Mapping and Movement of Partial Matrices in Navajo

MAPPING AND MOVEMENT OF PARTIAL MATRICES IN NAVAJO

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This paper presents and analysis of Navajo verb prefix phonology which argues that reference to partial feature matrices is possible at every stage of the derivation, crucially here reference is possible at the level of mapping of morphemes at each cyclic level, and movement of a single tier away from other tiers associated with it in underlying representation is also possible.

Recent literature, especially Clements (1985) and Schein and Steriade (1986) argue for access to partial matrices at any point in the derivation; details of the Navajo analysis provide further support for the loose bundling or hierarchical binding of tiers from processes other than linking and assimilation.

The analysis addresses two descriptive issues and their theoretical implications: The first descriptive problem is a morphological one and concerns ordering of the large number of prefixes involved in Navajo verb forms. The second descriptive problem concerns "toned" consonants in Navajo; here we suggest that a reanalysis of certain historical sound changes results in certain consonants being marked for tone and subsequently interacting with more ordinary tonal phenomena.

A large variety of problems which have required ad-hoc solutions in previous analyses -- either slot and filler approaches or stipulations on phonological rules, fall out simply under the approach in this paper. Because of space constraints, we present prefix ordering and perfectives as representative examples of some of the problems solved.

1. Problem 1. Ordering of prefixes.

This section will argue that general phonological considerations such as the Strict Cycle dictate a given ordering of prefixes for Navajo. Note also that such an ordering for Navajo or similar Athapaskan languages has been suggested on other grounds by Anderson (1982), Rice (1985), and Thomas-Flinders (1983).

1.1 Statement of the Problem

According to traditional literature on Navajo, which uses a slot and filler approach to prefix ordering, there exist 10 or more prefix slots before the stem, as shown in (1) below, using Kari's (1973) system.

	Disjunct				Conjunct				
ADV	ITER	PLUR	OBJ	DEIC	ASP	MODE	PERF	SUBJ	CLASS
1	2	3	# 4	5	6	7	8	9	10
(25-	ná	da	shi	?i	di...	Ø	í	sh	Ø
30)			ni	ji	hi	ghi		ni	ł
na			nihi	hwi	ni...	ni		iid	1
ch'í			.	.	dzi	si		oh	d
ná			.	.	si	ó			
cho			.	.	.				
.					.				
.					.				
.									

Underlining marks the end of set; di...etc. stands for various morphemes sharing the same shape).

However, not all prefixes are equal -- phonological differences exist between 'disjunct' prefixes (positions 1-3) and conjunct prefixes (positions 4-10). Wright (1984) argues that the so-called conjunct prefixes are really consonantal with the traditional i vowel showing up as a result of epenthesis, so we will continue to refer to these as consonantal prefixes, and will base certain well-known phonological differences between conjunct and dijunct prefixes on the fully specified versus epenthetic vowel involved.

In terms of morphology, not all prefixes are equal, either. (2) shows some verb bases which consist of stem and prefixes which are

closely linked to the semantics of the verb stem, for example, ch'í 'horizontal' is used with motion verbs, etc., d is used for curtain like things.

2) Verb bases (imperfective forms of stems given here)

/ch'í - ____ - Ø - máás / 'to roll out horizontally'
(1) (10) stem (Ø classifier)

/d - ____ - 1 - baaɬ/ 'to hang it up'
(6) (10) stem

However, interspersed between these prefixes and the stem are mode prefixes which are associated with stem changes. For example, future is formed transparently by prefix d-gh plus suffixation of ɬ to the stem root to form the future stem. Examples of stem changes for a simple verb form are shown in (3).
Future is the usual citation form -- we assume here underlying open root.

(3) ɬ-[chííɬ 'to give birth to it' ROOT = chi

([marks stem boundary; ɬ = classifier chosen by semantics of the verb and constant through paradigm)

Future:	/d-gh-ɬ	[chííɬ	/
Imperfective:	/ Ø-ɬ	[chí	/
Perfective:	/s-H- ɬ	[chɬ	/
Iterative:	/ná-0- ɬ	[chíih	/
Optative:	/ ó- ɬ	[chííɬ	/

Furthermore, semantics of verb stems determine prefix choice in certain cases, for example, most motion verbs will take n rather than s in the perfective, and n rather than Ø in the imperfective, etc. Thus, a motion verb paradigm would be as in (4).

(4) Ø-[mas 'to roll' ROOT = maas

Future:	/d-gh- Ø	[mas	/
Imperfective:	/ n-Ø	[máás	/
Perfective:	/n-H- Ø	[mááz	/
Iterative:	/ná-Ø- Ø	[mas	/
Optative:	/ ó- Ø	[máás	/

Thus, we have a situation where morphemes which are mutually dependent, such as mode prefixes and suffixes OR thematic prefixes of position 6 and stem are separated from each other by material not involved in the dependency.

We can then have a rationale for ordering cycles in which mutually dependent material comes in on the same cycle and that rationale forces us into an infixation solution. The cycles will be as in (5).

(5) First cycle: Root + Idiosyncratic prefixes (including classifiers) - concatenated.
Second cycle: Addition of tense mode prefixes and suffixes to root, with cyclic rules applying.
Third cycle: Finally, other prefixes should be able to be added with no cyclic rules giving further change to root , classifier or other first cycle prefixes.

How this will work is illustrated in (6).

(6) //so... .d.... 1 - zin // (1) (6) (10) stem	Step 1 - Verb base - 'to pray'
/so d [d-gh] 1 zi̱i̱ɬ/	Step 2 - inflect for mode
/so d d gh [sh] 1 zi̱i̱ɬ/	Step 3 - inflect for subject
[sodideeszi̱i̱ɬ]	Output of phonological rules which apply after subject insertion

However, if the infixation required by this approach is not to be a restatement of the slot-filler approach, then the phonological insertion environment needs to be simply stated; the description in (7) will state basic ordering.

(7) 1. Insert material of the present cycle after rightmost C V prefix., i.e. after the last fully specified vowel.
↖F

2. Subjects (position 9 on last cycle) - inserted before final syllable.

Finally, we will need a metathesis rule, which says that consonants within the scope of the rule, i.e. inserted on the present cycle, or strictly adjacent to those inserted on the present cycle will be mapped in the order shown in (8).

(8) [-cont] before [+cont]
[-voice] before [+voice]

The system will work as follows. In (9) we see the prefixes which are involved, with one group circled. Those in positions 1, 2 and 3 are ordered left to right as the insertion stipulates and the traditional positions 6,7, and 8 marking aspect and mode will be after the CV prefixes and before cycle 1 CL and stem. Finally, Object and Deictic (4 and 5) will be after the CV prefixes and before the previous cycle 2 consonantal prefixes as predicted. Thus much of the ordering falls out.

(9)

	ADV 1	ITER 2	PLUR 3	# 4	OBJ 5	DEIC 6	ASP 7	MODE 8	PERF 9	SUBJ 10	CL	STEM
Concat.	+						Some				+	+
First insert #(CV)*_		+					Rest	+	+			
Subj-Obj. insert			+		Non-co-occuring					+		

However, there exist two apparent problems in the section circled on the chart and these are what lead to the mapping rules given in (8). Mode and perfective (positions 7 and 8), should by our hypothesis appear before cycle 1 position prefixes, and they do not, and we need an ordering of the cycle 2 position 6, 7 and 8 prefixes, since these all go in on the same cycle. Solutions to both of these involve the rules in (8).

Two examples will show how this works, in (10).

(10) (Present cycle material encased in [])

a. //d-dziɬ//; insert s+H 'to strain, make an effort, perfective'

3s-Add Ø: /d - [s - (H)] - dzil/ (s is inserted after d)
[-cont] before [+cont]
(floating H)

Output: [deesdziɬ]

b. //n-Ø-daaɬ//; insert d-gh ɬsit down, future'

3s-Add Ø: /[d]- n -[gh] - Ø - daaɬ/
[-cont] before [+cont] (gh inserted after n)
[-voice] before [+voice] (d inserted before n)

Output: [dínóodaaɬ]

(10b) requires further explanation -- the regular reflex of gh in 3s forms is o by rules we will discuss in what follows -- for now notice the o is to the right of the n.

Thus, the ordering of Navajo prefixes follows simply from three intersecting points: 1. Three cycles of affixation; 2. C vs. CV prefixes and 3. a reference to [cont] then [voice] features in mapping.

Furthermore, we can see that the reference to the partial matrix and mapping/metathesis is a cyclic rule. Third cycle object prefixes should not interact with cycle 1 prefixes or with cycle 2 unless adjacent. Two cycle 2 prefixes will interact on cycle 3 only if one has been changed on cycle 3. This is exactly what we find in the problematic hi seriatives, an example being given in (11). I assume two things about hi: I assume that it is cycle 2 since it is involved in the mode system, and I assume that h is underlyingly an underspecified consonant with features only of [back] and a L on the tonal tier, and as such will not participate in rule 8 and will remain on the periphery of the cycle 2 consonantal prefixes.

However, as noted by Kari (1973), two rules apply to h. These rules can be reanalyzed in the present framework as: If a cycle 3 consonant precedes h , such that h is not on the periphery, then h changes to y and now it can interact with adjacent consonants from a previous cycle and will undergo metathesis. An example is as in (11).

(11) 'break it up, future' 4th person

End of cycle 2: /ni--h--d-gh-tih/

Cycle 3: add j: /ni-j-d--y-gh-tih/

Output: [nizhdiyootih]

Thus, the solution being advocated here for prefix ordering follows from principles of the cycle, and from a single ordering based on a partial matrix, with such ordering part of the cyclic

component.

Problem 2. Movement of Partial Matrices

2.1 Toned consonants

In this section, we will argue for certain consonants having low tone associated with them, crucially the d and 1 classifiers (positioned before stem) and s and sh. We will show how positing low tone gives a simplification to certain of the classic Navajo phonological problems and then we will present a brief historical digression showing how the historical situation of consonants became reinterpreted tonally in Navajo.

(12) a. Consonants tone-marked everywhere:

s,	sh	(n	(also h, but not part of discussion here))
|	|	|	|
L	L	(H	L

b. Consonants tone-marked in coda position:

C	[STEM	C	[STEM
|		|	
d		1	
|		|	
L		L	

2.1.1 Perfectives

We are now in a position to look at some perfectives. Navajo perfectives have traditionally presented certain problems because Ø/± classifier paradigms differ from d/1 classifier paradigms and there are apparently ad-hoc vowel shifts, lengthening and tonal shifts. We can now offer explanation for some of these changes.

Part of the problem can be briefly seen in (13), for a ni- perfective for 1st singular. Perfectives are formed with gh, n or s plus H tone, here n + H tone. Ø/± classifiers will be unmarked tonally and d/1 will be L marked, as suggested above. If we compare n-perfective 1st person forms, we can see the results of this tonal contrast of the classifiers.

From (13) we can see that if the classifier is 0 or 1, then s never appears; if it is d or 1 then H tone never appears.

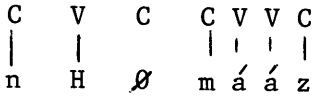
(13)

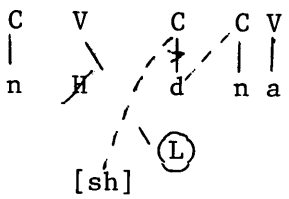
a.	/n - H - Ø - máázˊ/ 1 sg.	[nímáázˊ]	'to arrive rolling'
	/n - H - ± - báázˊ/ 1 sg.	[ní±báázˊ]	'to arrive driving it'

b.	/n - H - d - na/	1 sg.	[nish'na]	'to arrive crawling'
	/n - H - 1 - tɬ'ah/	1 sg.	[nishtɬ'ah]	'to arrive trotting'

Derivations will be as in (14), on cycle 2. Cycle 2 prefixes are n and H, cycle 1 prefixes include in these examples only the 0 or d classifier. Crucially d is L tone marked, marked the entire rime as L and H cannot attach, and will be lost in the d-classifier forms. On cycle 3, sh is attached, sh is marked as L tone, and cannot be attached in the Ø/ɬ classifier forms, since the H of cycle 2 has already marked the rime as H. In the d/1 classifiers, which have not allowed H to attach, sh can then attach on cycle 3.

(14)





sh-(L) cannot attach;
H marks rime as H

[nímaaz] [nish'na]

The same derivations are true of other 1 sg. perfectives -- the gh and s perfectives also. (15) gives a partial paradigm for si perfectives and note the same non-attachment of either H or L-marked sh.

(15) Si-perfective partial paradigm

Pre-subject morphology /s + H + classifier + stem/
Subject formation: 3,4 sg: Add y-, j-;
1sg. Insert [sh] before classifier
(sh ~ s in d-tin and 1-jíid not relevant here)

	a. Ø-tɬ'in 'pile them'	b. ɬ-tin 'freeze it'	c. d-tin 'freeze up'	d. 1-jíid 'squat'
1s	sé tɬ'in	séɬ tin	sis tin	shish jíid
3	yiz tɬ'in	yis tin	yis tin	yish jíid
4	jiz tɬ'in	jis tin	jis tin	jish jíid

Note the presence or absence of H tone and sh subject correlating with classifier as in the ni perfectives. Note also in the 3rd and

4th forms that the s perfective marker shifts to coda position (appearing as z with no classifier and sh if harmonizing with j).

Thus the ni analysis is reinforced, and an additional property of perfectives -- shift of fricative to coda position will need discussion.

2.1.2 Gh-perfectives.

The final type of perfective -- the gh perfective is a bit more complex. Gh is quite unstable. In all forms of the language, gh becomes a glide if before underlying high vowels. Here we will suggest an extension of the glide formation environment:

(16) 1. Instability of gh. Becomes glide if not followed by [low] on laryngeal or vowel height tier.

We have noted the swing of fricative s to coda position in 3rd and 4th forms, and we can note that if there are two consonants before the stem such as first subject sh with a classifier, or second dual h with a classifier, that only one consonant appears on the surface. If such a consonant is s or sh then it will appear -- in effect winning out over the classifier. (17) shows this for the previous 1s perfective.

(17) //s-__-sh-1-jɨ́ɨ́d// 'squat' 1s perfective
[shish jɨ́ɨ́d]

Let us suggest that there are two places where consonants can attach at the pre-stem coda, with a post-cyclic rule fusing the two Cs or deleting one C, i.e. a situation as shown in (18) with later rules giving correct surface single C.

(18) There exist two C slots in coda position, i.e.

C C [C (stem)
|
cl. = classifier

Thus, we find, in the general case, a schema such as shown in (18) and subject prefixes such as sh, h, etc. will map into the empty C slot, and s perfective will shift to such an empty C position in the 3rd and 4th forms. Such s or sh will surface over the classifiers, however, if the subject consonant is a back consonant, such as h 2 dual, then it appears only when there is no classifier, but causes epenthetic vowel to become back, resulting in o.

We now can examine partial paradigms involved with gh perfectives. Again, the 1s forms show different behavior based upon whether the classifier is Ø/ɬ or d/l. (19a) shows the now expected 1s forms.

(19a) 1 sg forms - gh perfectives

a.	/gh - H - [sh]-Ø - cha/	1sg	[yícha]	'cry'
	/gh - H - [sh]-ɬ - chǫ'/	1sg	[yíɬchǫ']	'ruin it'
b.	/gh - H - [sh]-d - lą́ą́'/	1sg	[yishdlą́ą́']	'drink it'
	/gh - H - [sh]-l - nóód/	1sg	[yishnóód]	'dive into it (the water)'

(19b) shows 4th persons for these -- the forms relevant to the discussion here.

(19b) 4th person forms - gh perfectives

a.	/gh - H - 0 - cha/	4th	[jíícha]	'cry'
	/gh - H - l - chǫ'/	4th	[jííɬchǫ']	'ruin it'
b.	/gh - H - d - lą́ą́'/	4th	[joodlą́ą́']	'drink it'
	/gh - H - l - nóód/	4th	[joolnóód]	'dive into it (the water)'

Let us assume gh --> y is a cyclic rule with environment either i or H, i.e. no unspecified vowel. In the (19b-a) forms the gh --- y environment will be met at the end of cycle 2 since H remains and derivation will be as in (20).

(20) 1.

C	V	C	C	V
gh	H	Ø	ch	a
↓				
y				

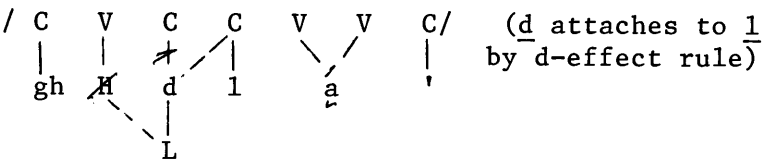
2.

	V				
C	Ø	V	C	C	V
j	y	H	Ø	ch	a

CL gives C --> V here (as well as in other forms such as futures)

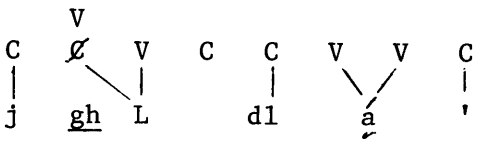
Output: jíícha

If the classifier is a low toned classifier, then H is lost and gh will not become y, but rather will remain as a [bk] voiced continuant. If there is only a single consonant or no consonant in coda position (assuming two melody slots in coda), then the features of backness from gh will attach to the coda. Derivation for (19b)--lą́ą́ is as in (21).

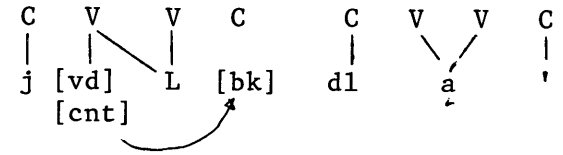
(21) 1. 

(d attaches to l by d-effect rule)

2. Add j:



3. Movement of [gh] features to right:



Output: joodlaa'

We now have vowel insertion -- the epenthetic vowel before other back consonants is regularly o as shown in by 2d forms. An example is shown in (22).

(22) /n - Ø - teesh/ 'to lie down, dual, imp.
/n - h - teesh/ Subject cycle - insert h pre-stem
[nohteesh] Output

O insertion does not occur after back consonants -- note the forms in (23) with h seriative -- h coda being one of the triggers for o insertion as in the previous example.

(23) /ni - h - tiih/ 'break it up, imperfective'
[nihishtiih] 1 sg. - insert sh pre-stem

Thus, the possibility exists for the feature of the velar fricative to shift to coda position resulting in the regular case of o-insertion. However, we note that only the back features do shift; were the entire feature matrix to shift backward, we would expect to find the remaining features appearing when there was no other coda consonant, i.e. a situation such as in (19b), where d attaches rightward, vacating the coda position might appear with coda gh and note in this case, that no such velar fricative appears. Thus we argue that only part of the feature matrix is involved in the movement.

2.2 The Historical Development of Toned Consonants

In this section, we will present two reasons for the development of tone on classifier d and l; the first involving a general Athapaskan rule of metathesis, and the second unique to Navajo and other "low-marked" Athapaskan languages.

2.2.1 Athapaskan d-n metathesis

We note that the H which we have seen in the various perfectives derives historically from n, and that many if not most Athapaskan languages have a difference in behavior in the Ø/ɬ classifier perfectives, versus the d/l classifier ones. In the Ø/ɬ classifier forms, n shows up typically as vowel quality raising or high tone, and there is no trace of the n in the d/l forms. Note also that l is derived historically from d+ɬ, so that in both cases, the appearance of n before d results in apparent loss of n. But note that n (cycle 2) if it has a representation of n would be in a position to undergo the Navajo cyclic metathesis rule with d, resulting in d-n, and hence n would never occur as raising before d. Thus, we suggest that the metathesis of n-d may be older than Navajo, and may be part of the reason why d/l classifiers have been reanalyzed as having low tone associated with them.

2.2.2 Navajo stem tone.

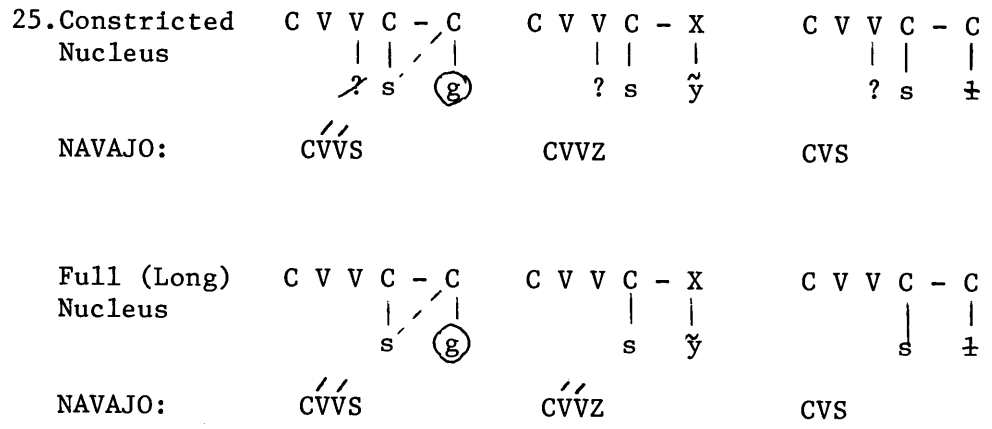
As we know from traditional literature, and from work by Leer (1979) and Hardy (1979, Navajo stem tone arose from two contributing factors and their interaction. In general, long nuclei developed high tone, short nuclei developed low tone. In general, glottalization of the syllable coming either from a final glottal consonant or from a nucleus consisting of V+?, caused lowering of the tone; loss of glottalization meant that there was no lowering of tone. This description is given in (24).

(24) General development of Navajo stem tone

a. Long nuclei yields H tone; short nucleus yields L tone.
b. V?(C) (constricted nucleus) or VC'] (glottalized coda) yields L tone; loss of glottalization from CL or double glottalization cancel-out then subject to clause (a)

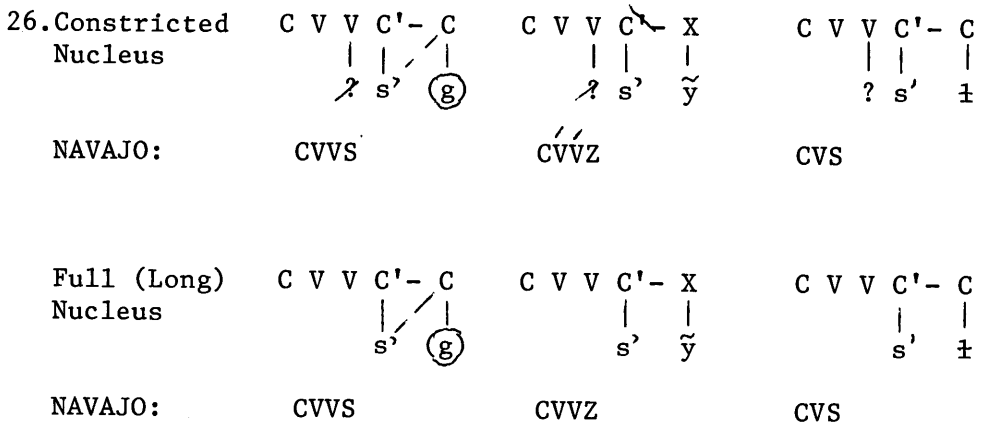
Two factors could give loss of glottalization. One, as noted by Hardy, double glottalization, i.e. both constricted and glottalized consonant together would cancel out to yield no glottalization. Two, a process of compensatory lengthening, with loss of final velar consonant involved in imperfective stem formation, also caused loss of glottalization.

Thus, in (25), I give a sample schematic of how a constricted and non-constricted non-glottalized fricative-closed stem developed. Note shortening of the syllable when nucleus is followed by two Cs in the future forms, also.



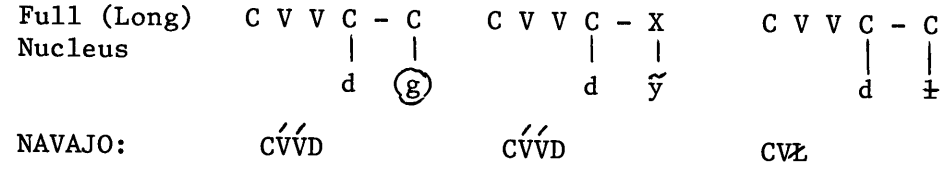
Thus, from (25) we can see that coda fricatives yield low tone when followed by a second [+cont] consonant or when in a short syllable. Since this environment is met in a cyclic situation of suffixation, we assume that it could be generalized to all cyclic situations, and could be generalized crucially to sh first person, and s perfective marker, as we shall see.

Historically final glottalized consonants were all [-cont] stops or affricates. Spirantization yielded fricatives for these, with the [-cont] feature being retained on the laryngeal tier only, and then, we speculate, being reinterpreted as a (L) tone marker. A schematic presentation of present day Navajo forms for an historically glottalized-final stem is shown in (26).



Furthermore, if we look at a d-final stem, we can see that d will be retained in the imperfective and perfective cases, but in futures, i.e. short syllable, followed by [+cont], d will be lost and L tone will develop. This is shown in (27). Thus, two situations conspire to give us d-loss or [-cont] feature loss associated with short syllables and the [-cont] feature becoming reinterpreted as a L tone marker.

(27) D-final stem development (full nucleus example)



Again, since this environment is met in a cyclic situation of suffixation, we assume that it could be generalized to all cyclic situations, and could be generalized crucially to d classifier, and l classifier, derived from de-affrication of d-ɬ affricate classifier. Thus, we suggest that the L tone in these cases then becomes part of the cyclic component. and we should find L in two places as in (28).

(28) a. Voiceless syllable final continuants after a short vowel- - later generalized to voiceless continuants in general.

b. With loss of a [-cont]; this happens in d-effects where d-classifier is lost or with l classifier - derived from d+ɬ, at least in some cases, synchronically.

Thus, we suggest that two processes may have together brought the reanalysis of certain consonants in Navajo - one the general Athapaskan metathesis, whose presence is still felt in the ordering of prefixes, and the second the special development of stem tone on the cycle above the root, hence as the first part of the cyclic component.

NOTES

*I am grateful to Keren Rice and Ken Hale for discussion on earlier versions of this paper, and for comments which I have incorporated. Additional problems which have not been dealt with in this paper because of space considerations are discussed in Wright (forthcoming).

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