GEMINATION AND SYLLABIC REPAIRS IN SANSKRIT AND MIDDLE INDIC

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Abstract

This paper deals with consonantal gemination in Sanskrit and Middle Indic. It proposes that this gemination process resulted from a process called here root spreading. By spreading the root node of a segment, this process creates configurations that satisfy constraints against complex onsets or codas with the consequence that these syllabic configurations are eliminated. A detailed analysis of the development of consonantal clusters in Sanskrit and Middle Indic is provided.

1. Introduction

Saussure (1889) observed that there was a lack of contrast between the Sanskrit forms in (1) a) as discussed in the passage in (1)b)*:*

(1) a. *śara-trayam* 'tree arrows' *śarattrayam (< śarad-trayam)* 'three autumns'

b. Saussure (1889, 426-7):

"Devant liquide, nasale ou semi-consonne, le catégories de la consonne double et de la consonne simple sont absolument confondues en sanskrit. Etant donnés les composés *śara-trayam* (trois flèches) et *śarad-trayam* (trois automnes), nous croyons devoir en Europe observer la differérence étymologique dans l'orthographe, écrire l'un *śaratrayam* et le second *śarattrayam*. Si nous consultons la tradition indigène, nous apprenons qu'il faut écrire:

a. D'après nombre de manuscripts dans les deux cas *śaratrayam..* Aucune occlusive n'est marquée double devant [r, w].

b. D'après certains P*rātiśākhyas:* dans les deux cas *śarattrayam*. Aucune occlusive n'est marquée simple devant [r, w].

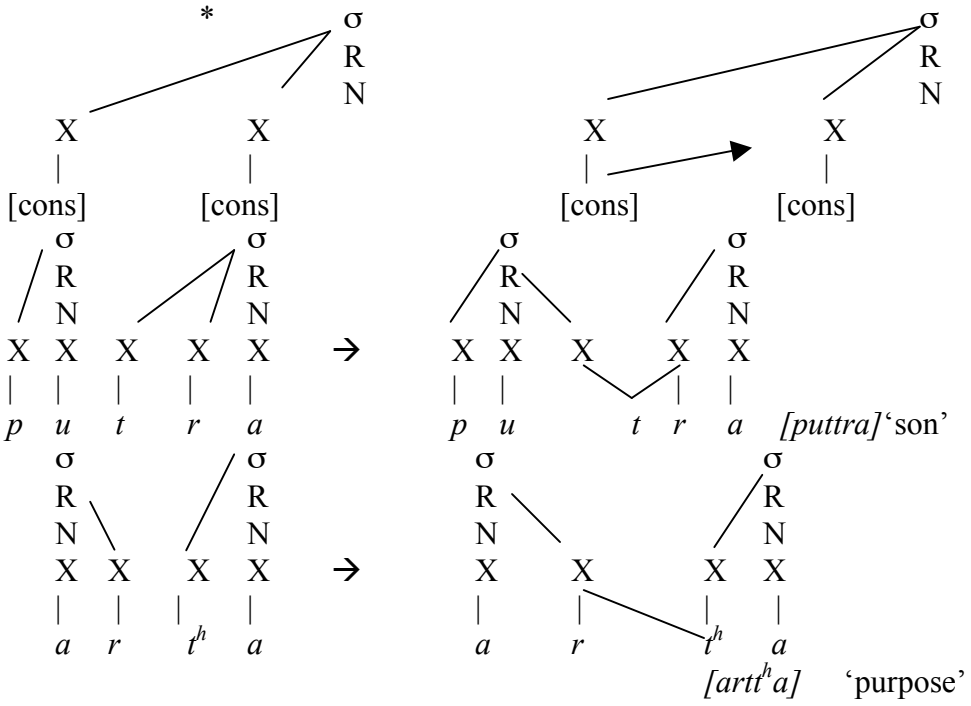
c. D'après P*āṇini* (8, 4, 47); cf. avec critique 48 et 50-52): dans les deux cas *śaratrayam* ou dans le deux cas *śarattrayam*. Emploi à volonté de la lettre double ou simple devant [r, w].

Cette dernière doctrine, pour etre fidèlement rapportée, doit plutot se formuler comme suit: toute occlusive est supposée simple devant [r, w], mais on peut toujours la redoubler"

Saussure argued that the fundamental reason for the lack of contrast in the Sanskrit forms in (1)a) is that the stop in clusters stop+ sonorant was always geminated; this gemination was sometimes not represented orthographically in Sanskrit. The topic of this paper is this process of gemination. My hypothesis is that this gemination process results from a process removing complex onsets and codas. The basic assumption behind this hypothesis is that skeletal positions represent the interface between syllable

structure and the melodic segments. A given melodic segment is assigned a given syllabic status through its association with a skeletal position. By changing its association relations with the skeletal positions we can change its syllabic status. Complex onsets are governed by constraints targeting the relations between classes of melodic segments and syllabic positions such as the one in (2)a). We can then remove complex onsets by changing their sub-skeletal representation by an operation I will call root spreading as in (2)b). (2)b) eliminated complex onsets in Sanskrit (see (3)). As we will also see, the mirror image application of (2)b) eliminated codas (see (4)):

(2) a. No complex onsets b. Root spreading:



(3)

(4)

2. Sankrit and Middle Indic Gemination

In Calabrese (2009) I provide evidence showing that at least two different passes of syllabification must be postulated for Sanskrit. In an initial pass complex onsets and simple and complex codas are allowed. In a later pass, in contrast, both complex onsets and simple and complex codas are disallowed. The main focus of this paper is the resyllabification process that brought about the changes characterizing the second pass of syllabification.

2.1 Graphic Doubling of consonants in Sanskrit Manuscripts

In many Sanskrit manuscripts, the first consonant of clusters of rising sonority is written as double as shown in (5)(see Vaux (1992), Whitney (1868), Wackernagel (1896:112) and especially Varma (1929, chapter II and V), for a detailed discussion of the facts).

(5)

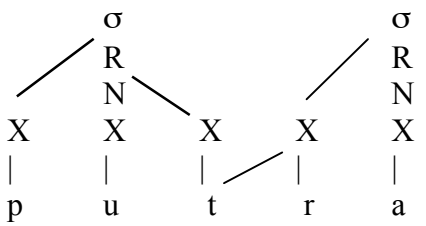
dádhy átra	-->	*daddhy átra*	'sour milk + here '
mádhv átra	-->	*máddhv átra*	'delicious + here'
agnḗ	-->	*aggnḗ*	'fire'
putráḥ	-->	*puttráḥ*	'son, child'
satyáḥ	-->	*sattyáḥ*	'true'

Whitney (1868) provides the following account of the conditions under which graphic doubling occurs in Sanskrit:

(6) The first consonant of a cluster is doubled, but when the first member of the cluster belongs to the set *{r l v h}*, it is the second member which is doubled; in addition, the phonemes */r/* and */h/,* geminates, and members of homorganic stop clusters do not geminate.

Calabrese (2009) shows that the first consonant of intervocalic clusters of rising sonority has a peculiar property in Sanskrit: it has a double identity: it seems to be the coda of the preceding syllable, thus making it heavy, but at the same time, it behaves as if it is in the onset of the following syllable. Observe that it is precisely this consonant that is doubled in the manuscripts. Varma (1929) argues that this graphic doubling represents actual phonetic gemination: wherever a consonant is graphically double in the Sanskrit manuskripts, later stages of Sanskrit, and in particular Middle Indic, display an actual geminate in its place (see also Jacobi (1881: 609)). We can thus assume that Sanskrit word *putra* was phonologically represented as in (7):

(7)



One of these middle Indic languages displaying cluster gemination is Pāli (Hankamer and Aissen (1974))).

(8)

a. Sanskrit:	*kalya*	Pāli:	*kalla*	‘ready’
	catvaras		*cattaro*	‘four’
	aśva		*assa*	‘horse’
	kurvanti (v=[w])		*kubbanti*	‘they make’
	kilbiṣa		*kibbisa*	‘guilty’
	kalmāsa		*kammāsa*	‘freckled’

Notice, however, that clusters in word initial position are simplified by eliminating the second onset consonant (see later for discussion):

(9)

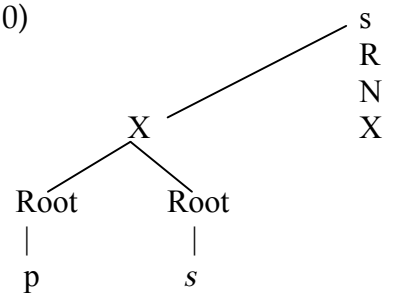
Sanskrit			*Pāli*
kvaṭhati	'boils'	→	*kaḍhai*
trasati	'tremble'	→	*tasati*
grāma	'village'	→	*gāma*
śruta	'heard'	→	*suta*
dhvani	'sound'	→	*dhani*

3. Explanation of gemination in Sanskrit and Middle Indic

I propose that the main purpose of the gemination process we see in Sanskrit and Middle Indic is the elimination of complex onsets and codas.

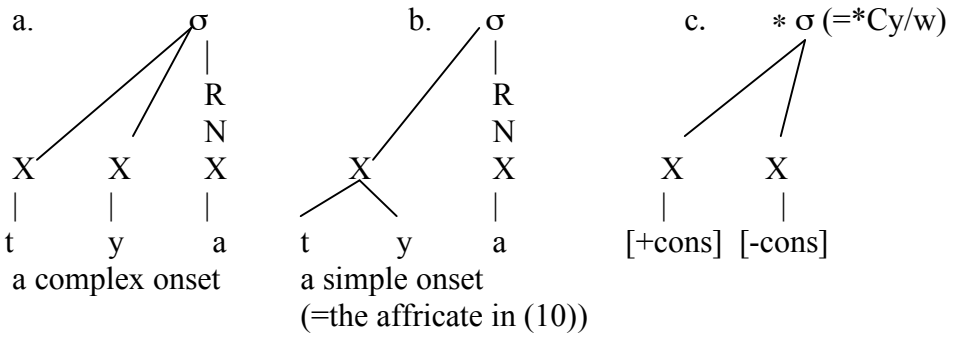
Consider the status of skeletal positions and their relation to segmental roots. The skeletal positions must be considered as the interface level between the melodic component and syllable structure. A skeletal position represents the syllabic segment, the structural unit that is relevant for syllable structure. A skeletal position is to be distinguished from the root whose function is to represent the temporal overlap or simultaneity among the features it dominates. The root represents the melodic segment, a bundle of simultaneously articulated features, namely, the phoneme. Such a distinction between syllabic segments and melodic segments is needed to describe sounds such as the labio-coronal /ps/ of Margi (Ladefoged 1968), the velarized coronal affricate /tx/ of Xũ (Snyman 1970) or the double fricatives *fs, ʃf, βʃ* of SePedi (Ladefoged and Maddieson (1996). The languages where they are found have simple CV syllables and therefore do not allow consonantal clusters. Hence these sounds involve a single syllabic unit but two melodic elements. For example consider Margi /ps/(see Clements (1992)) (See Calabrese (2009) for more discussion and evidence in support of this type of representations):

(10)



The crucial assumption in the analysis of gemination in Sanskrit is that a given melodic segment is assigned a given syllabic status through its association with a skeletal position. By changing its association relations to the skeletal positions we can change its syllabic status. Calabrese (2005) proposes that the operation of root spreading in (12) must be recognized as a strategy to repair syllable structure which can be used as an alternative to nucleus-insertion (epenthesis) and deletion. In particular, root spreading ((2)b)) can repair violations of the constraint in (11)c) and convert (11)a) into (11)b).

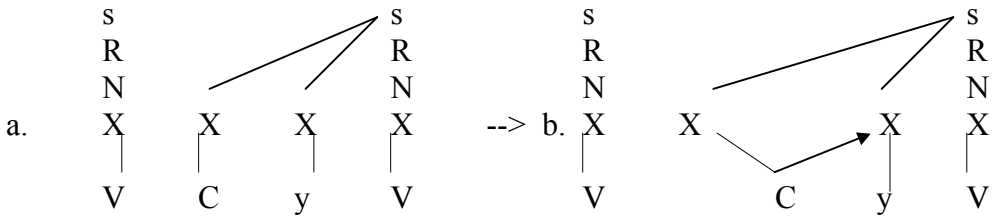
(11)



Consider the structure in (11)a). If the root node of the first onset consonant is incorporated under the skeletal position dominating the glide as in (11)b), we are no longer dealing with an onset cluster. To have an onset cluster one needs two or more skeletal positions, each exhaustively associated with a melodic segment. Thus, by the root spreading operation in (2)b, the onset cluster is removed from the syllabic interface, and can no longer be targeted by the constraint in (11)c).

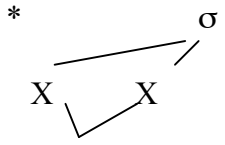
As we can see in (12), the application of root spreading in (12) creates an onset geminate:

(12) Application of Root spreading to repair a complex onset:

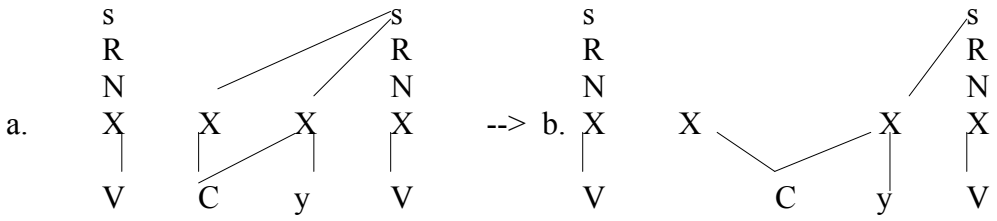


Onset geminates are disallowed by the constraint in (13). This onset geminate is repaired by delinking its first member from the onset position as in (14):

(13)

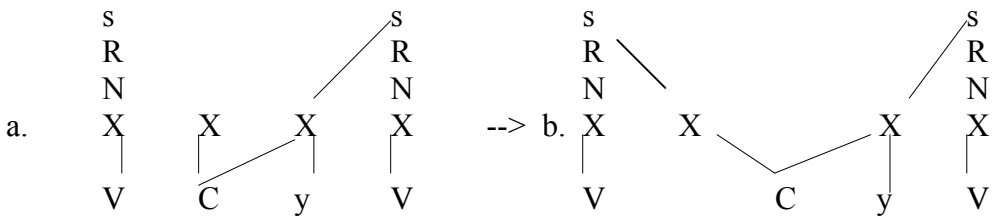


(14)



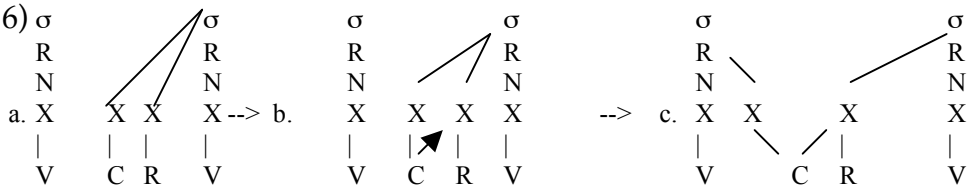
The unsyllabified consonant that results is incorporated into the preceding syllable thus resulting into a legitimate geminate.

(15)



Summarizing what proposed above, we can repair an onset cluster by spreading the root of the first onset consonant onto the skeletal position of the following one. The surface effect of this repair is that of geminating the first consonant (see (16)):

(16)



4. Analysis of gemination in Sanskrit and Middle Indic .

4.1. Elimination of complex onsets

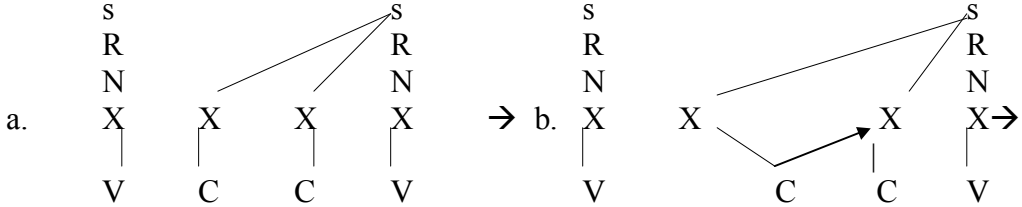
Let us consider Sanskrit and Middle Indic again. Examples in (17) are from Pischel (1981: 225, 233), Masica (1981: 174-15).

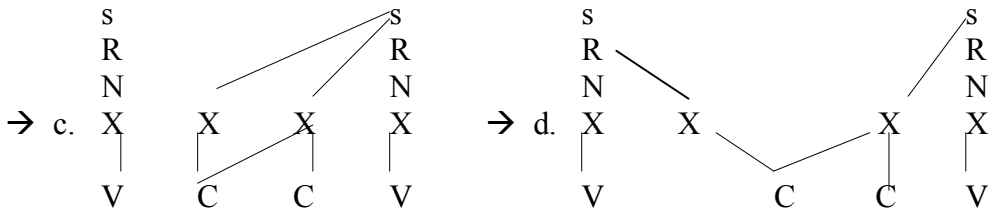
(17)

a. Skt. Input		*b. Skt. Surface*	*c. Middle Indi*
aśakya	'impossible'	*aśakya*	*asakka*
supyatē	'sleeps'	*suppyatē*	*suppati*
ramya	'enoyable'	*rammya*	*ramma*
S*arasvati*	'n. of goddess'	S*arassvati*	S*arassadi*
cakra	'wheel'	*cakkra*	*cakka*
aśru	'tear'	*aśśru*	*assu*
agnih	'fire'	*aggnih*	*aggi*
yugma	'pair'	*yuggma*	*jugga*

In Calabrese (2009), I proposed that in initial syllabification complex onsets and codas are allowed in Sanskrit. In the preceding section I argued that these complex onsets and codas are eliminated in a second pass of syllabification through the operation of root spreading as in (18).

(18)

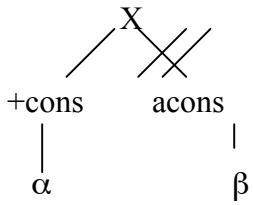




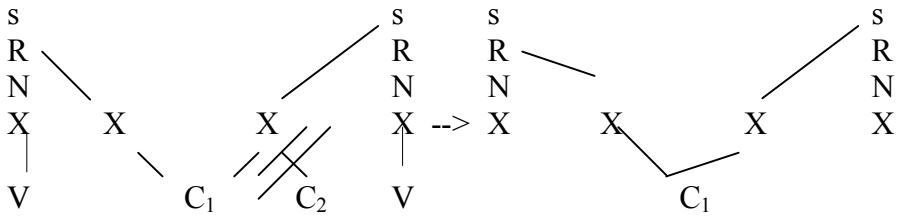
The Middle Indic outcomes can be accounted for by assuming a process delinking branching roots in (20). The Uniformity Applicability Condition (UAC) Schein and Steriade (1986)) (as reformulated in Calabrese (1999)) in (19) allows the application of (20) only to singly-linked branching roots.

(19) Given a node *n* and a set *S* consisting of all nodes linked to *n,* and given a rule or a constraint *T*, if *T* refers to *n* and any member of *S,* it must refer to all members of *S* to be active.

(20)

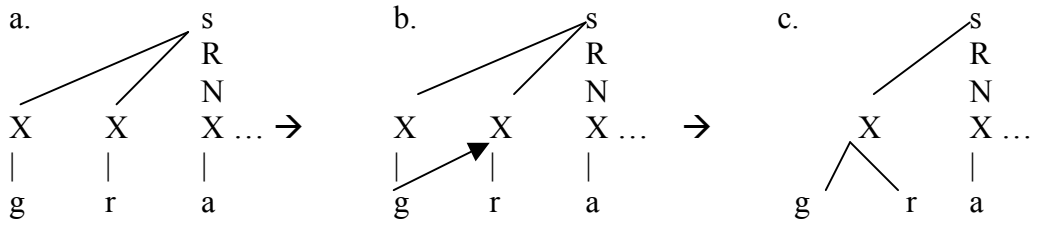


(21)



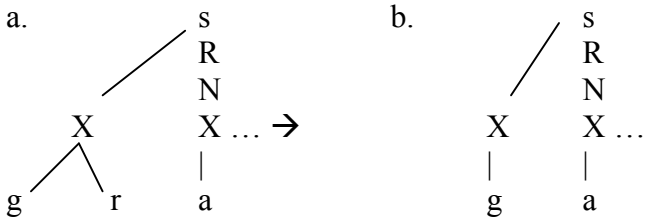
The analysis just proposed can be extended to word-initial position. No gemination in Sanskrit or in Middle Indic is observed in this case, as shown in (e.g., Skt. *grāma* 'village' Middle Indic*: gāma*). I propose that in this case, the onset geminate resulting from the application of root spreading (2)b) is eliminated by skeletal deletion (see (22)b):

(22)



In the affricate-like structure in (22)c), Middle Indic eliminates the most sonorous components as in (23):

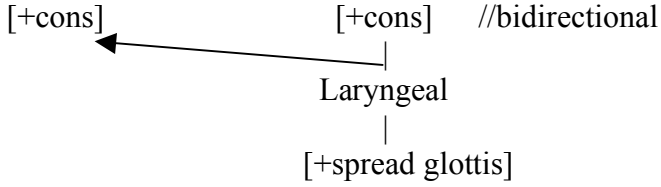
(23) a. b.



To account for the evolution of other consonantal clusters from Sanskrit to Middle Indic, some further rules are required, for example, aspiration. It is required to account for what happens in the clusters in (24)(Pischel (1981: 258):[1]

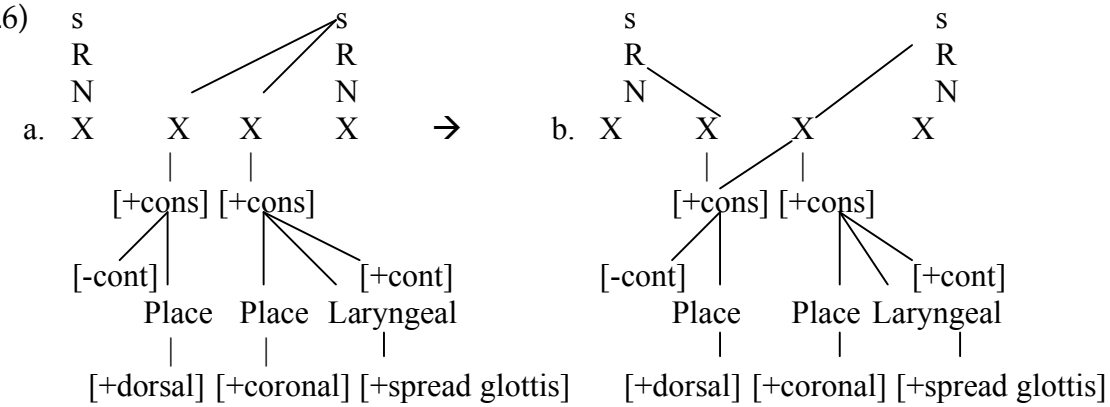
(24)	*a. Skt. Input*		*b. Skt. Surface*	*c. Middle Indic*
	kṣata	'wounded'	*kṣata*	*khata*
	akṣi	'eye'	*akkṣi*	*akkhi*
	bhikṣu	'mendicant'	*bhikkṣu*	*bhikkṣu*
	śikṣita	'learned'	*śikkṣita*	*sikkhida*

(25) Aspiration rule:



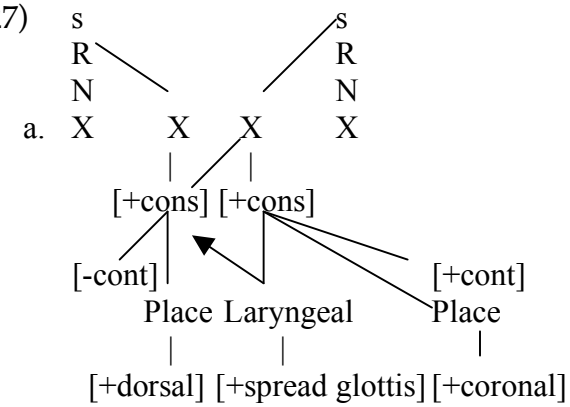
Consider a word such as *akṣi*. (2)b) generates (26)b). This is the Sanskrit situation. In Middle Indic, rule (25) applied as in (27).

(26)



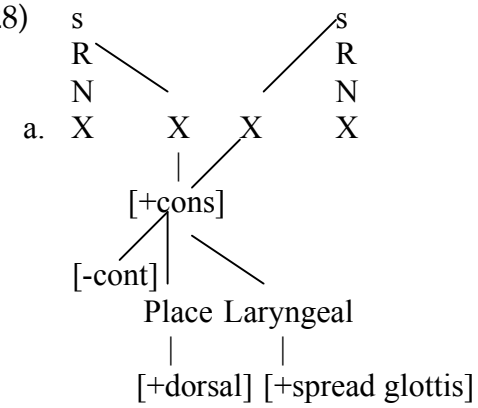
[1] Two rules of palatalization are also needed to account for the treatment of clusters in cases such as Skt. *satya* 'truth' Middle Indic *sacca* or Skt. *akṣi* 'eye' Middle Indic*: acchi* (when *k* < *ś*), Skt. *apsaras* 'nymph' Middle Indic: *acchara*. They cannot be discussed here. (see Calabrese (2009) for discussion))

(27)



Subsequent application of (20) generates the geminated aspirated stop in (28):

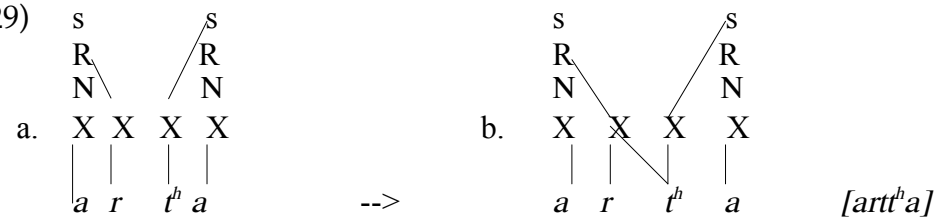
(28)



4.2 Elimination of codas

Gemination is also found in clusters such as that in (29)a) where we have a simple coda containing a liquid followed by simple onset. It is the simple onset that is geminated in this case. See sample cases in (30) (Pischel (1981: 233)(Masica (1991:176).

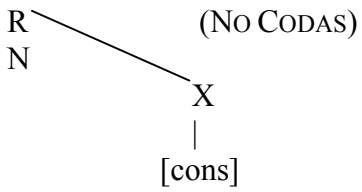
(29)



(30)	*a. Skt. Input*		*b. Skt. Surface*	*c. Middle Indic*
	ardha	'half'	*arddha*	*addha*
	mārga	'road'	*mārgga*	*magga*
	artha	'purpose'	*arttha*	*attha*
	arpita	'entrusted'	*arppita*	*appita*
	alpa	'small'	alppa	appa

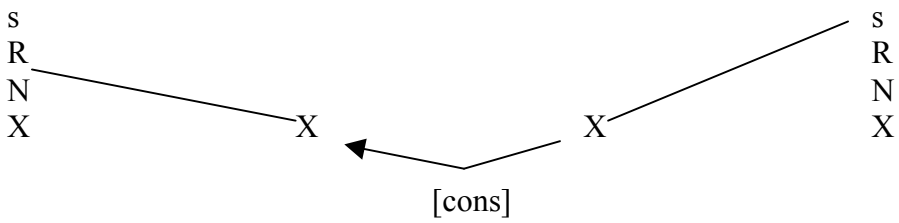
As dicussed above, root spreading (2)b) lead to the elimination of complex onsets in Middle Indic. I propose that its mirror image application also lead to the elimination of true codas where a true coda involves a violation of the constraint in (31) where we have an independent and unlinked root node.

(31)



The only codas that are allowed in Middle Indic after the application of (2)b) (mirror image) are the first member of a geminate as shown in (32). [2]

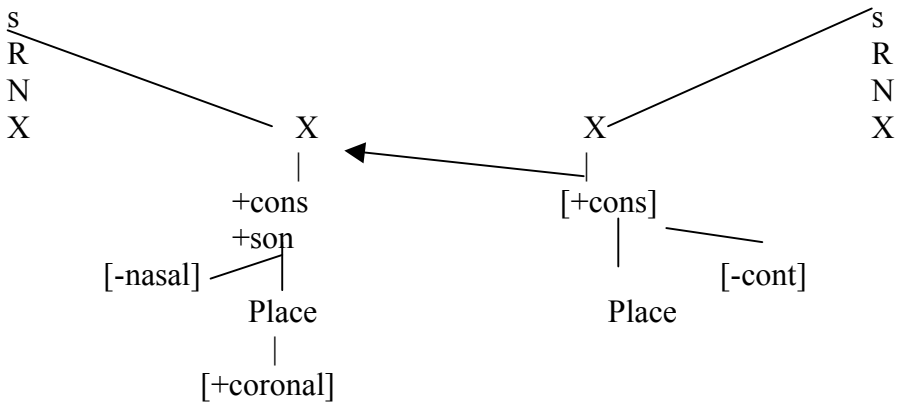
(32)



The constraint in (31) does not hold for (32) since the root in (32) is also part of the onset. Therefore, the coda in (32) does not violate (31) and is not a true coda. Therefore, the process in (2)b) (mirror image application) eliminates true codas.[3]

Consider the case of a cluster with [r] followed by a stop. The coda consonant violates (31). Root spreading (2)b) (mirror image) repairs this violation as in (33). In fact, after the application of root spreading, the coda skeletal position in (33) is not affected by the constraint in (31) according to the UAC because it also dominates a root that is dominated by the onset of the following syllable. The Middle Indic outcomes is obtained by the application of (20) as in (34):

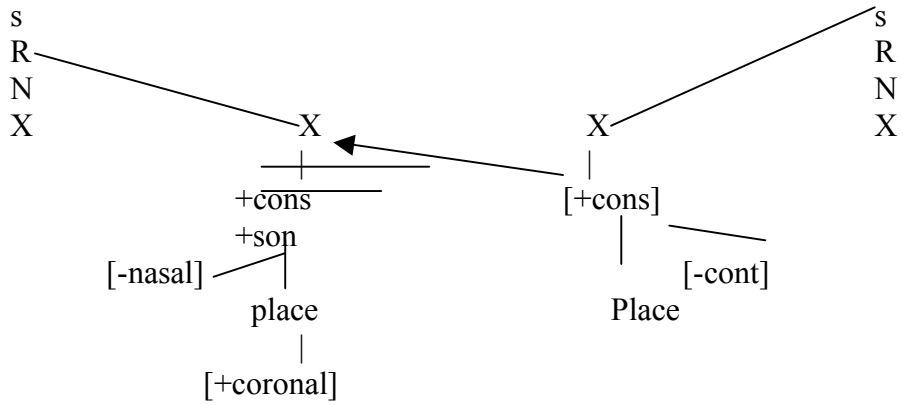
(33)



[2] Codas in Middle Indic can also contain nasals homorganic with the following onset. They behave like geminates, as discussed later.

[3] Observe that the final nasals, i.e.,the /*ṃ*/ of *kattuṃ* inf. kar 'to make, are anusvara which according to Calabrese (2009) are part of the syllabic Nucleus and therefore not true codas.

(34)



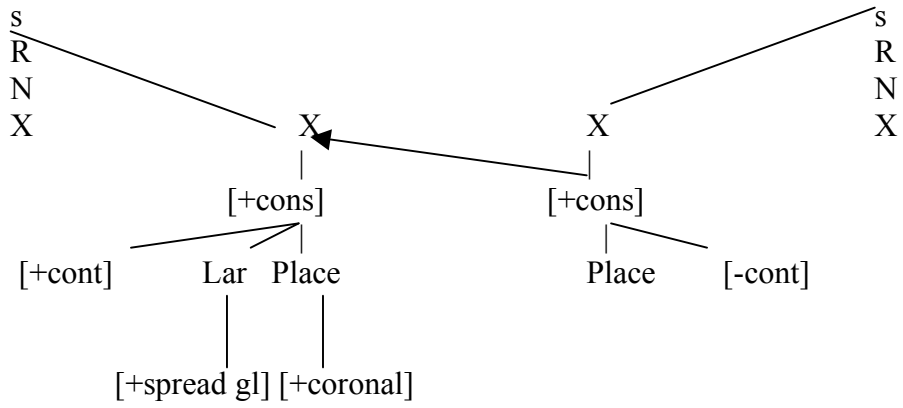
Consider now clusters containing a coronal fricative followed by a stop. In sequences such as these there is gemination of the stop (Varma (1929, 75) Pischel (1981: 238)(Masica (1991:177)):

(35)

a.	*Skt. Input*		*b. Skt. Surface*	Middle Indic
	hasta	'the hand'	*hastta*	*hattha*
	vastu	'thing'	*vasttu*	*vatthu*
	aṣṭā	'eight'	*aṣttā*	*attha*
	puṣpa	'flower'	*puṣppa*	*puppha*
	avaskanda	'assault'	*avaskkanda*	*avakkhanda*

The coda consonant in the examples in (35) is disallowed by (31). Root spreading ((2)b) (in its mirror image application) removes the configuration disallowed by (31) as discussed above (see (36)).

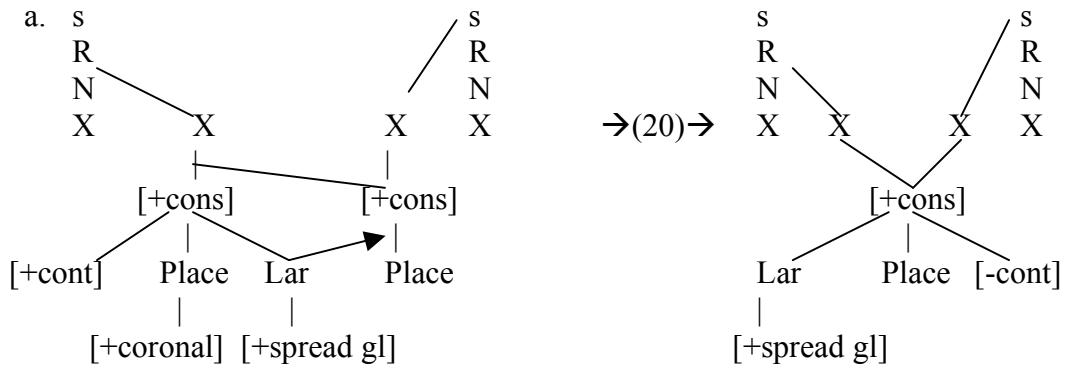
(36)



This accounts for the gemination we see in surface Sanskrit in these cases.

The Middle Indic outcomes are derived by the application of (25) followed by the delinking operation in (20) thus generating (37)b):

(37) a.

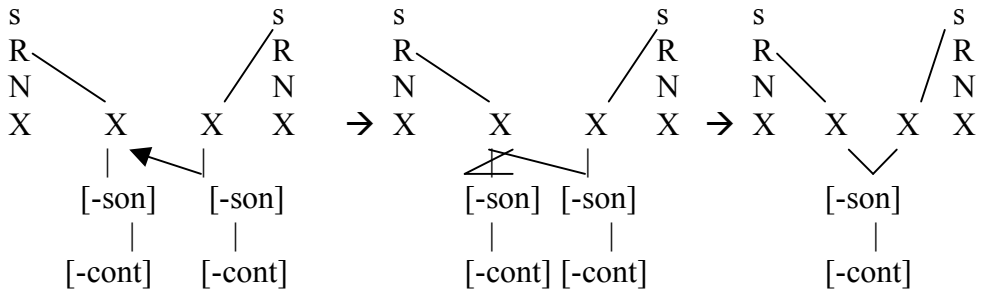


Root spreading in (2) (in its mirror image application) immediately explains the gemination we find in stop clusters:

(38)	*a. Skt. Input*		*b.Skt. Surface*	*c. Middle Indic*
	bhakta	'meal, food'	*bhaktta*	*bhatta*
	dugdha	'milk'	*dugddha*	*duddha*
	ṣaṭka	'set of six'	*ṣaṭkka*	*chakka*
	utpāta	'sudden portent'	*utppāta*	*uppāta*
	sapta	'seven'	*suptta*	*sutta*
	labdha	'taken'	*labddha*	*laddha*

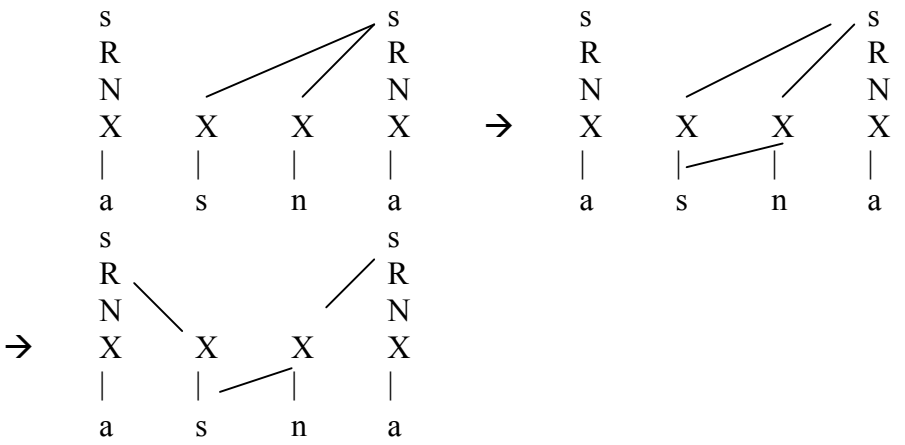
The input configuration for these clusters is shown in (39)a). The stop in coda position is disallowed by (31). Root spreading applies to repair this configuration and geminates the second stops as in (39)b). This is the Sanskrit surface situation. The Middle Indic outcomes are derived by applying (20), as in (39)c):

(39) a. Sanskrit: b. Surface Skt. c. Middle Indic

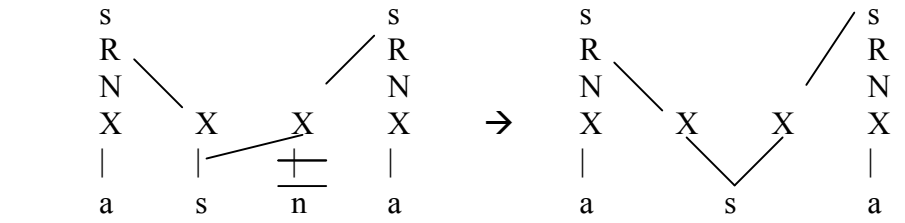


We can consider now the sequence of a fricative plus a nasal. In initial syllabification they behave as onsets (see Calabrese (2009)). Here application of (2)b) should give us gemination of /s/ (see (40)) and (41) for the Middle Indic outcome with loss of the nasal due to (20)).

(40) Sanskrit gemination



(41) Middle Indic outcome



There are a few of such outcomes (see (42)). However, the most common development of this cluster in Middle Indic is a geminated aspirated nasal (see footnote below about the digraphs nh/mh)[4])

	Skt. Input		*Skt. Surface*	*Middle Indic*
	raśmi	'rope'	rassmi	rassi
	etasmin	'this-Lsg.'	etassmin	edassim
(43)	*praśna*	'question'	*praśnna*	*paṇha*
	K*ṛṣṇa*	'dark blue'	K*ṛṣnna*	K*aṇha*
	gr̄iṣma	'summer heat'	*gr̄iṣmma*	*gimha*
	aśman	'stone'	*aśmman*	*amha*

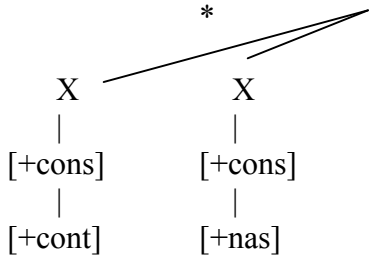
Observe now that although onset clusters fricative + nasal need to be reconstructed for common Indo-European, they were eliminated in Indo-European languages such as Greek and Latin . They can be considered quite instable and marked onset clusters. We should expect a tendency to eliminate them before of other clusters.

To account for the Middle Indic development we see in (42), I then propose that at a certain point of the history of Sanskrit, before the resyllabification process that lead to gemination occurred, there was a change in what was allowed in initial

[4] The digraph nasal+h represents an aspirated nasal (Masica (1981: 178)). Its geminate status is shown by the fact that it triggers shortening of the preceding vowel as all other geminates (Masica (1981:183): Skt. *gr̄isma* 'summer heat' MI *gimha;* Skt. *ślēṣman* 'mucus, phlegm' MI silemha/silimha). This shortening is due to Geiger's Law according to which syllable rimes in MI cannot exceed two moras (see Calabrese 2009 for more discussion)

syllabification. In particular, onset clusters of a fricative followed by a nasal became disallowed, i.e., the constraint in (44) became active)

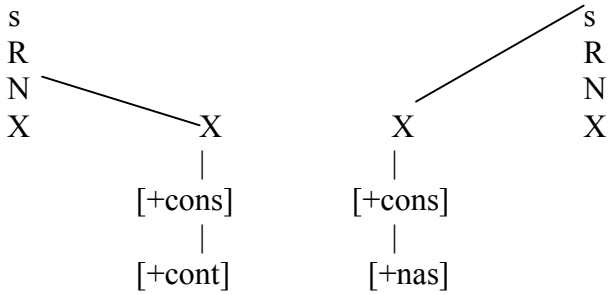
(44)



(No s+nasal onsets)

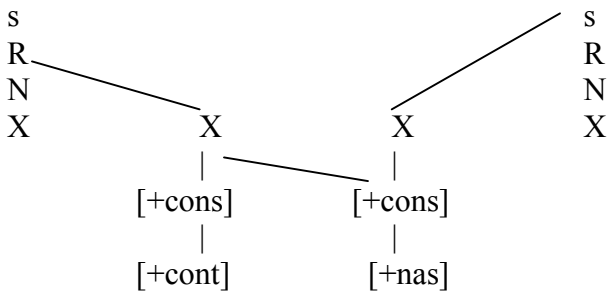
Therefore sequences of this type were syllabified as in (45) in initial syllabification

(45)



In the second pass of syllabification these configurations were removed by root spreading as in (46):

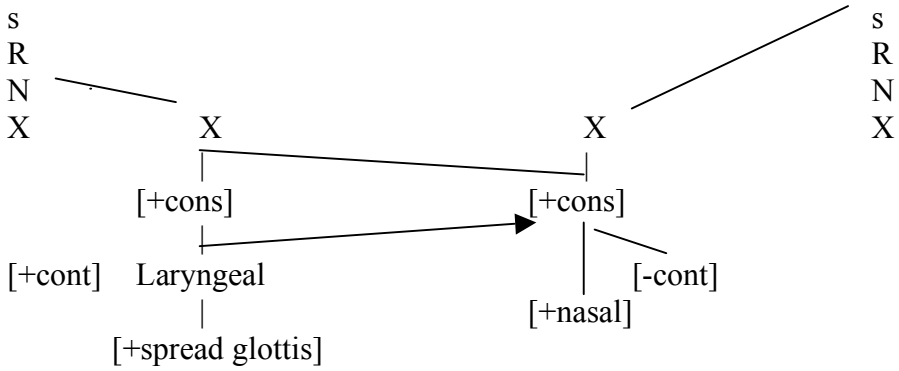
(46)



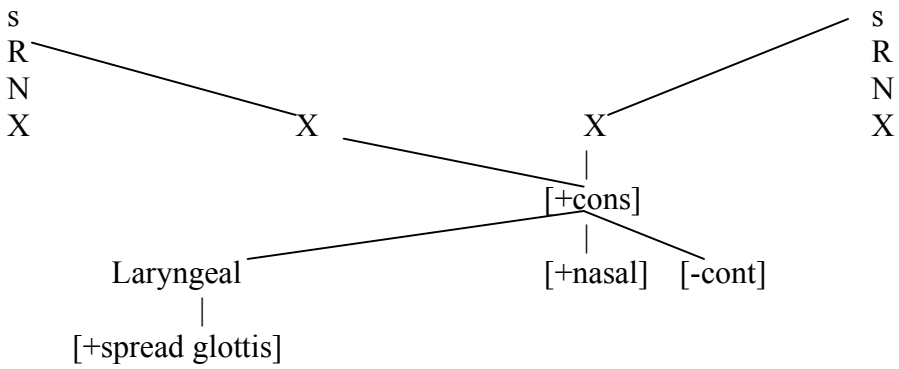
The Middle Indic outcomes are accounted for by applying the rule of aspiration in (25) as shown in (47). (20) then applies and (48) is generated. [5]

[5] Root spreading followed by skeletal deletion applies when these clusters occur in word-initial position: (*snāti* 'bathes'→ *nhāi, snāru* 'sinew' →*nhāru, snūsā* 'son'swife' → *nhusā*). In the case of these cluster also epenthesis can be observed (*snigdha* 'sticky'→*siniddha / saniddha*) .There are also cases with deaspiration: *snigdha* 'sticky'→ *ṇiddha*)

(47)



(48)

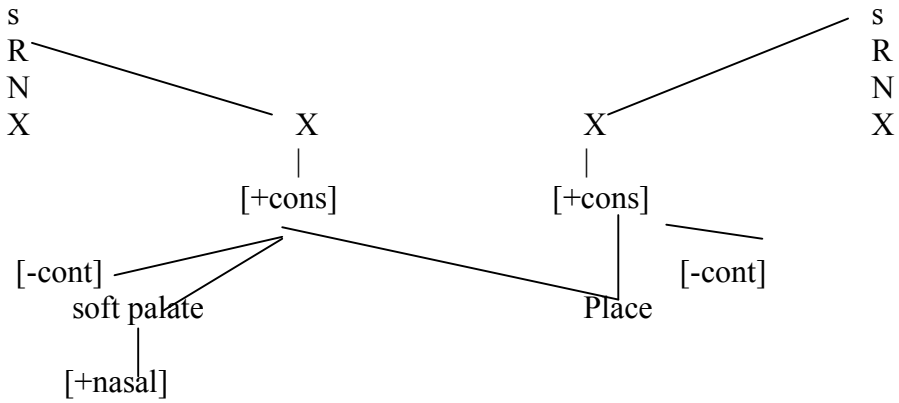


No graphic doubling in Sanskript manuscripts and no gemination in Middle Indic is found in the case of homorganic nasal stop clusters:

(49)	*a. Skt. Input*		*c. Middle Indic*
	antara	'interior'	*antara*
	andha	'blind'	*andha*
	aŋkuśa	'elephant'	*aŋkusa*
	lamba	'pendent'	*lamba*

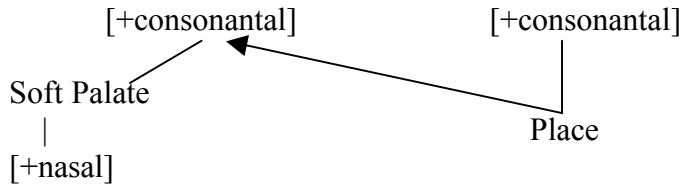
Nasals followed by a homorganic stop have the structure in (50):

(50)



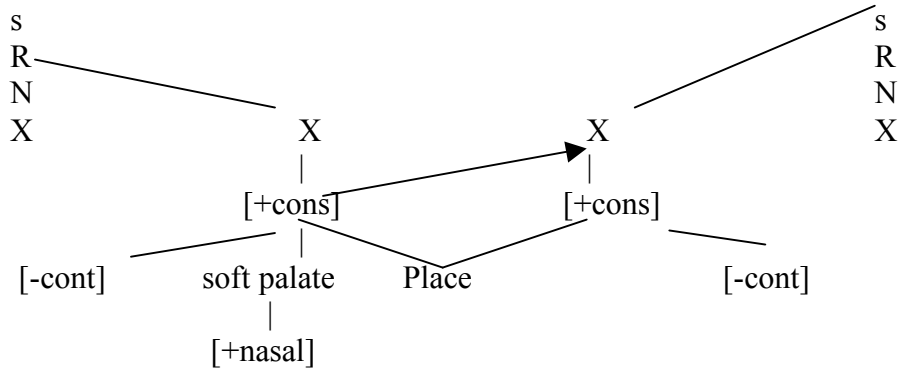
This structure is produced by a previous application of a process of nasal place assimilation given in (51).

(51)



I propose that the structure in (50) is automatically changed into (52). In other words, I propose that a homorganic nasal+ stop sequence is automatically changed into a prenasalized geminate stop, and that phonetically there is no distinction between them. Observe that I assume that prenasalized stops have the same affricate-like structure of the complex segments as in (10) with two root nodes linked to a single skeletal position (see Clements (1992), Calabrese (2005: chapt.4, 2009):

(52)



The coda skeletal position is therefore licensed by the onset root according to the UAC. No root spreading is then needed in this case. Therefore, there is no gemination in this case in Sanskrit and subsequently these structures are preserved as such in Middle Indic.[6, 7]

5. Conclusions

In this paper, I have shown that if we assume that an operation like root spreading can repair disallowed syllabic configurations, we can readily account for the gemination processes we find in Sanskrit and Middle Indic. Root spreading must be recognized as another possible source for gemination, in addition to processes such as assimilation, lengthening under stress, reanalysis (see Blevins (2005))

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[6] I assume that (20) does not apply in the prenasalized stop configuration with a single place node in (52).

[7] See Calabrese (2009) for an analysis of Sanskrit polisegmental clusters such as those in the following forms: Skt. *tīkṣna* 'sharp' MI. *tinha/ tikkha* (Pischel (1981: 254) Skt. *lakṣmī* 'good fortune' MI. *lacchi.*

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