Chapter 2. Cyclic and noncyclic phonological effects

A proper theory of the phonology-morphology interface must account for apparent cyclic phonological effects as well as noncyclic phonological effects. Cyclic phonological effects are those in which a morphological subconstituent of a word seems to be an exclusive domain for some phonological rule or constraint. In this chapter, I show how Sign-Based Morphology can handle noncyclic as well as cyclic phonological effects. Furthermore, Sign-Based Morphology, unlike other theories of the phonology-morphology interface, relates the cyclic-noncyclic contrast to independently motivatable morphological structures.

2.1 Turkish prosodic minimality

The example in this section is a disyllabic minimal size condition that some speakers of Standard Istanbul Turkish impose on affixed forms (Itô and Hankamer 1989, Inkelas and Orgun 1995). The examples in (28b) show that affixed monosyllabic forms are ungrammatical for these speakers (unaffixed monosyllabic forms are accepted (28a), as are semantically similar polysyllabic affixed forms (29b).

(28)	a)	doː	‘musical note C’	b)	*doː-m	‘C-1sg.poss’
		je	‘eat’		*je-n	‘eat-pass’

(29)	a)	sol^{j}	‘musical note G’	b)	sol^{j}-ym	‘G-1sg.poss’
		kɑzɑː	‘accident’		kɑzɑː-m	‘accident-1sg.poss’
		jut	‘swallow’		jut-ul	‘swallow-pass’
		tek^{j}mel^{j}e	‘kick’		tek^{j}mel^{j}e-n	‘kick-pass’

What happens when more suffixes are added to the forms in (28b) to bring the total size to two syllables? It turns out that nominal forms with additional affixes are still ungrammatical regardless of the total size, as shown by the data in (30).

(30)	*doː-m	‘C-1sg.poss’	*doː-m-u	‘C-1sg.poss’
	*reː-n	‘D-2sg.poss’	*reː-n-den	‘D-2sg.poss-abl’
	*fɑː-m	‘F-1sg.poss’	*fɑː-m-sɑ	‘F-1sg.poss-cond’

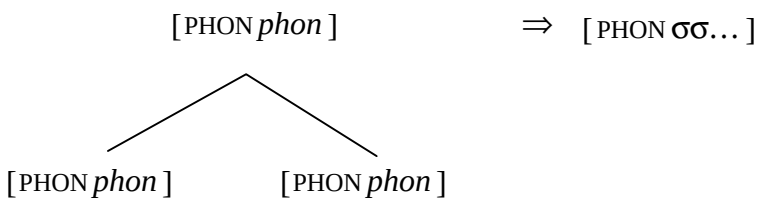
These forms suggest that the disyllabic minimal size condition is enforced cyclically. That is, assuming a binary left-branching structure for suffixed forms, each suffixed subconstituent must satisfy the minimal size condition.

(31) $[\ [\ [\text{root}]\ \text{suffix}\ ]_{\text{min}\,\sigma\sigma}\ \text{suffix}\ ]_{\text{min}\,\sigma\sigma}$

As we have seen in section 1.2, cyclic phonological effects result from the enforcement of phonological constraints on each constituent. If we assume that every nonterminal node is subject to the disyllabic condition, the rest follows simply from the constituent structure.

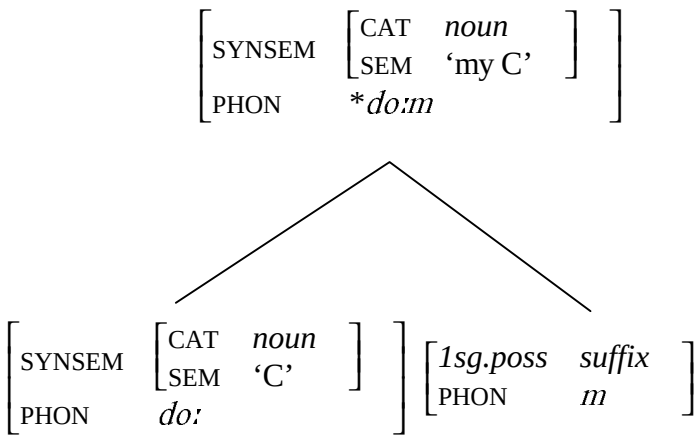
Example (32) schematically shows the disyllabic minimal size constraint.[10] The intended interpretation of this construction is that any node that is morphologically complex must contain at least two syllables.[11]

(32)



The structure for the ungrammatical subminimal form *do:-m* 'my C' is shown in (33):

(33)



This form is ungrammatical because the mother node contains only one syllable, and therefore violates the requirement that all nonterminal nodes contain at least two syllables. This violation is indicated by an asterisk preceding the phonological string of the mother node.

Example (34) shows the structure for the supraminimal form **do:-m-u* 'my C (acc.)', which is ungrammatical even though it contains two syllables.[12]

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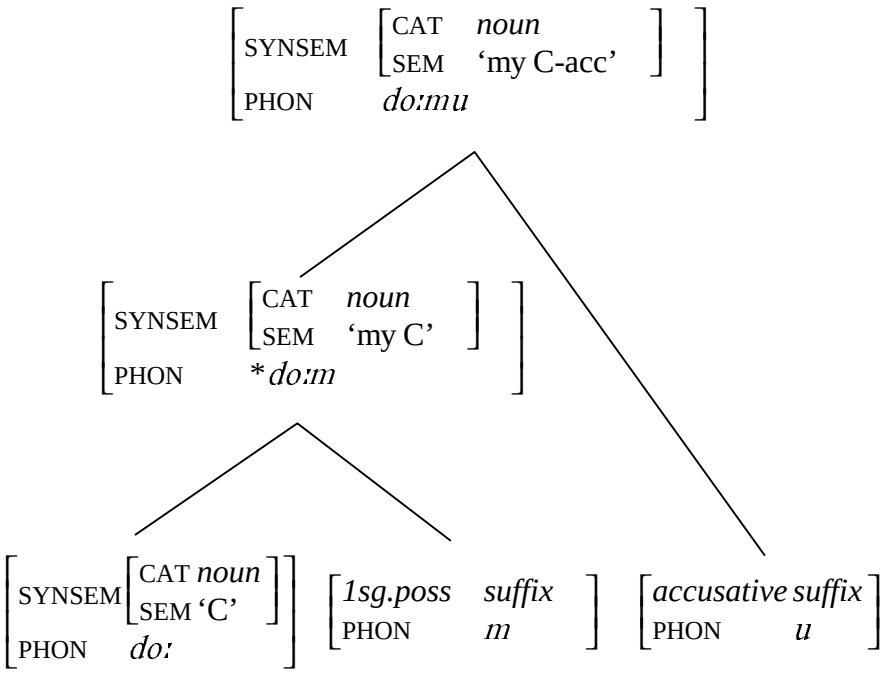
10 The constraint can be stated more formally if type hierarchies are used (see section 5.2.3 for discussion). We can then simply define a type nonterminal node (we independently need this to distinguish terminal nodes, which have immediate constituents from nonterminal nodes, which do not). Then, the disyllabic minimal size condition can be part of the definition of the type nonterminal node: nonterminal node ⇒ phon /σσ…/. I abstract away here from the issue of representing metrical structure in a feature-based formalism such as HPSG. See Bird and Ellison 1994 and Walther 1995 for some discussion.

11 I assume here that affixes are represented as terminal constituents. This assumption is not crucial, but makes the presentation more transparent.

12 I am using the synsem|sem attribute to provide English glosses, not to make claims concerning semantic representation. I am not claiming, for example, that "accusative" is part of the semantic representation of the accusative suffix.

(34)



This form is ungrammatical because it contains a nonterminal node (namely the intermediate node */doː-m/) that contains only one syllable. This example illustrates one of the basic principles of sign-based linguistics: a constituent structure is well-formed if and only if all nodes in it are well-formed. In other words, a constituent structure represents a grammatical construct of the language if and only if:

a) all nonterminal nodes are related to their daughters in a way licensed by universal percolation conventions and language or construction specific constraints (including the appropriate phonological mapping), and

b) all nodes satisfy all constraints imposed on nodes of their type (this is akin to the requirement in GPSG that all local trees must be well-formed).[13]

In (34), the intermediate node */doː-m/ violates clause (b), because it fails to satisfy a constraint (disyllabic minimality) imposed on nonterminal nodes.

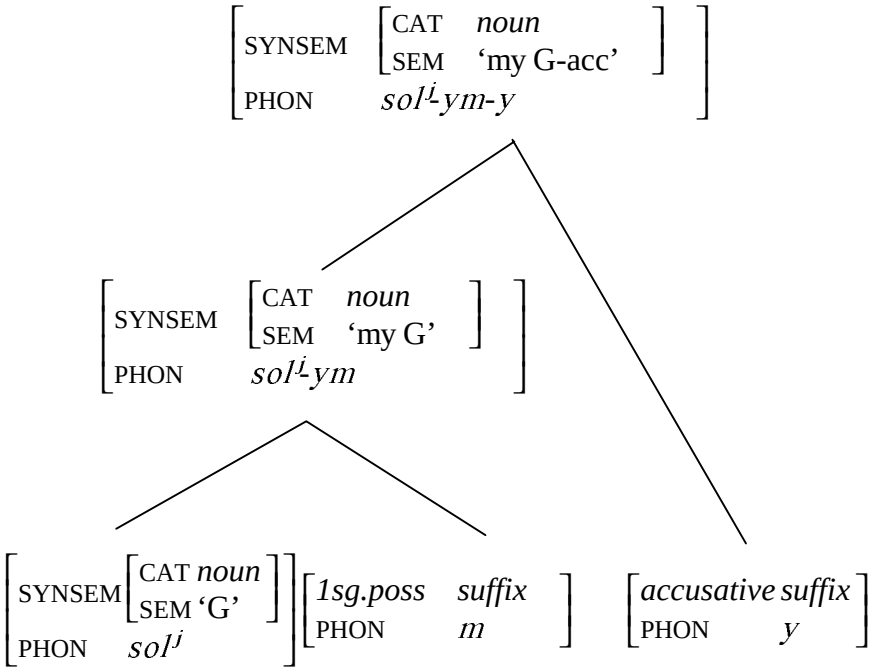
The apparent cyclic application of the minimal size condition thus follows from the requirement that every local tree be wellformed. In the minimality case, this translates into a requirement that every nonterminal node contain two syllables. Even when the whole word contains the required two syllables, it may still be ungrammatical because there is a subconstituent that does not meet the requirement. Another possible interpretation of this analysis is the following: cased nouns are built out of bare or possessed noun stems. In the case of **do:-m-u*, there is no possessed noun stem *do:-m* (this being ruled out by the

13 A local tree is a mother node plus its immediate constituents.

disyllabic minimal size condition). Therefore, there is nothing available to apply the case construction to.

For comparison, example (35) shows the constituent structure for the grammatical form *sol^{j}-ym-y* 'my G-acc':

(35)



In this structure, all nonterminal nodes satisfy the minimal size condition. This is therefore a grammatical form of Istanbul Turkish.

We see that cyclic phonological effects are an automatic consequence of using constituent structures in morphological description. The only tools that are needed to account for cyclic phonological effects are:

i) Constituent structures. These are a standard assumption in many linguistic theories.

ii) A mechanism of feature percolation whereby the features of a mother node are related to the features of its daughters. All constituent structure-based theories assume some degree of feature percolation.

It is thus fair to say that cyclic phonological effects come for free—no additional stipulation needs to be made to derive them once a constituent structure-based understanding of linguistics is adopted.[14] This conclusion is largely independent of the

14 There are, of course, linguistic theories that do not assume constituent structures, at least not for affixational morphology. Of those, the realizational approach of Anderson (1992) is quite similar in spirit to Sign-Based Morphology, as I show in section 3.2.2. In particular, realizational morphology, like Sign-Based Morphology, accounts for cyclic phonological effects at no extra cost. Thus, the

particular theory of phonology assumed. As long as all nodes (including nonterminal nodes) bear phonological information, and the information in a mother node is related in some fashion to the information in its daughters (as must be the case in *any* theory), cyclic phonological effects follow.

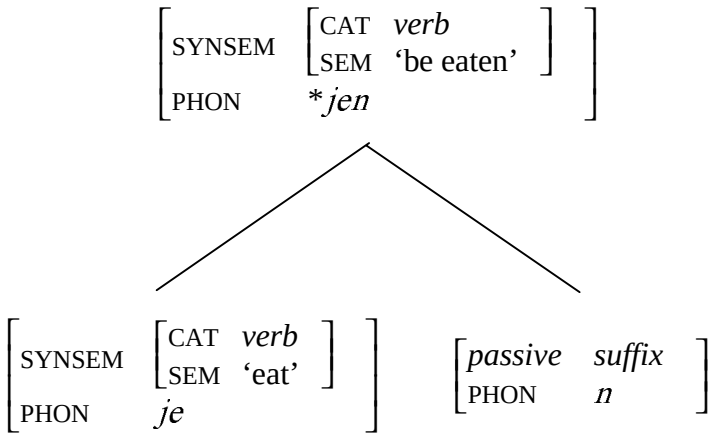
We have seen that the apparent cyclic application of the disyllabic minimal size condition is handled quite successfully and elegantly in Sign-Based Morphology. A quite different situation obtains in verbs. Verbal subminimal forms do become grammatical when more suffixes are added to bring the total size to at least two syllables.

(36)	*je-n	'eat-pass'
	je-n-ir	'eat-pass-imprf'
	je-n-di	'eat-pass-past'
	je-n-me-miʃ	'eat-pass-neg-evid'

In these forms, the minimal size condition seems to be enforced noncyclically. That is, only the whole word is subject to the minimal size condition. Intermediate suffixed stems are not required to be disyllabic.

Following Orgun (1994b,c, 1995a,b, 1996b) I use flat constituent structures to derive noncyclic phonological effects (see also Cole and Coleman 1993 for a similar approach). Accordingly, the verbal forms in (36) must have a flat structure (I show in section 2.2 that these flat versus branching structures find independent morphological motivation, providing striking support for the theory). The structure for the ungrammatical subminimal form **je-n* is shown in (37):

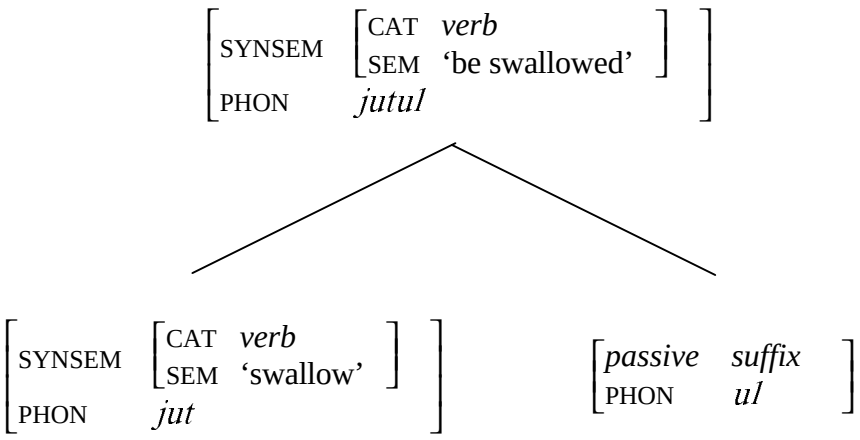
(37)



observation that handling cyclic phonology does not add and complexity to a linguistic theory is independent of whether constituent structure are to be used.

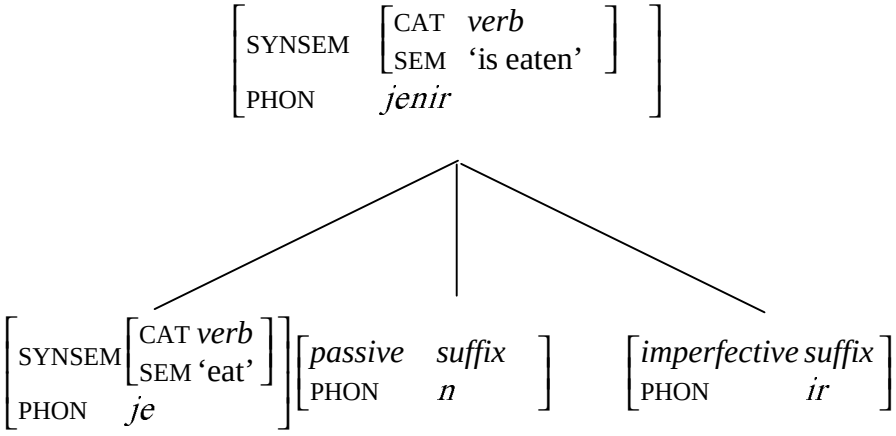
This form is ungrammatical because the mother node contains only one syllable, violating the disyllabic minimal size condition. Example (38) shows the structure for the grammatical form *jut-ul* 'swallow-pass' for comparison:[15]

(38)



Recall that subminimal verbal forms can be "repaired" by adding further suffixes, suggesting that the minimal size condition is enforced noncyclically in these forms. We account for this by assuming a flat structure, as shown in (39):

(39)



In this constituent structure, there are no nonterminal nodes that violate the minimal size condition. The structure therefore represents a grammatical construct of Istanbul Turkish, namely the form *jenir* 'is eaten'.

At this point, we must ask whether there is any independent linguistic evidence for the flat versus branching structures used in this section. It turns out that there is, as shown by Orgun 1995a,b. I summarize the relevant data below.

15 The allomorphy of the passive suffix (*-n* ~ *-Il*) is conditioned by the final segment of the stem. *-n* attaches to vowel-final stems and [l] final stems (with an epenthetic vowel in the latter), while *-Il* attaches to all others.

2.2 Suspended Affixation

Allowing both flat and branching structures raises a methodological question: in the absence of evidence for either, are we to assume flat or branching structures? I suggest assuming flat structures as a null hypothesis, and use branching structures only when motivated by positive evidence.[16,17] It is likely that this is the strategy that will converge on the desired result most quickly, since wrong branching patterns will never need to be considered. Accordingly, in this section, I will present independent positive evidence for the binary branching structure found in the nominal forms in (30). The lack of evidence for branching structures in the verbal forms in (36) will be taken to be sufficient to assume flat structures for those forms.

The evidence for branching comes from a construction called Suspended Affixation by Lewis (1967). In this construction, when two suffixed words are conjoined, suffixes that have scope over both conjuncts may optionally be omitted from the first conjunct, and realized only on the second conjunct.[18]

An example is shown in (40a), where the two nouns *sɯhhat* 'health' and *a:fijet* 'well being' are conjoined, and the locative suffix, which has scope over both of them, is found only once at the end of the conjoined phrase instead of on both conjuncts. Example (40b) is similar, with the plural (*-lʲer*) and possessive (*-i*) suffixes having scope over the conjuncts *adʒɯ* 'sorrow' and *sevintʃ* 'joy'. Further examples can be found in Lewis (1967), Underhill (1976), and Inkelas and Orgun (1994).

(40) a) sɯhhat ve a:fijet-te
health and well-being-loc
'in health and well-being'

b) (halk-ɯn) [adʒɯ ve sevintʃ]-lʲer-i
people-gen sorrow and joy-pl-3sg.poss
'the people's sorrows and joys'

Example (41) shows the null hypothesis for the structure of this construction. I assume that the constituent structure is as implied by the scope relations, with the locative suffix attached to the whole conjoined NP.

(41) [[sɯhhat ve a:fijet] -te]

16 This is of course related to the issue of whether cyclic or noncyclic phonology is the default assumption. My proposal amounts to claiming that noncyclic phonology is the default, and cyclic phonology is to be used only when there is positive evidence. This proposal is similar in spirit in current approaches (for example, Prince and Smolensky 1993), although I differ from them in allowing cyclic phonological effects to be sufficient to motivate branching morphological structures.

17 It is not clear to me at this point whether these same considerations are valid for syntax as well as for morphology.

18 The following summary has been adopted from Orgun 1995b.

[[ɑdʒɯ ve sevintʃ] -lʲer-i]

There are initially puzzling restrictions on the combinations of affixes that Suspended Affixation can target. Example (42b) shows that it is acceptable not to suspend any affixes at all. Here, all suffixes are realized on both conjuncts. As seen in (42a), it is possible to suspend ALL eligible affixes. Here, the plural suffix *-lʲer*, the possessive *-im* (1st person singular) in the first example, and *-i* (3rd person singular) in the second example, and the accusative suffix *-i* (in the first example) are all suspended.

(42) a) No affixes suspended:

kʲedi-lʲer-im -i ve kʲøpekʲ-lʲer-im -i
cat -pl -1sg.poss -acc and dog -pl -1sg.poss -acc

ɑdʒɯ -lɑr -ɯ ve sevintʃ -lʲer-i
sorrow -pl -3sg.poss and joy -pl -3sg.poss

b) All affixes suspended:

[kʲedi ve kʲøpekʲ]-lʲer-im -i
[cat and dog]-pl -1sg.poss -acc
'my cats and dogs (acc)'

[ɑdʒɯ ve sevintʃ]-lʲer-i
[sorrow and joy]-pl -3sg.poss

Example (43) shows the promised puzzling restrictions on Suspended Affixation. In (43a), we see that it is possible to suspend just the accusative suffix *-i* while realizing the plural and possessive suffixes on both conjuncts. Examples (43b,c) show that it is not possible to realize the plural suffix *-lʲer* on both conjuncts while suspending the possessive (and accusative) suffixes.

(43) Suspension of some but not all affixes

a) [kʲedi-lʲer-im ve kʲøpekʲ-lʲer-im]-i
-pl -1sg.poss]-acc

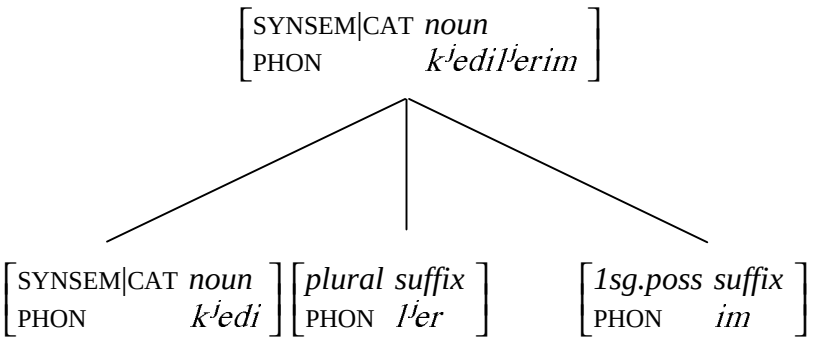
b) *[kʲedi-lʲer ve kʲøpekʲ -lʲer]-im -i
-pl -pl]-1sg.poss-acc

c) *[ɑdʒɯ -lɑr ve sevintʃ -lʲer]-i
-pl -pl]-3sg.poss

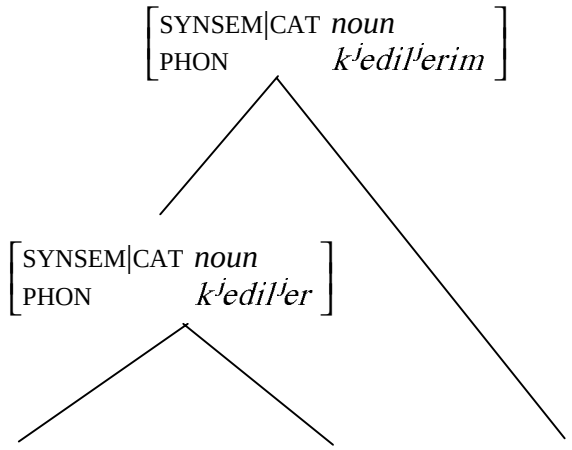
Our task is to account for this inseparability of the plural and possessive suffixes in Suspended Affixation. That is, we need to find a formal account of the observation that the plural and possessive suffixes are either both realized on all conjuncts or both suspended.

I offer an analysis of this seemingly strange restriction in terms of constituent structure. I claim that the plural and possessive suffixes form a flat (ternary branching) structure with the base they attach to, as shown in (44), rather than a binary branching hierarchical structure as in (44).

(44) a)



b) * a)

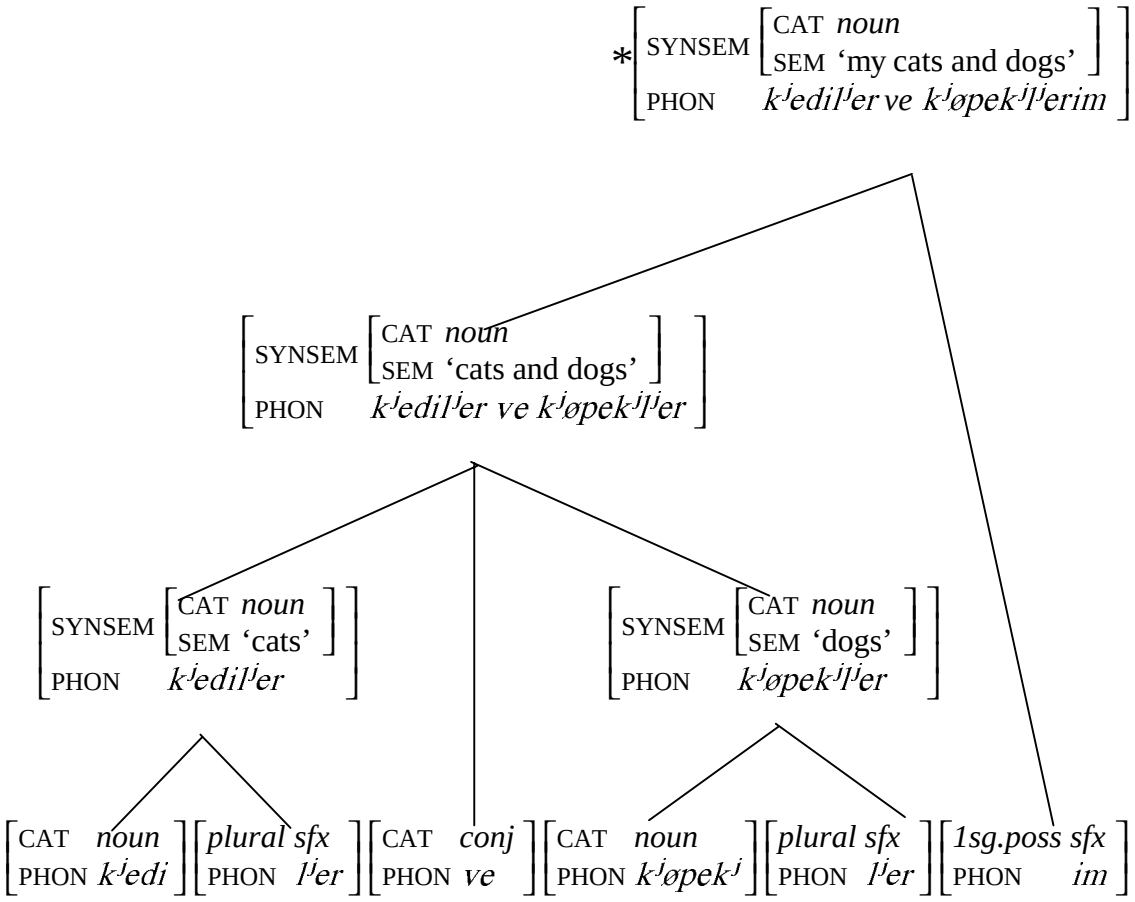


$$\begin{bmatrix} \text{SYNSEM|CAT} & \textit{noun} \\ \text{PHON} & \textit{k}^{j}\textit{edi} \end{bmatrix} \begin{bmatrix} \textit{plural suffix} \\ \text{PHON} \quad \textit{l}^{j}\textit{er} \end{bmatrix} \qquad \begin{bmatrix} \textit{1sg.poss suffix} \\ \text{PHON} \quad \textit{im} \end{bmatrix}$$

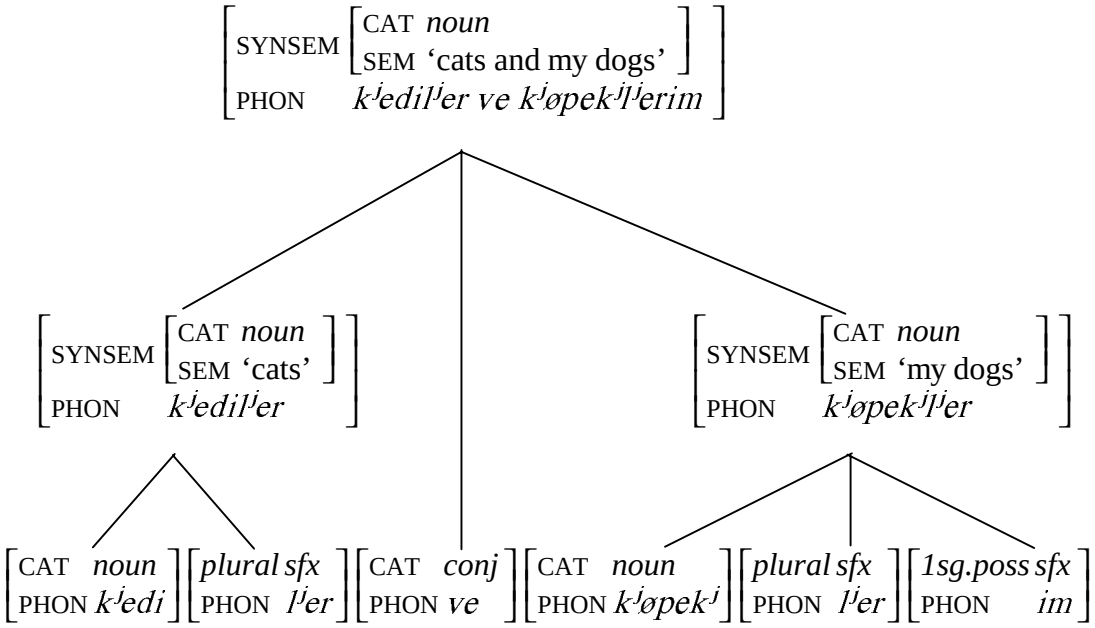
Given that the plural and possessive suffixes form a ternary branching structure with the base they attach to, the pattern of suspension in (45) is ungrammatical because it forces the plural and possessive suffixes to be in a hierarchical structure. This example is similar to the one we have seen before in (43b), except that the accusative suffix is not involved here. This further supports the position that the source of the problem is the configuration of the plural and possessive suffixes. There are two possible structures for this form. The first is shown in (45a). Here, the possessive suffix is attached to the conjoined noun phrase, as it has scope over both conjuncts. This configuration violates the condition that the plural and possessive suffixes must be sisters whenever they both have scope over the same head. Therefore, this structure is ruled out. This leaves us with the possibility in (45b), which is structurally well formed. However, this structure does not give us the desired scope relations. In particular, the possessive suffix has scope over the second conjunct but not the first conjunct. Therefore, we explain the fact that the plural and possessive suffixes have to be suspended together, or not suspended at all.

(45) *[k^{j}edi-l^{j}er ve k^{j}øpek^{j}-l^{j}er]-im
[dog-pl and cat-pl]-1sg.poss

a) Problem: -*lʲer* and -*im* not sisters



b) Problem: Incorrect scope (-*im*)[19]

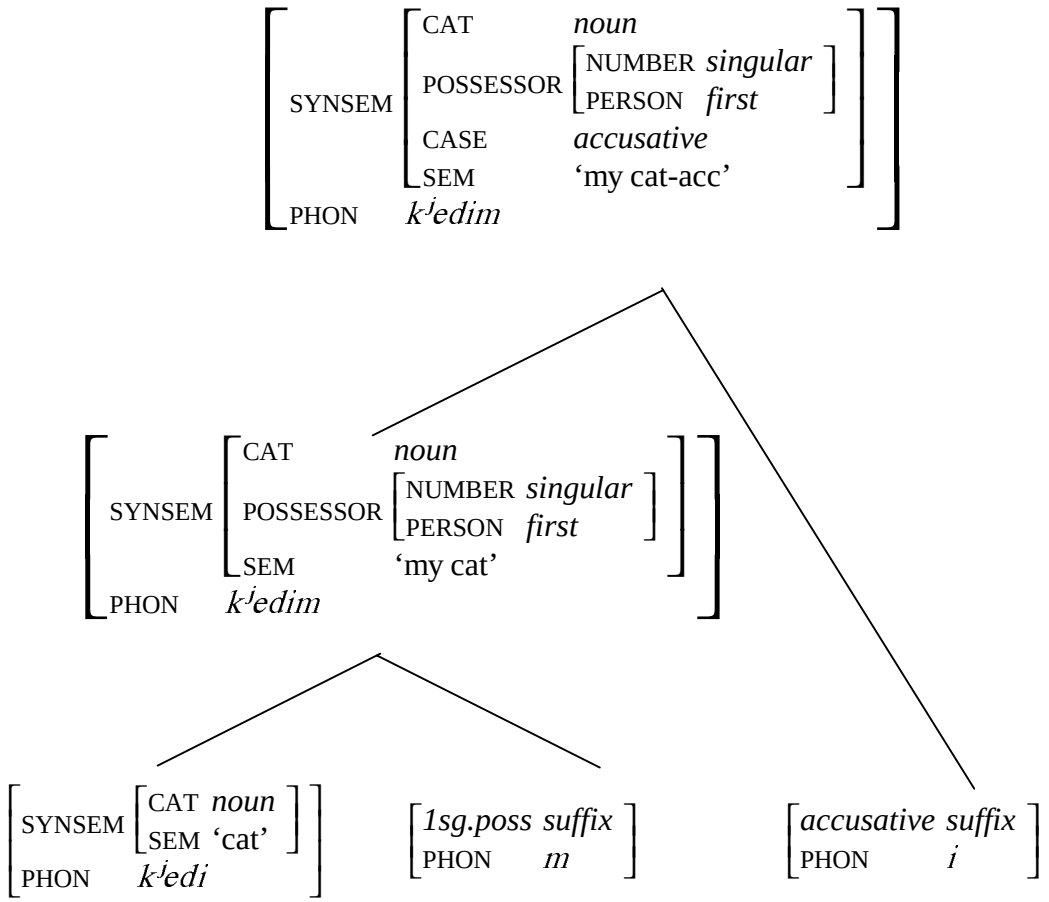


In general, then, suffixes can be separated in Suspended Affixation if and only if they form a hierarchical structure. If they form a flat structure, they have to be suspended as a group, or not at all.

Since the possessive and accusative suffixes can be suspended independently of one another (43a), they must form a binary branching, not a flat, structure. This is shown in (46):

19 This example is grammatical with the reading indicated on the top node. It is, however, not possible for the possessive suffix to have scope over both conjuncts.

(46)



It turns out that certain suffixes can never be suspended. Passive and aspect suffixes belong to this group. Thus, the suspension patterns in (47) are all ungrammatical.

(47) a) ɑl -ɯn -ɯr ve ver -ilʲ -ir
take -pass -imprf and give -pass -imprf

*ɑl ve ver-ilʲ-ir
*[ɑl-ɯn ve ver-ilʲ] -ir

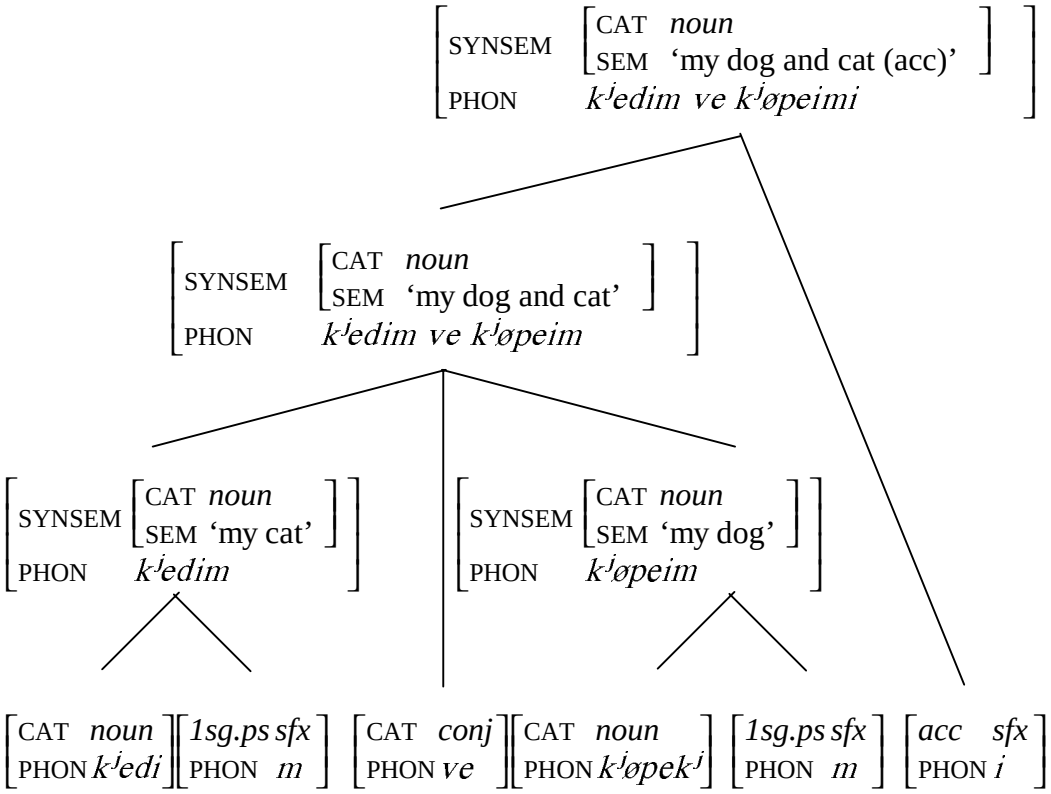
b) ɑl -ɯr ve ver -ir
take -imprf and give -imprf

*[ɑl ve ver] -ir

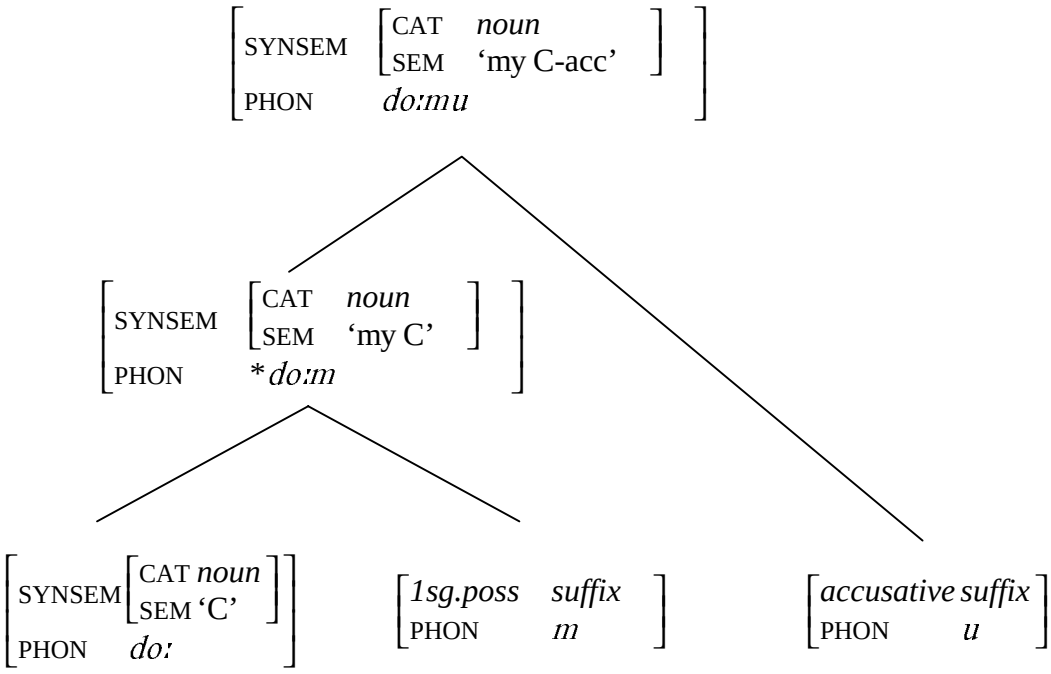
As a result, there is no evidence from Suspended Affixation for flat or branching structures for passive and aspect suffixes. According to our methodological principle of assuming flat structures when there is no evidence for branching, the passive and aspect suffixes must form a flat structure, as in (39).

We have thus found striking confirmation for the structures assumed in section 2.1: when the minimal size condition seems to be enforced cyclically, indicating binary branching constituent structures, the suffixes in question can be suspended independently of each other, also indicating a binary branching structure.

(48) a) Possessive and case suffixes in Suspended Affixation: branching structure



b) Minimality: branching structure



This convergence between purely phonologically motivated structures with morphologically motivated structures provides the most dramatic support for the framework of Sign-Based Morphology.

2.3 Optimality Theoretic analysis of Turkish minimality

In this section, I will present a rough Optimality Theoretic analysis of the Turkish data. The main challenge is to derive ungrammaticality. Since Optimality Theory is set up to declare the best candidate as the grammatical output, it would appear that there will always be a winner. Prince and Smolensky (1993) address this problem by proposing a "null parse" corresponding to a phonologically null output. If the null parse emerges as the winning candidate, no phonological output is created. By stipulation, the null parse satisfies every constraint except for a new one that Prince and Smolensky propose called MPARSE, which the null parse alone violates. Ranking a constraint C above MPARSE amounts to declaring that C is inviolable: any candidate that violates C is worse than the null parse. If a number of constraints are ranked above C, and some of them conflict (that is, satisfying one entails violating another), then the null parse emerges as the winner. Ungrammaticality is then to be handled by ranking the responsible constraints above MPARSE.

The Turkish minimal size condition turns out to provide somewhat of a challenge to this approach. Orgun and Sprouse (1996a,b) have proposed a solution to this challenge, which I summarize here.

For the Turkish minimality case, the minimal size condition, which I will call σσ, must therefore be ranked above MPARSE, such that, given input /je-n/ 'eat-pass', the null parse will be a better candidate than **jen*. This is shown in (49):

(49)

/je-n/	σσ	MPARSE
jen	*!	
☞ ∅		*

We must of course consider additional candidates, in particular, some that use phonological epenthesis to increase the size to the disyllabic minimum, such as **jene*, **jein*, **jejin*, or **ijen*. The candidates that have peripheral epenthesis could conceivably be ruled out by an inviolable constraint barring such epenthesis, which is never found in Turkish in any case.[20] It turns out not to be a simple matter to rule out the other candidates, however. Epenthesis is possible elsewhere in Turkish, as in /sol^{j}-m/→[sol^{j}ym]. This implies that the constraint against epenthesis (DEP in McCarthy and Prince 1995) is ranked lower than MPARSE. Otherwise the null parse would have been better than the epenthesizing candidate.

Vowel hiatus is also found, both within morphemes, and across morpheme boundaries (as a result of the productive intervocalic velar deletion process, as well as in a few morphophonemically irregular forms that fail to undergo glide epenthesis). Examples are given in (50), with syllable boundaries indicated by periods:

(50)

ɑ.i.l^{j}e	'family'		
re.is	'chief'		
mɑ.un	'mahogany'		
sokɑk	'street'	sokɑ-ɑ	'street-dat'
bɑlɯk	'fish'	bɑlɯ-ɯ	'fish-acc'
mek^{j}ik^{j}	'shuttle'	mek^{j}i-im	'shuttle-1sg.poss'
mɯsrɑː	'line(poetry)'	mɯsrɑː-ɯ	'line-acc'
dʒɑːmi	'mosque'	dʒɑːmi-i	'mosque-3sg.poss'[21]

We must conclude that the constraint barring vowel hiatus (call it *V.V) is also ranked lower than MPARSE. The ranking we have so far is shown in (51):

20 Except in some loanwords, such as istim 'steam'. The account I am developing will fail even without this complication. Therefore, I will not dwell on the issue of loanword adaptation, which is the subject of considerable debate.

21 These are conservative forms that most speakers of Istanbul Turkish have regularized. It is thus more common today to find mɯsrɑːsɯ and dʒɑːmisi than mɯsrɑːɯ and dʒɑːmii.

(51) σσ » MPARSE » DEP, *VV

This ranking, however, incorrectly predicts there to be a grammatical output for /je-n/ 'eat-pass'. This is illustrated in (52):

(52)

/je-n/	σσ	MPARSE	DEP, *VV
jen	*!		
(☞) ∅		*	
💣 jein			**

Trying to rule out epenthesis next to a morpheme boundary would be futile, since this is the usual epenthesis site, and occurs even when the passive suffix *-n* itself is involved, as in *bul-un* 'find-pass'.

Orgun and Sprouse propose to revise Prince and Smolensky's approach to ungrammaticality as follows: instead of using MPARSE, they propose excluding all inviolable constraints from EVAL. EVAL then always selects a winner for any input. This winner is judged grammatical if it satisfies all the inviolable constraints, now grouped into a separate constraint component that Orgun and Sprouse call CONTROL. If the winner of EVAL violates a constraint in CONTROL, then it is ungrammatical. No grammatical output is possible in that case.

For the Turkish minimality problem, EVAL will contain usual phonological constraints such as syllable structure constraints, faithfulness to the input, and so on. CONTROL contains at least the disyllabic minimal size constraint. EVAL now selects *jen* as the winning candidate for /je-n/ 'eat-pass', since this candidate is maximally faithful, and has no syllable structure or other problems (53):

(53)

/je-n/	DEP, *VV
☞ jen	
jein	**

This candidate, however, violates a constraint in CONTROL (54), as indicated by the scissors notation that Orgun and Sprouse have introduced:

(54)

	σσ
✂ jen	*!

Since the winner of EVAL violates a constraint in CONTROL, no grammatical output is possible, as desired. Further support for this approach to ungrammaticality is offered by Orgun and Sprouse on the basis of crosslinguistic evidence. A further example of ungrammaticality that calls for a CONTROL solution can be found in section 5.3 of this study.

2.4 Ondarroa Basque vowel height assimilation

Another phonological constraint that appears to be enforced cyclically or noncyclically depending on the morphological structure of the word in question is vowel height assimilation in Basque. The following discussion is based on Hualde (1989, 1991).

In the Ondarroa dialect of Basque, final low vowels become mid when there is a high vowel in the preceding syllable (a similar alternation takes place in most other varieties of Basque as well, but the details are different; see Hualde 1991). Hualde characterizes this alternation as a rule that spreads [-low] to the final vowel. Descriptively, the rule in (55) indicates the environment for this alternation.

(55) $\text{a} \rightarrow \text{e} \; / \; \overset{\text{V}}{[+\text{hi}]} \; \text{C}_0 \_\_\_ \#$

An example of the alternation is given in (56). In (56a), the definite article clitic *-a* is attached to a stem whose last vowel is mid. Raising does not apply. In (56b), the same clitic is attached to a word whose last vowel is high. The clitic vowel raises to [e] in this case.

(56) a) /giʃon-a/ [giʃona] 'the man'

b) /lagun-a/ [laɣune] 'the friend'

The data in (57) show that this is a "derived environment rule," that is, it only applies across morpheme boundaries. Thus, the low vowels in (57) do not raise to mid, yielding **fabrike*, **tʃimiste*.

(57) fabrika 'factory'
tʃimista 'lightning'

The data in (58) show that suffixes (as well as the definite article clitic in (56)) undergo raising. In (58a), the suffixes *-ka* and *-na* are added to stems whose last vowel is low. Raising does not apply. In (58b), the same suffixes are added to stems that end in high vowels, and raise to *-ke* and *-ɲe* (the palatalization of the [n] is due to the preceding [i]; this is an independent alternation that we are not concerned with).

(58) Suffixes that undergo raising

a) /pelota-ka/ [pelotaka] 'throwing a ball'
/bat-na/ [bana] 'one for each'

b)	/ɑri-kɑ/	[ɑrike]	‘throwing stones’
	/bi-nɑ/	[biɲe]	‘two for each’

More examples of clitics that undergo raising are given in (59). Once again, the forms in (59) do not exhibit raising, since the clitics in these forms do not follow high vowels, while the forms in (59b) do, since the clitics here follow high vowels.

(59) Clitics that undergo raising

a)	/koldo tɑ peru/	[koldotɑperu]	‘Koldo and Peru’
	/ɑmen dɑ/	[ɑmendɑ]	‘here it is’
b)	/peru tɑ koldo/	[perutekoldo]	‘Peru and Koldo’
	/xun dɑ/	[xunde]	‘he has gone’

The data in (60) show that raising does not apply to vowels that are not final. The forms in (60a) end in a consonant, and do not undergo raising. The forms in (60b) are phonologically similar except that they end in a vowel; these forms do undergo raising.

(60)	a)	ur-ɑk	‘water-abs.pl’
		lɑɣun-ɑk	‘friend-abs.pl’
	b)	ur-e	‘water-abs.sg’
		lɑɣun-e	‘friend-abs.pl’

The data in (61) confirm that the forms in (60b) indeed exhibit raising, as opposed to simply being underlyingly mid. In (61), the absolute singular suffix is added to stems whose last vowel is not high. The suffix in these cases surfaces with a low vowel rather than a mid one.

(61)	giʃon-ɑ	‘man-abs.sg’
	ɑr-ɑ	‘worm-abs.sg’

In summary, raising applies across morpheme boundaries to word-final vowels when preceded by a high vowel.

2.5 Optimality Theoretic analysis of Basque vowel height assimilation

In this section, I will present a very simple analysis of Basque vowel height assimilation. This is just for illustrative purposes. Of the various approaches to assimilation in the Optimality Theory literature, any one may be chosen, and will be consistent with Sign-Based Morphology.

I start by assuming that two vowel height features, [high] and [low] are active in Ondarroa Basque. High vowels are [+high, -low], mid vowels, [-high, -low], and low vowels, [-high, +low]. Vowel height assimilation causes an input low vowel to correspond to an output mid vowel following an output high vowel (across any number of consonants). I formulate the constraint responsible for this alternation as a negative target constraint along the lines of McCarthy 1996. McCarthy's constraint format allows specification of underlying or surface levels for the trigger or target. Surface specification is considered the unmarked case. For the Basque problem, it is possible to use all surface specifications. The constraint is shown in (62):

(62)

	Condition	Level
α	[+high]	Surface
β	[+low]	Surface
Precedence	<	Surface
Adjacency	V to V	Surface

The constraint, which I will call *[+high]C_0[+low] rules out a high vowel followed by a low vowel. Other constraints must be called on to make sure that potential violations of this constraint are avoided by raising the second vowel rather than any other means (for example, lowering the first vowel, deleting one of the vowels, or inserting a mid vowel between them). The constraints involved are various faithfulness constraints. The constraint IDENT(+high) makes sure that the first vowel will not be lowered. The constraints MAX-V and DEP-V make sure that a vowel will not be deleted or inserted. All these constraints are ranked above IDENT(+low), requiring faithfulness to an underlying [+low] specification. The following tableau illustrates how the system works:[22]

(63)

/bi-nɑ/	*[+hi]C_0[+lo]	IDENT(+hi)	MAX-V	DEP-V	IDENT(+lo)
biɲɑ	*!				
benɑ		*!			
bienɑ				*!	
biɲ			*!		
☞ biɲe					*

This analysis, however, incorrectly predicts that there should be no morpheme internal high vowel-low vowel sequences, as in *tʃimista* 'lightning'. In fact, vowel height assimilation applies only across morpheme boundaries in Ondarroa Basque. There are two

22 The restriction of the alternation to word-final vowels is not handled by this formulation. One way to fix this deficiency would be to build this restriction into the constraint by changing the constraint to something like [+hi]C_0[+lo]#, where # indicates the end of the phonological domain. This new constraint does not fit into McCarthy's format. Another way to deal with the problem would be to look for a special "morpheme integrity" type constraint that requires faithfulness to nonperipheral segments. This might be a better motivated move in light of the crosslinguistically special status of peripheral segments.

ways of dealing with this difficulty. The first is stipulating, in the fashion of the Strict Cycle Condition, that the constraint *[+hi]C_0[+lo] only applies when there is a morpheme boundary somewhere in its environment. The second way is to try to derive this effect instead of stipulating it, as Kiparsky (1993) has proposed, from underspecification. This involves assuming that the suffix vowels that undergo this alternation are underspecified for + or -low, and that IDENT(+low) is ranked higher than *[+hi]C_0[+lo]. If we assume in addition that + is the default value for low (that is, *[-low] » *[+low]), we obtain the desired result. With this new ranking, and the new underspecified representation for affix vowels, vowel height assimilation follows as shown in the tableau in (64):

(64)

/bi-nɑ/	IDENT(+lo)	*[+hi]C_0[+lo]	IDENT(+hi)	MAX-V	DEP-V
biɲɑ		*!			
benɑ			*!		
bienɑ					*!
biɲ				*!	
☞ biɲe					

The root *tʃimista* 'lightning', on the other hand, has a fully specified vowel. In this case, the optimal candidate is the faithful one, as shown in (65):

(65)

/tʃimistɑ/	IDENT(+lo)	*[+hi]C_0[+lo]	IDENT(+hi)	MAX-V	DEP-V
☞ tʃimistɑ		*			
tʃimiste	*!				

Kiparsky's proposal depends crucially on his assumption of Radical Underspecification. The current trend in Optimality Theory, however, is to leave underlying representations unrestricted, and to require that the grammar choose a legitimate output for any input. We must therefore consider different possible inputs with underspecified and fully specified vowels. Assuming an underspecified vowel within a root will give rise to an [iC_0e] sequence, which is legitimate. Assuming a fully specified vowel in an affix would predict that that affix will fail to undergo vowel height assimilation, surfacing consistently with a low vowel regardless of the environment it is in. Hualde (1991) does not report any such consistently low affix vowels in Ondarroa Basque. Such vowels are, however, found in other dialects of Basque, which also have a similar vowel height assimilation process. For example, in Baztan Basque, the suffixes -*garen* 'ordinal', -*tar* 'origin', and -*ago* 'more' idiosyncratically fail to undergo vowel height assimilation (in this dialect, vowel height assimilation is not restricted to word-final vowels as it is in Ondarroa, as shown by examples like *tratu-leri* 'dealer' versus *eske-lari* 'beggar'). It might therefore be considered an accidental gap in Ondarroa Basque that such nonalternating suffixes are not found. The restriction that the target vowel be word-final causes the set of eligible suffixes small to begin with in any case.

Whether we choose to stipulate the restriction of vowel height assimilation to morphologically derived environments or relate it to underspecification, an Optimality Theoretic account is readily formulable, and meshes nicely with Sign-Based Morphology.

2.6 Cyclic and noncyclic effects in Basque vowel height assimilation

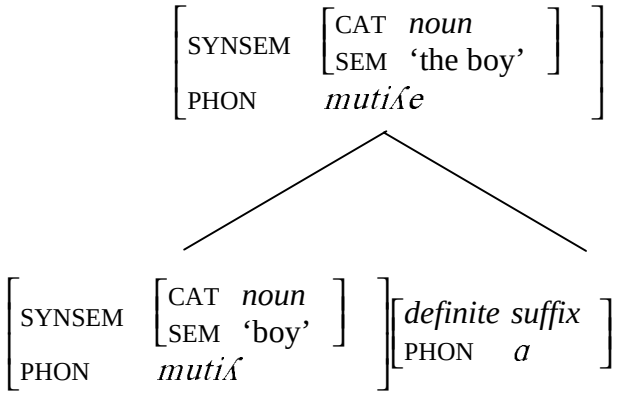
What happens when multiple affixes or clitics are added to a form, resulting in a number of stem-final vowels, one for each morphological subconstituent? The data in (66) show that raising does not apply cyclically in this case, as Hualde also notes. That is, raising does not apply to the final vowels of intermediate morphological constituents. It only applies to vowels in the absolute word-final position. In (66a), the suffix vowel is word-final and undergoes raising. In (66b), the suffix vowel is stem final (as in [[bi-n<u>a</u>] kɑ]), yet does not undergo raising.

(66) Noncyclic application in multiply suffixed forms

a)	/mutil-ɑ/	[mutiʎe]	'the boy'
	/bi-nɑ/	[biɲe]	'two for each'
	/ɑri-kɑ/	[ɑrike]	'throwing stones'
b)	/bi-nɑ-kɑ/	[biɲɑkɑ]	'two by two'
	/mutil-ɑ-k/	[mutiʎɑk]	'the boy-erg'
	/ɑri-kɑ-dɑ/	[ɑrikɑrɑ]	'throwing of a stone'

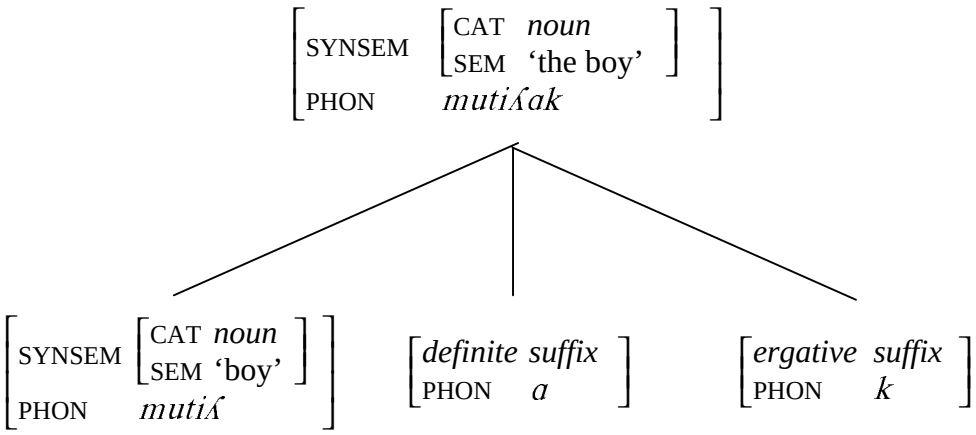
Since noncyclic application follows from flat structures, the forms with three morphemes in (66) must all have ternary branching constituent structures. The structure for *mutiʎe* 'the boy' is shown in (67):

(67)



In this form, the environment for vowel height assimilation is met in the mother node. Thus, the underlying /ɑ/ of the definite article corresponds to an /e/ in the mother node. Compare this with the constituent structure for the form *mutiʎɑk* 'the boy-erg' in (68):

(68)



In this form, the environment for vowel height assimilation is not met, as the definite article's /ɑ/ is not final in the mother node. Assimilation therefore does not apply. There is no possibility of cyclic phonological effects in flat structures.

We have seen that the apparent noncyclic application of vowel height assimilation can be handled by positing a flat structure for the forms involved. However, as Hualde shows, in forms containing clitics, raising applies to the base that the clitic attaches to, as well as to the whole word including the clitic. In (69a), the vowel of the definite article raises to [e] even though it is not word-final. The stem that the clitic attaches to qualifies as a domain for raising. In (69b), we see that the clitic vowel is itself subject to raising when preceded by a high vowel. This suggests cyclic application, with raising applying both "before" and "after" cliticization.

(69) Cyclic application in forms containing clitics

a) Applies before clitics:

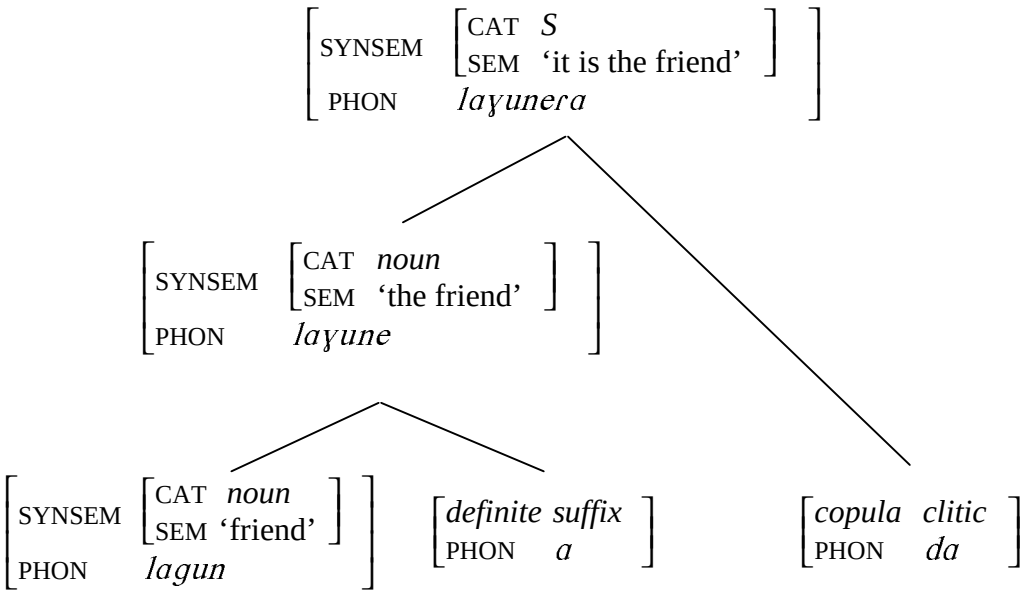
/lɑgun-ɑ-dɑ/	[lɑɣunerɑ]	'it is the friend'
/mendi-ɑ-dɑ/	[mendiʃerɑ]	'it is the mountain'

b) Applies to clitics:

/burᴜ-ɑ-dɑ/	[burᴜre]	'it is the head'
/bɑso-ɑ-dɑ/	[bɑsᴜre]	'it is the forest'

Raising in Ondarroa Basque is similar to the minimal size condition in Istanbul Turkish in that both may apply cyclically or noncyclically depending on morphological factors. The solution is also similar. Since cyclic application follows from branching structure, the forms in (69) must have binary branching structures. The structure for *layunera* 'it is the friend' is shown in (70):

(70)



In this form, the environment for vowel height assimilation is met in the intermediate node *layune* 'the friend'. The final vowel of this constituent is therefore /e/. Thus, the branching structure we assume accounts for the apparent cyclic application of vowel height assimilation in these forms.

We have seen that cyclic as well as noncyclic phonological effects follow from static constituent structure configurations in Sign-Based Morphology. In the Turkish case, the branching and flat structures needed for prosodic minimality enforcement match those motivated by Suspended Affixation. This match between phonologically and morphologically motivated structures provides striking support for the theory.

So far, I have introduced the basic structure of Sign-Based Morphology, and shown how it can offer a principled account of the apparent cyclic versus noncyclic application of phonology. In the next chapter (chapter 3), I discuss the relationship between Sign-Based Morphology and other theories of morphology.