

In Defense of Juncture Rules/Constraints

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Domain juncture rules which apply between two prosodic domains have been problematic in that they exhibit a gap in their distribution. There have been attempts to derive the apparent word-juncture effects of Sanskrit External Sandhi from the syllable-coda effects. The first part of the paper examines the arguments for the coda analysis, and concludes that, in view of cross-linguistic sandhi phenomena, the simplicity is bought at the expense of explanatory power. In addition, Italian Raddoppiamento Sintattico, another showcase example, is reanalyzed in terms of Optimality Theory, where there is no need for the junctural information necessary for consonantal gemination at the word-edge. The paper concludes that there are genuine cases of phonological juncture rules (the /n/-0 alternation in Korean) which cannot be reanalyzed as domain span or domain limit rules like the Sanskrit and Italian phenomena.

1. Prosodic Domain Rules

Prosodic domain rules have been divided into three basic types: domain span, domain juncture and domain limit rules (Selkirk 1980, Vogel 1985, Nespor and Vogel 1986). Domain limit rules apply to one end of a particular domain, while domain span rules apply across a particular prosodic domain (phonological word, phonological phrase, intonational phrase, utterance) without regard to the ways in which the domain in question is subdivided into smaller units. On the other hand, domain juncture rules apply between domains.¹ Whereas domain span rules and domain limit rules are amply

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¹ This type can be viewed as the phrasal equivalent of derived environment rules according to Rice (1990).

attested throughout all the prosodic categories, juncture rules, as schematized in (1), seem to exhibit a gap in their distribution, as noted by Vogel (1985). According to her, of all the possible combinations of categories in juncture rules, only two types have been found. In both of these cases the domain of juncture (D_j) is the phonological word; in one case the larger domain (D_i) is the phonological phrase, as in Italian *Raddoppiameto Sintattico*, and in the other, the phonological utterance, as exemplified by Sanskrit final voicing and stop nasalization.

(1) Juncture Rules

$$A \rightarrow B / D_i [\quad] D_j _ _ D_j [\quad] D_j] D_i$$

In addition to the limited distribution noted by Vogel (1985), there are other aspects of juncture rules that led people to reanalyze many of them as either domain span or domain limit rules. Moreover, even the existence of juncture rules has frequently been called into question (Kaisse 1985, Rice 1990, Kessler 1993).² For instance, Rice and Kessler reanalyze the showcase example of juncture rules, Sanskrit external sandhi, and attempt to derive the apparent word–juncture effects from syllable–coda effects. In the first part of this paper, I will re-examine their arguments and conclude that the simplicity of the coda analysis is bought with a loss of explanatory power.

2. Sanskrit External Sandhi

In Sanskrit, there are many phonological changes at boundaries. These are known as internal sandhi within words and as external sandhi across word boundaries. They are exemplified in (2). In (2a), a word-final obstruent assimilates in voice to the following vowel and sonorant consonant. In (2b), a word-final obstruent nasalizes preceding a nasal stop. What happens internally is remarkably different; voicing assimilation is limited to obstruents (2c and d). In addition, there is word-final neutralization of laryngeal features.

² With the advent of Optimality Theory (Prince and Smolensky 1993), the rule types cannot be taken at face value, but the analogous classification still holds. Now the question is whether there should be constraints that refer to phonological junctures.

Standard formulations are given in (2f).

(2) Sandhi in Sanskrit

a. External Voicing Assimilation

tat indriyam	tad indriyam	'that sense'
sat aha	sad aha	'good day'
tat manas	tad manas	'that mind'

b. External Stop-Nasalization

tat manas	tan manas	'that mind' ³
vāk me	vāṅ me	'my language'
tristubh nūnam	tristum nūnam	'meter indeed'

c. Internal Voicing Assimilation

dik-gajaḥ	dig-gajaḥ	'quarter elephant'
ap+jaḥ	abjaḥ	'wake up'
ad+si	atsi	'eat'
bodh+syate	bhotsyate	'wake up'

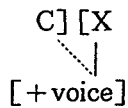
d. No Changes Internally

mahat-ā	mahatā	*mahadā	'great (inst. sg.)'
ad-mi	admi	*anmi	'eat (pres. 1st sg. act.)'

e. Word-Final Neutralization

agnimath	agnimat	'being near the fire'
suhrd	suhrt	'friend'
budh	bhut	'wise'

f. External Sandhi



Internal Sandhi



2.1. External Sandhi as Coda Rules

Kessler (1993) develops in detail the idea, first proposed by Rice (1990), that the so-called external juncture rules in Sanskrit are not juncture rules but rather processes that are manifested differently from internal sandhi due to differences in syllabification. According to this coda analysis, both the internal and external juncture phenomena in Sanskrit are one and the

³ [tad manas] and [tan manas] are surface variants.

same rule. In particular, voicing assimilation is due to a syllable-coda effect, and the differences between the internal and external sandhi can be accounted for by assuming that word-final consonants are in a syllable coda, in contrast to medial consonants, which are always syllabified into an onset.

(3) Sanskrit Syllabification according to Rice (1990) and Kessler (1993)

ma-hat+ā	ma.ha.tā (internally)	'great'
ma-hat ā-khyā-nam	ma.had ā.khyā.nam	'great narrative'
sat aha	sad. a.ha	'good day'

As shown in (3), an obstruent never voices before a vowel or a sonorant consonant word-internally because it will always be in an onset (as in [ma.ha.ta]), whereas a word-final obstruent ([mahat] and [sat]) undergoes voicing due to its position as a coda (as in [sat.a.ha]). Kessler extends Rice's analysis of voicing assimilation one step further to all other external sandhi (such as stop-nasalization) in Sanskrit.

2.2. Problems with the CODA Analysis

However attractive this reanalysis might appear in its simplicity, there are several serious problems associated with it. First, in order for the coda-analysis to go through, a highly unnatural syllable structure needs to be assumed.

2.2.1. Highly Unnatural Syllable Structure

The first problem concerns /s/+stop clusters. It has long been noted that a special dispensation allows a cluster of /s/+obstruent either at word-edges or as a well-formed onset, even though /s/ is higher on the sonority hierarchy than /p, t, k/.

According to Kessler (1993), medial /s/+stop clusters are always tautosyllabic, in spite of several processes in Sanskrit in which /s/ behaves heterosyllabically in relation to the following stop. First, let us look at the reduplication process. The second member of /s/+stop clusters reduplicates, rather than the first, as usual in clusters.

(4) Reduplication (Steriade 1982)

<u>stem</u>	<u>perfect stem</u>	
a. tud	tu-tud	'to push'
dru	du-druv	'to run'
snih	si-snih	'to be sticky'
smi	si-šmi	'to smile'
tsar	ta-tsar	'to approach stealthily'
psā	pa-psā	'to devour'
mluc	mu-mluc	'to set'
mnā	ma-mnā	'to note'
vyac	vi-vyac	'to extend'
vraj	vi-vyaj	'to proceed'
b. stu	tu-štu	'to praise'
sphut	pu-sphu	'to burst'
šcut	cu-šcut	'to whet'

According to Steriade (1982), because the initial /s/ in the s+stop cluster is stray, it cannot be copied as part of the first syllable, and should be skipped over. Kessler's answer to the special behavior of /s/+stop is that the cross-linguistic pattern involving /s/+stop clusters is so varied in any case that a generalization cannot be made. Unlike other clusters, they alliterate as units in Germanic versification, and in Gothic reduplicate as units.

(5) /s/+stop clusters

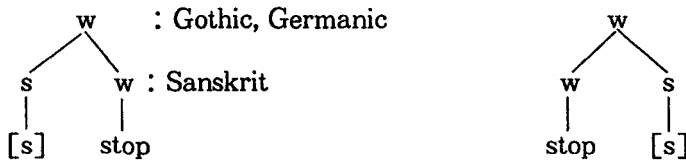
- a. Gothic: *gai-grot* 'wept' *stai-staut* 'pushed'
- b. Avestan: the initial /s/ is always reduplicated.⁴
- c. English: form a unit that occupies a single obstruent slot

Selkirk (1982) observes that clusters with the initial /s/ in English provide the sole instances of onsets where the second consonant may be an obstruent, and of onsets with three consonants instead of two or one. In addition, clusters of /s/+obstruent form a unit that may occupy a single obstruent slot, whether the slot be in the onset or the coda (e.g. *capstan*),

⁴In fact, there is only one relevant form in the oldest Avestan texts (Gathic) where the first consonant is reduplicated without regard to sonority (Kessler p.c.). The Avestan form /štat/ 'he stands', in contrast to Sanskrit [tištati], seems to represent *sištati>hištati>xštati (Beekes 1988).

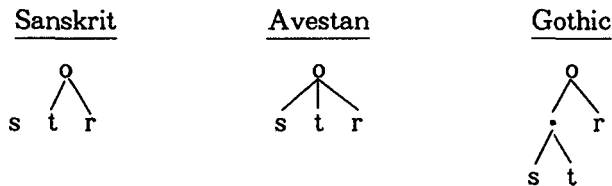
Kiparsky (1979) offers an explanation in terms of the rhythmic organization of the syllable. He assumes that syllable is rhythmically organized, as illustrated in (6), and the reduplication and alliteration can all be interpreted as applying to the first *w* of the syllabic tree. In case the first segment is an *s*, Germanic takes the nearest nonterminal *w* above it and Sanskrit the nearest terminal *w* to its right. However, it cannot be explained why Germanic languages still choose the closest the terminal *w* in all other onset clusters.

(6) Kiparsky (1979)



I believe relevant differences in the syllable structure along the lines of (7) can account for the different behavior of /s/+ stop clusters. /s/ is stray in Sanskrit, whereas in Avestan it is a full-fledged onset consonant, and in Gothic, the /s+stop/ cluster forms a unit as in English.

(7) Representations for /s/+stop



A second, more serious problem arises in the deletion pattern of the /s/-aorist in Sanskrit.

(8) the /s/-aorist

a. a-tan-s-mahi	'we stretched (middle)'
a-tār-ṣ-ma	'we passed (active)'
a-yak-ṣ-mahi	'we offered (middle)'
yuk-ṣ-va	'we (dual) joined'
yut-s-mahi	'we fought (middle)'
a-tan-s-ta	'you stretched'
a-kār-ṣ-tam	'you (dual) did'

b. a-chid-s-ta	→	achit-ta	'you cut off'
a-tap-s-thās	→	atap-thās	'you heated (middle)'

The underlying CsC clusters will surface if /s/ can be syllabified either as the coda of the first syllable or the onset of the second syllable. When the aorist /s/ is inserted between the stem and the personal ending, it deletes when it would appear between two oral stops as in (8b) but nowhere else. If /s/+stop were a well-formed onset, following Kessler, regardless of its status as a premargin, there is no reason why /s/ would delete precisely when it could not be incorporated into the coda position. The deletion of /s/ clearly argues for an assignment of /s/ and stop into different syllables.

Also, gemination in both Sanskrit and Pali argues for the heterosyllabicity of /s/ and the following stop. As illustrated in (9), one of the medial clusters is geminated, and a simple generalization is based on syllabification. In all cases, the segment that occupies the first onset position is the one that is geminated.

(9) Gemination in Sanskrit and Pali

a. Sanskrit Postlexical Doubling (Varma 1961)

navya	navvya
cakra	cakkra
pārta	pārtta
hasta	hastta

b. Pali Gemination (Hankamer and Aissen 1974)

vak+ssa	vakkha
dis+ya	dissa
pac+ya	pacca
lag+na	lagga
gam+ya	gamma
vas+tum	vatthum
kar+tum	kattum
kar+ssa	kassa

Similarly, certain verbs in Berber form the imperfective by geminating one of their consonants. In some cases it is the first consonant that is geminated and in others it is the second, but the third consonant is never geminated. Again, a proper analysis of gemination leads to the correct location of the onset.

(10) Imperfective Gemination in Imdlawn Tashlhiyt Berber (Dell and Elmedlaoui 1988)

<u>Verb</u>	<u>Syllabification</u>	<u>Imperfective</u>	
mrz	mɾz	mmrz	'wound in the head'
frn	fɾn	ffrn	'sift'
xng	xŋg	xxng	'choke'
rkm	ɾ.km̩	rkkm	'rot'
kʃm	k.ʃm̩	kʃʃm	'enter'

In addition to /s/+stop clusters, there is one other aspect of universal syllabification that a coda analysis cannot explain. Aside from the sonority dimension, we must consider the place dimension in syllable phonotactics. That is, the existence of constraints against consonants sharing place of articulation within an onset is a well-attested, cross-linguistic generalization (Clements and Keyser 1983, Harris 1983, Rice 1992): /pw, bw, tl, dl/ sequences are not allowed in many languages. In order for the coda analysis to go through, all homorganic clusters must be considered well-formed onsets, along with less controversial heterorganic clusters such as (/pn, kn, km/). This is because homorganic clusters (like heterorganic clusters) do not undergo internal voicing or nasalization.

(11) Homorganic Clusters in Sanskrit (*tl, dl, tn, dn, pm, bm*)

budhnaḥ	'bottom'	/-dhn-/
pāpmā	'evil'	/-pm-/

This clusters, however, never occur at the beginning of words. Kessler adopts the position that these homorganicity requirements are simply morpheme structure constraints, or word margin constraints. However, there is indirect support for the homorganic constraint in Sanskrit. In the development from Sanskrit to Pali, a less sonorous consonant geminate and a more sonorant member of a cluster deletes, as illustrated in (12a), however, show that in the case of a voiced obstruent and a homorganic nasal, a nasal doubles even though it is more sonorous than the preceding stop. It can be inferred that there is a phonotactic constraint which forces the homorganic cluster to be heterosyllabic.

(12) Differences between Sanskrit and Pali:

<u>Sanskrit</u>	<u>Pali</u>
a. takra	takka
svapna	soppa
ramya	ramma
śakya	sakka
b. nudna	nunna (*nudda)
rājñā	rājñā (*rājñā)

A clearer case of the homorganicity constraint is found in Catalan, where coda obstruents devoice and undergo assimilation. (13b) illustrates an asymmetry between initial and medial homorganic clusters. All of the homorganic clusters found medially must be broken up into two syllables, and the independently motivated coda-devoicing nicely accounts for the gap for [dl, bm] medially.

(13) Catalan Voicing Assimilation (Mascaró 1988, Cho 1990)

a. Coda Devoicing

me[z]os	‘months’	me[s] ‘month’
me[s k]urt	‘short month’	
me[z β]inent	‘next month’	

b. word-initially *bl, pl, gl, kl* but medially only *tl, pm* but **dl, bm*

adlatere [-tl-]	‘side-kick’	submari [-pm-]	‘submarine’
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2.2.2. There are Word-Edge Effects Anyway

The second problem with the coda analysis is that even with the unnatural syllabification assumed by Kessler, not all sandhi processes can be attributed to the coda-effect. In particular, /r/ devoices only in the word-final position, but never medially, even though the word-internal /r/ clearly occupies the coda in pre-obstruent position as in (14c). Devoicing of /r/, then, has to be a separate word-edge rule.

(14) Word-Edge Rules in Sanskrit

a. Devoicing of word-final /r/ and Visarga

/abibhar/	→	abibhas	→	abibhaḥ	‘he carried’
/manus/	→		→	manuḥ	‘man’

b. Voicing Assimilation of final /r/ and /s/

manus	gacchati	manur	gacchati	'the man goes'
punar	api	punar	api	'on the other hand'
bhrātar	dehi	bhrātar	dehi	'Brother, give'

c. Word-internal /r/ does not change.

dhūr-su	dhūrsu	'yokes'
suhārd	suhārt	'good-hearted'

2.2.3. Asymmetry of Triggers

Third, the coda account fails to capture the cross-linguistic generalization that lexical and postlexical assimilations are often conditioned by different sets of triggers. It can be demonstrated that the different sets of triggers cannot be correlated with the difference in syllabification. Both Catalan and Polish have two distinct obstruent voicing processes.

(15) Catalan Voicing Assimilation: Phrasal

to[d r]ic	'all rich persons'
se[d m]ans	'seven hands'
fe[t a]nar (*fed anar)	'made to go'
to[l l]iquid	'all liquid' (due to alveolar assimilation)
to[ʌ ʌ]amp	'all lightening'

As illustrated by (15), obstruents as well as voiced sonorants trigger assimilation postlexically.⁵ However, we have already seen in (13) that word-internally sonorants do not trigger voicing in Catalan, even if the potential target is found in the coda position, as in the case of [atlatere].

(16) Voicing Assimilation (OCP) Coda-Devoicing

		*Coda
*Laryngeal	Laryngeal	Laryngeal

Under the assumptions of Lexical Phonology, there are principled reasons why word-internal assimilation is not triggered by redundantly specified segments even though in both cases the coda target is available: the voice

⁵ Something must be said about the reason why vowels do not trigger voicing assimilation in Catalan. One solution may be to assume that sonorant consonants and vowels are specified for voice at different stages.

distinction is neutralized before a vowel or a sonorant (Kiparsky 1993). On the other hand, phrasal assimilations which take place across word-boundaries can be triggered by sonorants. Word-internal assimilation is triggered by obstruents only, even if the potential target is in the coda, whereas phrasal level assimilation is freely triggered by sonorants (e.g. /set mans/ → [sedmans] vs. su[pl]ari). In this regard, the coda account also misses another generalization, namely, that word-final neutralization is closely correlated with phrasal assimilation (a one-way implication).

(17) Close Relationship between Word-Final Neutralization and Phrasal Assimilation

- a. No word-final devoicing and internal voicing assimilation only:
Serbo-Croatian, Hungarian, Pengo, Kolami
- b. Word-final devoicing and internal voicing assimilation only:
Russian, Czech
- c. Word-final devoicing and both internal and external assimilation:
Polish, Catalan, Sanskrit, dialects of Ukrainian
- d. No word-final devoicing and external assimilation: none

Postlexical voicing assimilation occurs only across word-boundaries and is triggered by redundantly voiced segments as well as distinctly voiced segments. In addition, phrasal assimilation takes place only when there is final devoicing, as summarized in (17). A dialectal study of Ukrainian makes this point clear. According to Zilyns'skkyj (1979), the generalization is that only if a dialect has a rule of devoicing, then there is assimilation triggered by vowels and sonorant consonants.

3. Polish

Let us look at Polish, in particular, the Cracow dialect which has exactly the same voicing pattern as Sanskrit. After considering two quite different analyses of Polish syllabification and voicing assimilation, I will conclude that it is next to impossible to give a coda treatment to the Polish facts.

(18) Polish Voicing (Rubach and Booij 1990, Gussmann 1993)

- | | | | |
|----------|-----------|-----------|------------|
| a. [gd]y | 'when' | [bzd]ura | 'nonsense' |
| o[dv]aga | 'courage' | gwi[zd]ac | 'whistle' |

- b. [pstr]y 'gaudy' [pt]ak 'bird'
 ne[ptk]a 'klutz, gen.sg.' gwia[stk]a 'star, dim.'
- c. Word-final devoicing
- wa[d]a 'fault' wa[t] 'gen.pl.'
 ro[zg]a 'rod' ro[sk] 'gen.pl.'

As for assimilations across word boundaries, in the Warsaw dialect, a word-final obstruent or obstruent clusters assumes the voice quality of the obstruent that begins the next word while a word-final obstruent is voiceless when the next word begins with sonorant or a vowel. In contrast, the Cracow-Poznan' dialect allows sonorants to trigger voice assimilation across word boundaries but not word-internally.

(19) Phrasal Assimilation of Voicing

- a. Warsaw Dialect (no assimilation to sonorants or across sonorants)
- ja[g z]awsze 'as always'
 te[gzd v]ydano 'the text has been published'
 pró[k rdz]y 'a threshold of rust'
 gwia[st mg]ławica 'a nebular of stars'
- b. Cracow-Poznan' dialect
- bra[d ojca] 'father's brother'
 okrzy[g r]ozpaczy 'a cry of despair'
 te[dzd n]oweli 'the text of the story'

Syllabification in Polish is much more complex in that it allows a sonorant to precede an obstruent and obstruent clusters in defiance of the Sonority Sequencing Generalization while there are no syllabic sonorants in Polish.

(20) Polish Clusters Violating the Sonority Sequencing Generalization

- mxy 'moss, nom. pl.' rdza 'rust'
ptak 'bird' pstry 'gaudy'

3.1.1. Polish Syllabification According to Rubach and Booij (1990)

Rubach and Booij (1990) propose the two principles in (21) governing Polish syllabification. (21a) is the universal sonority hierarchy, but the second principle permits stops and fricatives in onsets and codas to appear in

any order, and in any number.

(21) a. Sonority Sequencing Generalization (universal):

Vowels-Liquids-Nasals-Fricatives-Stops

b. Obstruent Sequencing Principle (Polish-specific)

With obstruents there is no requirement for sonority distance.

c. pa-sta 'toothpaste' ka-ftan 'jacket'

Additional violations of the SSG are mostly found in word-initial and word-final clusters. According to Rubach and Booij, the offending segments are incorporated into prosodic structure by rules of adjunction, directly to the phonological word, as exemplified in (22).

(22) Extrasyllabic Segments (underlined)

<u>rd</u> za	'rust'	<u>lk</u> ac'	'sob'
met <u>r</u>	'meter'	cy <u>kl</u>	'cycle'
p <u>ios.n</u> .ka	'song'		
kar. <u>m</u> .nik	'feeder'		

A sonorant between two obstruents (e.g. /n/ in [pios.n.ka]) is extrasyllabic and linked directly to the phonological word.

Given these assumptions, voicing assimilation can be characterized as a prosodically conditioned rule which requires adjacency within a prosodic constituent. In other words, only unsyllabified consonants are transparent to voicing because assimilation applies before Sonorant Default in the Warsaw dialect when sonorants have no Laryngeal node.

(23) a. Internal sonorants are transparent.

[krf']i 'blood, gen.' me[tr+k]+owac 'to speak cleverly'

b. Word-initial sonorants are not transparent in Warsaw Polish.

bra[k rz]y 'lack of rust' ry[k lv]a 'roar of a lion'

On the other hand, word-initial extrasyllabic consonants in the phrasal environment are not transparent to assimilation, since they have already been specified with voice and render the trigger and the target non-adjacent, unlike word-internal sonorants.

3.1.2. Polish Voicing as Coda Voicing

We can try to extend the coda analysis proposed for Sanskrit to Polish. For example, can we assume that word-medial consonant clusters which undergo voicing assimilation are always in the coda? The answer is definitely in the negative because cluster voicing is needed independently. Voicing alternation cannot be correlated with the coda target since word-initial clusters also agree in voicing (e.g. [dg]y).

(24) Coda Devoicing and Cluster Devoicing

Obs \$ Son \$ Obs. Obs.Son

In a cluster like the one in (24), the first obstruent undergoes devoicing due to coda-devoicing and the second obstruent due to cluster-devoicing, since the syllabic division is as shown in (24), with the medial sonorant extrasyllabic.

Given the syllable structure proposed by Rubach and Booij, the distinction between the two dialects of Polish can in no way be derived from differences in syllabification. Not all medial obstruents can be regarded as onsets (as in Sanskrit, which has relatively simple clusters). Moreover, a coda rule is not enough to account for cluster effects which are abundant both in initial and medial clusters.

3.2.1. Polish Syllabification According to Gussmann (1992)

Gussmann (1992), on the other hand, proposes a radically different view on Polish syllables and voicing alternations. He proposes that the Polish onset is a potentially complex, bipartite structure, each subpart constituting a proper onset (O→O+O). A proper onset then is a sequence of an obstruent optionally preceded by an /s/ and followed by a sonorant as in English and other Indo-European languages. The universal sonority sequencing principle is observed. This view predicts the sequencing of consonants in three- and four-member clusters on the basis of general sonority considerations holding for pairs of consonants. In addition, there is a coda condition that solely licenses a sonorant consonant.

(25) a. Polish Onsets

O→O+O

[drgn]ac' 'shudder' [strf]onic' 'squander'
 dr+gn str+f m+gw kl+n s+s m+r
 piosnka→pios.nka karmnik→kar.mnik

b. Coda Condition: only a sonorant consonant is licensed in coda.

Given this syllable structure, Gussmann accounts for the Polish voicing facts with three language-particular conditions. The first conditions are the Voice Licensing Principles which recognize a single contrastive voice specification per syllable. The second involves Resyllabification, assigning unsyllabified consonants to existing syllables. The third condition ensures the leftward propagation of voicing to obstruents. The absence of voice contrast in obstruent clusters is a direct consequence of the syllable node licensing only one occurrence of the voice autosegment. Thus licensing is directly responsible for the voice uniformity of obstruent clusters.

As for word-final obstruent devoicing, word-final obstruents cannot be resyllabified into the preceding syllable because of the coda constraint allowing only sonorants in that position. Thus a word-final obstruent loses the voice specification. Finally, the difference between the two dialects consists of a minor difference in the formulation of the rule of spreading, as shown in (26).

(26) Polish Voicing



Gussmann's rule of Obstruent-to-Consonant Spreading supplies the unsyllabified final cluster with the voice of the obstruent starting the next word. The Cracow-Poznan' dialect spreads voicing across word-boundaries from all voiced segments (vowel, sonorant, voiced obstruent).

3.2.2. Phrasal Assimilation as a Coda Effect?

Now let us look at the problems with a coda analysis. First, we observe that voicing assimilation occurs in both codas and clusters. Second, there is no way to explain the difference between the two dialects of Polish in terms of syllabification.

In the Warsaw dialect, if one assumes that a word-final consonant is extrametrical and syllabifies as an onset of the following syllable, one might be able to explain why sonorants are not triggers. This analysis relying on extrametricality, however, fails to account for the difference between word-internal sonorants (which are transparent) and sonorants found at the beginning of the next word (which are blockers).

In the Cracow dialect, all medial obstruent clusters are onsets and undergo voicing assimilation. However, a final obstruent can be syllabified neither as an onset (due to the domain of syllabification) nor as a coda (due to the coda condition that permits only a sonorant in the rhyme). We need yet another rule which devoices it (perhaps, a version of Final Devoicing). Still we have not accounted for the phrasal assimilation, another rule where a word-final obstruent undergoes voicing. There is simply no way to unify word-internal voicing agreement with phrasal assimilation, even though Cracow Polish exhibits the exactly same voicing pattern as Sanskrit.

4. Proposed Analysis of Sanskrit and Polish

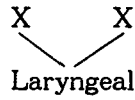
It is not merely complicated to unify internal and external assimilations in Polish and Sanskrit. A coda analysis, even if it could be made to work somehow, makes the false prediction that the nature of the triggers and the domains of rule application are determined by two independent factors. In language after language, however, we find that word-level assimilations are triggered by distinctively voiced obstruents, whereas sonorant triggers (i.e. redundantly voiced segments) are closely correlated with phrasal level assimilations.

However, the problems with a coda-account disappear when one accepts the existence of word-edge neutralization (domain-limit rules), which we need independently to account for the final devoicing of /r/ in Sanskrit, in addition to assimilations (domain-span rules). The difference between the Warsaw dialect on the one hand, and the Cracow dialect and Sanskrit on the other, lies in the relative order between Voicing Assimilation and Redundant Voicing assignment. Only obstruents are triggers when sonorants are not specified for voicing.

(27) Voicing Assimilation (Polish and Sanskrit)

- a. Cluster devoicing (OCP)
- b. Word-edge neutralization of Laryngeal Node
- c. Assimilation of [voice]
- d. Assimilation ordered before or after default rules

- | | |
|-----------------------------|--------------------------------|
| a. <u>Cluster devoicing</u> | b. <u>Word-final devoicing</u> |
| *Laryngeal Laryngeal | *C] _w |
| | |
| | Laryngeal |

c. Voicing assimilation

This proposal is supported by the fact that there are languages in which clusters agree in voicing regardless of syllabification (e.g. Polish and Russian onsets) and that word-edge devoicing is also independently motivated in many languages. Even though codas are known to frequently undergo neutralization and assimilation, not all rules target codas. Moreover, treating neutralization as being disjunctively conditioned by word-margins and by obstruent clustering is empirically motivated in both Sanskrit and Polish.

5. Other Juncture Rules

Having reanalyzed what appears to be a juncture rule in Sanskrit and Polish as composition of domain-limit and domain-span rules, let us look at other cases of juncture rules.

5.1. Morphological Juncture Rules

There are juncture rules that are clearly morphological in nature. For instance, the well-known phenomenon of Korean Bindungs-/s/ involves gemination of the first consonant of the second member in sub-compounding (Huh 1965, Kim 1970, Cook 1987), as illustrated in (28). The traditional analyses usually involve inserting a linking morpheme (whether it be a consonant, a feature or a skeletal slot) at the compound juncture.

(28) Korean Bindungs-/s/ (Gemination)

k ^h o + nolɛ	k ^h onnoɛ	‘humming’
pata + mul	patammul	‘salt water’
namu + pɛ	namupp’ɛ	‘wooden boat’
mul + soli	muls’oli	‘sound of water’
Insert X/]__[

Similarly, Rendaku in Japanese introduces a linking morpheme at the compound juncture (a [+voice] autosegment bound to its skeletal anchor according to Itô and Mester).

(29) Japanese Rendaku (Itô and Mester 1986)

iro+kami	irogami	'colored paper'
take+sao	takezao	'bamboo'
Insert [+voice]/]__[
X		

I believe that these morphological operations differ fundamentally from rules which are phonological in nature. In the next section, I will review two other cases of phonological juncture rules.

5.2. Phonological Juncture Rules

5.2.1. Raddoppiamento Sintattico as a Non-juncture Rule

Raddoppiamento Sintattico (RS) in Italian applies in a sequence of two words (w_1 , w_2) to lengthen the initial consonant of w_2 when w_1 ends in a stressed vowel. Such vowels are all short due to the surface true constraint in Italian and that disallows long vowels in word-final position. On the other hand, a short stressed vowel in an open syllable is ill-formed in non-final position and undergoes lengthening.

(30) Italian RS (Nespor and Vogel 1982, 1986, Chierchia 1982)

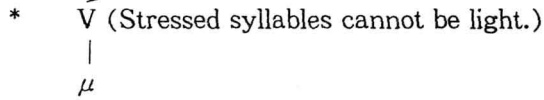
a. tre cani	tre ccani	'three dogs'
va via	va vvía	'go away'
avrà tro	avrà ttro	
b. già stanco	'already tired'	
parló svelto	'he spoke very fast'	
c. Insert C/	V]_____w[C	(Nespor and Vogel 1986)

As illustrated by (30b), however, gemination is blocked when the second word begins with a consonant cluster composed of an /s/ and another obstruent. RS is specific to word-edges, and creates a geminate to close the short syllable. Clearly, there is a constraint against repairing the violation of a light stressed syllable by vowel-lengthening within words and gemination across words. While Nespor and Vogel formulates RS as a juncture rule that applies between two phonological words, Chierchia (1982) argues that RS should be accounted for in terms of the principles underlying Resyllabification and the rhythmic constraint of the language. His insights can be translated into an optimality theoretic analysis (Prince and Smo-

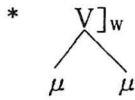
lensky 1993, McCarthy and Prince 1993) in which there is no need for the junctural information.

I propose the two constraints shown in (31). Stressed Syllable Lengthening (SSL) prohibits a light stressed syllable while the constraint against long vowels at word-edge (*LVE) disallows long vowels at word-edge.⁶

(31) a. Stressed Syllable Lengthening (SSL)



b. Constraint against long vowels at word-edge (*LVE)



As illustrated in (32), the constraint order (LVE >> SSL) accounts for the RS facts, namely, word-final gemination instead of vowel lengthening.⁷

(32) The constraint order (*LVE >> SSL) accounts for word-final gemination instead of vowel lengthening.

	*LVE	SSL
$\begin{array}{c} \mu \quad \mu \\ \backslash \quad / \\ V]_w \end{array}$	*!	
$\rightarrow \begin{array}{c} \mu \\ \\ V]_w \end{array}$		*
$\rightarrow \begin{array}{c} \sigma \\ / \quad \backslash \\ \mu \quad \mu \\ \quad \\ V]_w [C \end{array}$		
$\begin{array}{c} \mu \\ \\ V]_w [C \end{array}$		*!
$\rightarrow \begin{array}{c} \mu \quad \mu \\ \quad \\ V]_w [V \end{array}$		*

⁶ As suggested by an anonymous reviewer, *LVE is not active in English where in monosyllabic words a short (lax) vowel is not allowed in word-final position due to a minimal word constraint.

⁷ The Italian case can be seen as violating CrispEdge (Itô and Mester 1994) in that it allows junctures with multiple linking.

	*LVE	SSL
$\begin{array}{c} \mu \quad \mu \\ \quad / \\ V]_w [V \end{array}$	*!	

Under the assumption that the constraint that takes care of stressed syllable lengthening (SSL) is dominated by the constraint against long vowels at the word-edge (*LVE), all the attested cases can be accounted for: word-internally stressed vowels are lengthened (presumably because of the universal tendency to preserve strict layering) and word-finally the following consonant is incorporated as the coda consonant of the preceding syllable to create a heavy syllable (thus resulting in gemination), as it is not possible to have a long vowel at the juncture. On the other hand, when the next word starts with a vowel, *LVE, which dominates SSL, prevents the lengthening with no consonant available to close the syllable.

As noted above, /s/+stop clusters behave differently and this can be attributed to an onset constraint which prohibits /s/+stop as a well-formed onset. As demonstrated in (33), Parse dominates this onset constraint, and an /s/ in initial position has to surface as part of the onset. In the medial position, however, it is syllabified as a coda as in /cittá strana/ or /basta/ when such a slot is available. In sum, there is no stipulation needed to handle RS specifically. Also noted that there is no juncture constraint; *LVE is a word-edge constraint and SSL is a domain-span constraint. The RS facts follow naturally from three constraints that play a role in other parts of Italian grammar.

- (33) /s/+stop clusters behave differently from other clusters due to the onset constraint.

	SSL	Parse	*s+stop onset
cittá strana	*!		*
→cit. tás. tra.na		*	
cittá trana	*!		
ba.sta	*!		*
→bas.ta			
→stra.da			*
tra.da		*!	

The constraint SSL is closely related to a common phenomenon which Hayes (1985) calls “Iambic Lengthening.” This refers to the case where the prominent syllable is lengthened by rule when an iambic stress rule parses two light syllables in a row ([CVCV]→[CVCVV]). It is attested in languages such as Choctaw, Chickasaw, Yup’ik Eskimo, Cayuga, Onondaga, and reconstructed Tubatulabal. Instead of vowel lengthening, some languages (Menomini and some dialects of Yup’ik) choose to close the short stressed syllable by gemination, producing durationally iambic feet ([CVCV]→[CVCVC]) Similarly, there is stress-sensitive resyllabification in English (Myers 1987). As exemplified in (34b), when a C-initial suffix is added to a stem ending in VVC, it always surfaces as VC. The examples in (34a) show that the shortened vowel is always in a stressed syllable immediately followed by an unstressed vowel. This is because V.CV is resyllabified as VC.V in a stressed syllable and thus subject to Closed Syllable Shortening.

(34) Stress-Sensitive Resyllabification in English (Myers 1987)

- a. véhiclé (no [h] in the coda) vehícular ([h] in the onset)
- átic (flapping of /t/) attáck (/t/ is not intervocalic)
- b. Closed Syllable Shortening (CVC.V)
- keep-kept deceive-deceptive elide/elision
- sane-sanity cone-conic nature/natural

5.2.2. /n/- ϕ Alternation in Korean as a Juncture Rule

It is a well-known fact of Korean historical phonology that in the late 18th century the coronal /n/ started to delete in word-initial position before a high vowel /i/ and /y/ (Lee 1977). As a result, /ni/ and /i/ are completely neutralized in the word-initial position in Modern (Standard) Korean, except for recent loans.

(35) Word-Initial Neutralization of /ni/ and /i/

yæca	‘woman’	(<nyæca)	yæyu	‘leisure’
ilim	‘name’	(<nilim)	ius	‘neighbor’

However, the synchronic alternation is much more complex in the medial position. As exemplified in (36), not only the etymologic (historically true) /n/ but also the non-etymologic (historically unattested) /n/ surfaces in the non-initial position.

(36) Synchronic $n \sim \emptyset$ Alternation in Medial Position

a. etymologic /n/ in postconsonantal position

əkɪm + ni	əkɪmni	*əkɪmi	'molar'
tanp ^h uŋ + nip ^h	tanp ^h uŋnip	tanp ^h uŋip	'maple leaf'
sol ^h + nip ^h	sollip ⁸	*solip	'pine needle'
pəs + nim	pənnim	*pənim *pəsım	'friend'
k'oc ^h + nip ^h	k'onnip	*k'onip *k'otip	'petal'

b. non-etymologic /n/ in postconsonantal position

pam + il	pamnil	*pamil	'night work'
k ^h oŋ + yəs	k ^h oŋnyəs	k ^h oŋyəs	'bean taffy'
mul + yak	mullyak	*mulyak	'liquid medicine'
sək + yuli	səŋnyuli	səkyuli	'colored glass'
cip + il	cimnil	cipil	'house work'
pat ^h + ilaŋ	pannilaŋ	patilaŋ	'ridge of a field'
(cf. monomorphemic forms			
ani	*anni	'oh!'	
muni	*munni	'pattern')	

c. etymologic /n/ in postvocalic position

alɛ + ni	alɛnni	*alɛni	'lower teeth'
k'ɛ + nip ^h	k'ɛnnip	*k'ɛnip	'sesame leaf'

d. non-etymologic /n/ in postvocalic position

noŋsa + il	noŋsail	*noŋsanil	*noŋsannil	'farm work'
k'ɛ + yət	k'ɛyət	*k'ɛnyət	*k'ɛnnyət	'sesame taffy'

Whereas the historical change of /n/-deletion neutralized only the initial distinction between /ni/ and /i/, the synchronic rule seems to work in two ways: first delete the initial /n/, second, insert /n/ in the relevant juncture position. In the Standard dialect, one of the relevant boundaries involves the position after a prefix or a stem in a compound⁹ when the preceding element ends in a sonorant. Etymologic /n/ behaves somewhat differently in compounding from non-etymologic /n/ when the first element ends in a vowel as show in (36c, d). There are no empirical reasons to prefer an in-

⁸ A sequence of /n+l/ is always realized as [ll].

⁹ This involves a prosodic word boundary in the framework of Lexical Prosodic Phonology of Inkelas (1989). See Han (1994) for a detailed prosodic analysis of Korean compounding.

sertion account over a deletion account. In fact, the alternations call for a nondirectional account in which /ni/ alternates with /i/, where the outcome depends on the separately stated constraints, a typical case of synchronical rule inversion. A deletion account (Huh 1965, Kim 1970) cannot provide the sonorant and optionally after a nonsonorant). On the other hand, an Insertion account cannot explain why all words beginning with /ni/ must lose /n/ in the initial position. Since no underlying representations begin with /i-/ under an insertion account, (36 c, d) are again problematic.

Cho (1994) attempts an optimality-theoretic account in which the interaction among several constraints shown in (37), plays a crucial role in determining the alternation.

(37) Constraint for n- ϕ Alternation

- a. **Sonorant Juncture Constraint:** a sonorant consonant followed by a high front vocoid across a prosodic-word boundary is ill-formed.

* Son][i

- b. **Initial ni-Constraint:** the sequence *ni* is ill-formed in the initial position of a phonological word.

* [ni

- c. **Constraints Ranking**

Juncture >> *[ni >> Parse-seg >> Parse-feat, Fill

What matters for the purpose of this paper is the observation that there is no way to explain away the Sonorant Juncture Constraint. This is clearly a phonological constraint referring to a phonological category, according to which a consonant surfaces in a junctural position as in [pam nil] 'night work.'

Interestingly enough, the relevant junctures can differ from dialect to dialect. The standard dialect involves the prosodic word (in stem-compounding) and phonological word (in the phrasal case), whereas the constraint in the Kyengsang dialect is also sensitive to the even smaller, root boundary, as illustrated in (38). Root Compounding in the Kyengsang dialect illustrates an obligatory insertion of a sonorant ([annyak], [illyoil]).

(38) Different Junctures in Different Dialects (Han 1994).

	<u>Kyengsang</u>	<u>Standard</u>	
<u>Root Compounding</u>			
an-yak	annyak	anyak	'eye drop'
il-yoil	illyoil	ilyoil	'Sunday'
<u>Stem-Compounding</u>			
nun + yak	nunnyak	nunnyak	'eye drop'
mol + yak	mollyak	mollyak	'myrrh'
<u>phrasal (phonological word boundaries)-both dialects</u>			
t'an yəs	→	t'annyət	'different taffy'
al ius →	al niut →	alliut	'neighbor to know'

6. Conclusion

I have argued that there are genuine cases of phonological juncture rules which cannot be reanalyzed as domain span or domain limit rules. In addition to the cases analyzed in this paper, there are other putative cases of juncture rules, as listed in (39). While it has been claimed that all these cases involve syntactic or morphological junctures, further research is needed to determine if these processes involves phonological junctures.

(39) Other 'Juncture' Rules

- Kimatuumbi vowel shortening (Cowper and Rice 1987)
- Ewe tone sandhi (Clements 1978)
- Mandarin third tone sandhi (Cheng 1987)
- Mende/Welsh consonant mutations

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