[5]

Assuming this structure, we can account for the lack of nasal harmony onto preverbs by pointing out that there is actually a word boundary between the preverb and the verb complex. The caveat is that this word boundary is an internal word boundary, rather than the boundary between two words as seen in a compound. We can thus say that Mandan still only has three conditions for blocking nasal harmony. The conditions outlined in (22) are reiterated and updated in (26) below.

(26) Nasal harmony spreads leftward in Mandan if...

a. The nasal element is preceded by a voiced consonant (i.e., /w/ or /ɾ/), or

b. The nasal element is preceded by a non-mid vowel (i.e., /a i u/), or

c. The nasal element is not preceded by a word boundary.

We can appeal to these three conditions account for all documented instances of so-called unexpected blocking of nasal harmony.

[5]See chapter 4 of Kasak (2019) for additional discussion of the composite structure in Mandan and Siouan.

(27) Word-boundary blocking of nasal harmony

a. *íminikihe'sh* 'I waited for you' (Kasak 2019:344)
[*í* [*minikihe*]] *'sh*
[i [w-rį-kihE]] =o'sh
[PV.INS [1A-2S-wait.for]] =IND.M

b. *áamanahuuro'sh* 'you came here with me' (Kasak 2019:344)
[*áa* [*manahuu*]] *ro'sh*
[aa [w-rą-huu]] =o'sh
[PV.TR [1S-2A-come.here]] =IND.M

In the data above, there is morphology containing underlying nasal vowels within the stem of the head of the composite word. In each of these cases, nasal harmony begins at the second person marker and travels leftward, nasalizing the /w-/ first person marker, but stopping before reaching the preverb. This lack of nasalization onto the preverb is now expected due to the fact there is an internal word boundary between the domain of the head of the composite word and the domain of the greater word where the preverb is. We can thus account for all the instances of unexpected blocking of nasal harmony in (24), which is repeated below with the internal structure of each word explicitly shown.

(28) Expected nasal harmony blocking from word boundaries

a. *ímanapshe'sh* 'you bother me' (Hollow 1973b:133)
[*í* [*manapshe*]] *='sh*
[i [w-rą-pshE]] =o'sh
[PV.INS [1S-2A-bother]] =IND.M

b. *káare ótaamaharaata!* 'don't point it at me!' (Hollow 1973a:167)
[*káare*] [[*ó* [*taa*]] [*maharaa*]] *=ta!*
[kaare] [[o [taa]] [wą-hrE]] =ta
[NEG.IMP] [[PV.LOC [be.facing]] [1S-CAUS]] =IMP.M

c. *Núu'etaamiihseena* 'that Mandan woman there' (Hollow 1973b:89)
[[*Nuu'etaa*] [*miih*]] *=s =ee =na*
[[rųų'etaa] [wįįh]] =s =ee =rą
[[Mandan] [woman]] =DEF =DEM.DIST =TOP

d. *míihkanatka* 'lizard [lit. 'female's heart']' (Hollow 1970:286)
[[*míihka*] [*natka*]]
[[wįįh=ka] [rąt=ka]]
[[woman=HAB] [be.in.the.middle=HAB]]

In each of the words above in (28), regressive nasal harmony should be permitted to keep moving leftward given that there is nothing featurally blocking harmony: i.e., the conditions in (26a) and (26b) are met. However, the condition in (26c) is preventing regressive nasal harmony from continuing toward the left edge of the overall word.

By positing word internal boundaries, we also can account for the unexpected lack of nasal harmony in the enclitic field.

(29) Blocking of nasal harmony in the enclitic field

a. *húuni* 'he came and...' (Hollow 1973a:163)
[*húu*] =*ni*
[huu] =rį
[come.here] =ss

b. *kįnúuxik túnashoomako'sh* 'he got kind of scared' (Hollow 1973b:71)
[*kįnúuxik*] [*tú*] =*nash* =*oomak* =*o'sh*
[ki-rųųxik] [tu] =rąsh =oowąk =o'sh
[MID-fear] [be.some] =ATT =NARR =IND.M

c. *wáarakų'karaanitinixanaate'sh* 'you (pl.) almost didn't give it to them' (Hollow 1970:468)
[*wáarakų'*] =*karaa* =*nit* =*inix* =*anaate* =*'sh*
[waa-ra-kų'] =krE =rįt =rįx =rąątE =o'sh
[NEG-2A-give] =3PL =2PL =NEG =PRSP =IND.M

d. *káare ka'ótaahkani* 'don't let him get hurt, and...' (Hollow 1973a:63)
[*káare*] [*ka'ót*] =*aahka* =*ni*
[kaare] [ka-ot] =aahka =rį
[NEG.IMP] [INS.FRCE-mix] =ABLE =SS

In (29a), nasal harmony should be permitted from the word-final nasal onto the /u:/ in the stem *húu* 'come here', but the word boundary prevents the spread of nasal harmony from the same-subject switch-reference enclitic =*ni*. Thus, we have [ˈhu:nĩ] instead of *[ˈhũ:nĩ]. Similarly, the attitudinal =*nash* in (29b) does not spread nasality leftward onto the /u/ in *tú* 'be some' due to the intervening word boundary between the stem and the enclitic.

Also noteworthy is the fact that nasal harmony cannot spread from one enclitic onto another. In (29c), the second person plural enclitic =*nit* should be able to spread nasality leftward onto the third person enclitic due to the fact that [a:] is featurally vidable for receiving the [+nasal] feature, phonologically. Yet instead of *[ˈwa:.kũʔ.kʰãnã:.nĩtʲnĩ.xʰãnã:.teʔʃ] for 'you (pl.) almost didn't give it to them', we have [ˈwa:.kũʔ.kʰra:.nĩ.tʲnĩ.xʰãnã:.teʔʃ]. We observe the same behavior in (29d), where the nasality from the same-subject switch-reference enclitic =*ni* does not spread leftward onto the /a/ in the modal enclitic =*aahka*. We can thus surmise that enclitic boundaries have the same effect on nasal harmony as word boundaries. This behavior suggests that enclitic boundaries are also a kind of word boundary, where additional boundaries appear as enclitics accrete at the right edge of the word. A more articulated structure for (29c) appears below.

(30) Explicit encliticization-driven word boundaries in (29c)
[[[[[[*wáarakų'*] =*karaa*] =*nit*] =*inix*] =*anaate*] =*'sh*]
[[[[[[waa-ra-kų'] =krE] =rįt] =rįx] =rąątE] =o'sh]
[[[[[[NEG-2A-give] =3PL] =2PL] =NEG] =PRSP] =IND.M]

For the sake of ease of reading, the use of '=' as an enclitic marker shall serve as a shorthand for stating that there must be a word boundary placed around the stem and the enclitic. However, the lack of additional bracketing with the addition of enclitics should be assumed.

Previous analyses of nasal harmony in Mandan (i.e., Hollow 1970) have only addressed general tendencies in nasal harmony, rather than looking at cases of exceptional blocking as done above. These data show that word boundaries play a critical role in blocking regressive nasal harmony in Mandan, both due to synchronic processes such as compounding and encliticization

and diachronic such as employing composite structures. Nasal harmony in Mandan is not merely relegated to the domain of phonology, but is sensitive to morphological structure as well.

4.3. Comparison of blocking environments

Hoocąk and Mandan share several identical featural blocking environments. Namely, voiceless obstruents and mid-vowels block nasal harmony, regardless of directionality. What no other sources to date have adequately addressed is whether nasal harmony is sensitive to word boundaries in these languages. To address this question, we look at compound words in each language. In Mandan, there is substantial evidence that nasality is blocked in compounds. However, because compounding is quite rare in Hoocąk, only a limited set of examples are available for study. Based on available documentation, we tentatively conclude that spread does not occur across the compound barrier (i.e., a word boundary).

(31) Blocking nasal harmony in compounds

a. Hoocąk
[[*wanį*][*ruxiri*]] ‘ground meat’ (*wanį* ‘meat’ + *ruxiri* ‘ground [by hand]’)

b. Mandan
[[*Núu’etaa*][*miih*]] ‘Mandan woman’ (*Núu’etaa* ‘Mandan’ + *míih* ‘woman’)

In (31a), nasal harmony cannot spread rightward from *wanį* onto *ruxiri*: i.e., we have [wa.nį̃.ru.xi.ri] and not *[wa.nį̃.nũ.xi.ri]. Conversely, in (31b), nasal harmony cannot spread leftward onto *Núu’etaa* from *míih*: i.e., the word is [ˈnũ:.ʔe.ta:.mĩ:h], not *[ˈnũ:.ʔe.tã:.mĩ:h]. While it is true that word boundaries can impede nasal harmony in these languages, all word boundaries are not equally impermeable.

Hoocąk allows nasal harmony to pass a right word boundary provided that there is no intervening left word boundary. We can see this in DPs, where nasality from the left edge of a noun will progress onto the determiner.

(32) Nasal spread across right word boundaries in Hoocąk

a. Single prosodic word
[*wanį*] *=nąk*
[wanį] =ra
[meat] =DEF
‘the meat’

b. Multiple prosodic words
[*wanį*] *=nąk* [*waahąk*]
[wanį] =ra [ho-ha-hą]
[meat] =DEF [PV-1A-boil.something]
‘I boiled the meat’ (Helmbrecht & Lehmann 2006:80)

The definite article enclitic *=ra* must not have a left word boundary, else it should prevent nasal harmony from spreading onto it. This nasal harmony is able to pass the right word boundary of *wanį* ‘meat’, but is unable to pass the left word boundary of *waahąk* ‘I boil it.’ The /w/ in

waahą should permit nasal harmony to continue spreading progressively, but that is not the observed behavior of the nasal harmony above: i.e., This behavior contrasts sharply with Mandan, where word boundaries are insurmountable barriers to nasal harmony, as shown earlier in (29) and (30).

5. Discussion of nasal harmony in Siouan

What is surprising about these data is the similarity in how nasal harmony functions in both languages. Both languages are unremarkable in their lack of nasal mid-vowels, as this is a general rule among all Siouan languages. Those languages that have synchronic nasal mid-vowels, such as Kanza, have nasal mid-vowels due to the lowering of *ų to [õ] (Rankin 1990:4). This lowering of *ų to [õ] is common in Dhegihan languages, but also occurs in Virginian Siouan (Oliverio 1996:23). Catawban languages have nasal mid-vowels in addition to the expected [ã ĩ ũ] (Shea 1984), though correspondences between Proto-Siouan and Catawban is poorly understood (Rankin et al. 2015).[6]

For both Mandan and Hoocąk, mid-vowels are noteworthy in that they act as blocking agents for nasal harmony. This fact is robustly true in both languages. When looking across the Siouan language family to observe how other kinds of nasal harmonies work, we can look to Lakota for other examples of nasal harmony. Lakota appears to exhibit long-distance nasal harmony, we cannot necessarily make the generalizations regarding what the blocking environments for nasal harmoney are in Siouan languages, given the data from (7), repeated below.

(33) Nasality in Lakota

a.	*lowáŋ*	'sing'	/lɔwã/	→	[l̃õ.ˈw̃ə̃]
b.	*lená*	'these'	/lɛna/	→	[l̃ɛ̃.ˈnə̃]
c.	*akáŋl*	'on top'	/akãl/	→	[a.ˈkə̃l̃]
d.	*nážiŋ*	'stand'	/ˈnaʒĩ/	→	[ˈnə̃.ʒ̃ĩ]

Nasal harmony in (33a) appears to be regressive, as the underlying nasality in the /ã/ spreads leftward across each voiced segment, including the mid-vowel /o/. Not only is this nasality spreading leftward within its syllable of origin, it is able to cross the syllable boundary onto each [+voice] segment available. This behavior contrasts with the data in (33c), where nasal harmony appears to be progressive, originating on the /ã/ and spreading rightward onto the next available voiced segment, the /l/. Both of these examples seem to display unidirectional nasal harmony, but we can observe the datum in (33b) to see that bidirectional nasal harmony is observed. The /n/ is the only element that is underlyingly nasal in this word, and this nasality spreads regressively and progressively, given that this word is composed entirely of [+voice] segments. We see a similar situation in (33d), except there are two underlying nasal elements, the /n/ and the /ĩ/,

[6]Catawba has been analyzed by previous scholars as having /ę/ (e.g., Speck 1913, Shea 1984, Rudes 2007). Often, this /ę/ corresponds to the Proto-Siouan ablaut vowel *E: e.g., PSi *ksE 'break off,' Lakota *-ksA*, Biloxi *kšědi* 'break by hand,' versus Catawba *sę* 'chop wood.' Catawba /ǫ/ also can arise from Proto-Siouan *ąhe sequences: e.g., Proto-Siouan *pąhe 'call, shout,' Crow *páa∼paá*, Osage *(ki-)pą́* 'call, invite,' versus Catawba *wǫǫ* 'cry out.' Additional work is needed to further investigate these correspondences between mid-vowel nasals in Catawba and the rest of Siouan, as well as look at whether there is any evidence of a synchronic system of nasal harmony in Catawba or diachronic evidence of one in the past. For these reasons, the Catawban branch is excluded from the discussion of nasal harmony across Siouan, though its inclusion may become more appropriate in the future when there is a better understanding how Proto-Siouan corresponds to Catawban languages.

causing two competing instances of nasal harmony which converge as they spread the [+nasal] feature to each voiced segment in the middle of the word. Thus, in these Lakota examples, we can say that nasal harmony spreads bidirectionally from some underlying nasal segment. However, the one instance of nasal harmony being blocked is a voiceless stop, as we see in (33c), where /k/ prevents the spread of the [+nasal] feature leftward: i.e., we have [a.ˈkə̃Ĩ] and not *[ə̃.ˈk̃ə̃Ĩ].

Scarborough et al. (2015) address the spreading of nasality onto other segments in Lakota, but their analysis holds that this process is purely phonetic (i.e., coarticulatory) in nature. However, the presence of the data from James (1983) suggest something more formalized and systematic than mere nasal carryover or anticipatory coarticulation. The presence of long-distance nasal harmony without the immediate presence of a nasal segment. Furthermore, nasality in (33) is only carried by voiced segments and is blocked by voiceless segments. This behavior is much more in line with the long-distance nasal harmony we have observed for Hoocąk in §3.2 and Mandan in §3.3.

Long-distance nasal harmony in Lakota is briefly discussed in Ingham (2003:6), where he states that nasalization can spread progressively. Examples demonstrating long-distance nasal harmony appear below, with the nasal spread depicted with an underline. In all the examples below, an underlying nasal segement (either a vowel or a consonant) spreads nasality rightward until it encounters either a voiceless obstruent, as in the case of (34a) through (34d), or a consonant cluster, as in the case of (34e) and (34f). No regressive harmony is described, even though a small set of his data are conducive to the regressive harmony akin to the kind observed in James's (1983) data. For example, in (34c), the /a/ before /m/ is a candidate for regressive nasal harmony, but Ingham (2003:6) transcribes it as [i.ˈt͡ʃʰa.mã.ˌjã.pi], not *[i.ˈt͡ʃʰã.mã.ˌjã.pi].

(34) Nasal harmony in Lakota

a. *yápi*
yA=pi
go.there=PL
'they go' (Ullrich 2011:695)

b. *uŋyáŋpi*
uŋ-yA=pi
1A.PL-go.there=PL
'we go' (Ingham 2003:6)

c. *ičháȟye*
ičhaǧA#yA
grow#CAUS
'she raised her' (Ingham 2003:6)

d. *ičhámayaŋpi*
ičhaǧA#ma-yA=pi
grow#1S-CAUS-PL
'they brought me up' (Ingham 2003:6)

e. *waŋyáŋke*
waŋ-yaŋkA
PV-see
'he/she sees' (Ingham 2003:6)

f. *waŋbláke*
waŋ-w-yaŋkA
PV-1A-see
'I see' (Ingham 2003:6)

It is unclear from Ingham's (2003) description whether only vowels become nasalized, or if consonants can also take on the [+nasal] feature: e.g., the data in (34c) might actually be [i.t͡ʃʰa.mã.j̃ã.pi], instead of the nasality skipping over the voiced semi-vowel /j/. What is clear is that there are several sources that attest to the existence of long-distance nasal harmony in Lakota. One issue with addressing the systematicity of this phonological process is whether there is a single system or if there are several. James (1983) notes that his consultants are exclusively from the Pine Ridge community, while Ingham (2003) draws upon transcribed data from various Lakota sources. In the closely-related language variety of Dakota, Boas & Deloria (1941:11) note that there is a strong tendency in Dakota to anticipate nasalization, which runs opposite the description for Lakota per Ingham (2003:8). Between James (1983), Ingham (2003), and Scarborough et al. (2015), three different systems are described for nasal harmony in Lakota, with James (1983) having the most prolific system of bidirectional harmony, and Ingham (2003) describing only progressive harmony. Scarborough et al. (2015) are more restrictive in their analysis, positing only a varying degree of anticipation and coarticulation in the environment of an underlying nasal segment.

What unifies all three of these descriptions is that there is at least some kind of progressive (i.e., carryover) nasalization in Lakota, and for James (1983) and Ingham (2003), nasal harmony is blocked by voiceless consonants and consonant clusters. Both Mandan and Hoocąk share voiceless consonants as a blocking environment for nasal harmony, so this behavior is expected. Data on nasal harmony across word boundaries in Lakota is not explicitly discussed in the literature, so it is not possible at this moment to conclusively compare how word-internal structure in Lakota compares with the conditions for nasal harmony in Mandan and Hoocąk discussed in §4. However, it is worth noting that there is evidence of nasal harmony in other Siouan languages beyond Mandan and Hoocąk.

The presence of nasal harmony in different branches of the language family raise the question of whether long-distance nasal harmony is prevalent across Siouan as a whole, or simply a parallel innovation shared between Mandan and Mississippi Valley Siouan. The data and analysis presented in this paper suggest that productive nasal harmony may synchronically exist across Siouan. Michaud et al. (2012:214) lay out six different stages of nasalization that have occurred between Proto-Siouan and its evolution into the various Siouan languages.

There is a complicated diachronic relationship between surface and underlying nasal segments throughout the language family, with nasality moving from underlying vowels onto consonants, and in some cases, moving from a consonant back onto a vowel in certain linguistic subgroups. This complex relationship is further rendered opaque by the phonetics-phonology interface in each of the Siouan language varieties, where certain articulatory phenomena may become phonologized or even cause certain phonologically elements to become neutralized under phonetic pressures, as discussed in Scarborough et al. (2015). The fact that the Hoocąk and Mandan have a very productive and predictable phonological rule for nasal harmony, coupled with the evidence of some kind of nasal harmony (or at least nasal coarticulation) in Lakota support the hypothesis that nasality is not purely local within Siouan, and different languages may

have varying degress of long-distance harmony at work.

6. Conclusion and future research

This paper has outlined the conditions for nasal harmony in Hoocąk and Mandan. Nasal spread is progressive in Hoocąk and regressive in Mandan. In both languages, nasalization is triggered by vowels /ą į ų/ as well as consonants /n m/. While nasalizable vowels and consonant /r/ are treated the same in each (with /a i u/ converting to /ą į ų/ and /r/ to /n/), treatment of consonants differs in that /w/ becomes /m/ only in Mandan. Hoocąk and Mandan share many of the same conditions which block nasal harmony, including interruption by a mid-vowel or a (non-nasal) stop consonant. We suggest that word boundaries affect nasal harmony in each language as well, a hypothesis which resolves apparent exceptions to the nasalization rules described in previous research.

This work is among the first of its kind in that we investigate how nasal harmony works in two Siouan languages, as well as investigate the possibility that nasal harmony is not confined to Mandan and Hoocąk. Additional work is needed in other languages to determine to what degree nasal harmony happens, or if Mandan and Hoocąk really are the only two modern languages with productive nasal harmony as part of their phonological systems. More attention is needed for Dhegihan languages and Ohio Valley languages to look for patterns of nasal spreading onto surrounding segments for a better idea of how nasality has evolved in Siouan over time. Not only is this relevant for understanding the development of Siouan languages from Proto-Siouan, such work would also contribute to the typology of nasalization and how phonetics and phonology interact in the environment of nasal segments.

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