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ON THE HIERARCHY OF BOUNDARIES

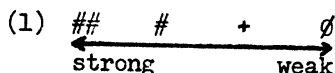
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1. Introduction.¹

Chomsky and Halle's (1968) study of phonological organization includes discussion of the following boundary phenomena: full word boundary ($\#\#$), internal word boundary ($\#$), morpheme boundary ($+$), and no boundary ($\emptyset$), representing unanalyzed, unstructured strings. These boundaries, which are uncontroversial and needed in most languages, are arranged by Hyman (to appear) in the following hierarchy:



The above hierarchy is said to represent both the relative synchronic strength and the natural historical weakening of the boundaries.

This paper examines synchronic and diachronic facts from Hungarian which bear on the suggested hierarchy of boundaries. The evidence presented supports the thesis that boundaries are hierarchically organized.³ However, a slight reinterpretation of the hierarchy in (1) is found necessary.

2. Synchronic Evidence for the Hierarchy of Boundaries.

One obvious interpretation of a linear hierarchy like (1) is that a weaker boundary (i.e. lower in the hierarchy) implies a stronger boundary (i.e. higher in the hierarchy), but not vice versa. That is, if boundary B is stronger than boundary B', then: a, any process (rule) that takes place in the context of B' also takes place in the context of B; and b, there exist processes which are restricted to the context of B to the exclusion of B'.⁴

The facts of Hungarian suggest that a stronger boundary does not imply a weaker boundary. These facts are consistent with the claims Chomsky and Halle make in SPE about boundaries in English. Let us look at some examples.⁵

$\#\#$ does not imply $\#$. Stress is assigned to the initial syllable of a full word:

$$(2) \quad V \Rightarrow [\text{stress}] / \#\# C_0 \underline{\quad}$$

The initial syllables of enclitic postpositions and the second members of compounds, both of which are preceded by $\#$, are not stressed. Note the following examples, where stressed vowels are underlined:

- (3) ##kilenc##óra##/ kilenc óra 'nine o'clock'
 $\text{##kilenc##óra#kor##/}$ kilenc órákor 'at nine o'clock'
 ##óra#bér##/ órabér 'hourly wage'

The failure of rule (2) to apply in the context of #C₀ ____ shows that ## does not imply #.

does not imply +. The final h of nouns is deleted word finally and before a consonant initial suffix:

- (4) $h \Rightarrow \emptyset / \text{____} \{ \# \}$
 C

For example, h is not pronounced in méh 'bee', méhtől 'from (the) bee', méhkás (/méh#kas/) 'bee-hive'. h remains and is predictably pronounced as voiced [h] before a vowel initial suffix (by rule (7), formalized below): e.g., mé[h]ünk (/méh+unk/) 'our bee'. If # implied +, then rule (4) would have applied to /méh+unk/.

+ does not imply $\emptyset$. The low vowels a and e are lengthened to a and e before a suffix:

- (5) Low Vowel Lengthening (LVL)
 $\left[\begin{smallmatrix} \text{V} \\ +\text{low} \end{smallmatrix} \right] \Rightarrow [+long] / \text{____} + [+segment]$

For example: alma 'apple', almám 'my apple', almaért 'for (the) apple'; kefe 'brush', kefém, keféért. LVL is inapplicable if the low vowel is not morpheme final: e.g. radír, *radír 'eraser'.

Let us now look in the opposite direction and see if a weaker boundary implies a stronger one. It will be seen again that the facts of Hungarian bear out the SPE claims about boundaries.

$\emptyset$ implies +. In SPE, Chomsky and Halle (1968:364) state the following convention:

- (6) Any rule which applies to a string of the form XYZ also applies to strings of the form X+Y+Z, XY+Z, X+YZ, where X, Y, Z stand for sequences of zero or more units and + represents formative [morpheme] boundary.

The above convention has received unmitigated support in the post-SPE years of phonological research. For example, Hungarian contains an allophonic rule which voices /h/ to [h] between voiced segments:

- (7) $h \Rightarrow [+voi] / [+voi] \text{____} [+voi]$

Rule (7) applies to /h/ in the intra-morphemic context / [+voi]h[+voi]/, as well as in the inter-morphemic contexts / [+voi]h[+voi]/ and / [+voi]+h[+voi]/:

- (8) /konyha/ $\Rightarrow$ kony[h]a 'kitchen'
 /juh+unk/ $\Rightarrow$ ju[h]unk 'our sheep'
 /asztal+hoz/ $\Rightarrow$ asztal[h]oz 'to (the) table'

Another rule of Hungarian assimilates a vowel in backness to the preceding vowel:

$$(9) V \Rightarrow [\alpha \text{back}] / \left[\begin{matrix} V \\ \alpha \text{back} \end{matrix} \right] C_0 \text{ \_\_\_\_}$$

Thus, /ember+nál/ 'at (the) man' and /tanár+nál/ 'at (the) teacher' are realized respectively as embernél and tanárnál.

The well known vowel harmony rule (9) interacts with the following epenthesis rule:

$$(10) \emptyset \Rightarrow o / C \text{ \_\_\_\_ } C \left\{ \begin{matrix} \# \\ C \end{matrix} \right\}$$

Rule (10) accounts for stem alternations like bokor/bokr- 'shrub':⁸

(11) /bokr#rózsa/	bokorrózsa	'shrub rose'
/bokr+nál/	bokornál	'at (the) shrub'
/bokr+unk/	bokrunk	'our shrub'

When rule (10) applies to a front vowel stem, the epenthetic o undergoes the vowel harmony rule (9). For example, /tűkr+nál/ becomes /tűkor+nál/ by rule (10); the vowel o is assimilated to the front vowel ü by rule (9): /tűkör+nál/; rule (9) reapplies and harmonizes á to ö: /tűkör+nél/; the final output is tűkörnél 'at (the) mirror'. This derivation illustrates the fact that the vowel harmony rule applies when the focus vowel and the determinant vowel occur in the same morpheme, as well as when these vowels are separated by +.

+ does not imply #. A rule which applies to the string X+(Y) does not apply to the string X#(Y). Observe the application of rule (5), for instance: /kutyá+m/ => kutyám 'my dog'; /kutyá+ól/ => kutyáól, *kutyáól 'dog house'.

implies ##. A rule which applies to the string X#(Y) also applies to the string X##(Y). Note the application of rule (10): /##bokr##/ becomes bokor 'shrub'.

Another pertinent example of a rule which applies in the context of # as well as ## is the following: (= rule (4))

$$(12) h \Rightarrow \emptyset / \text{ \_\_\_\_ } \left\{ \begin{matrix} \# \\ C \end{matrix} \right\}$$

This rule deletes the final h of nouns word finally, in compounds (also before an enclitic postposition), and before a consonant initial suffix. h remains before a vowel initial suffix and is predictably realized as [h] by rule (7). E.g.:

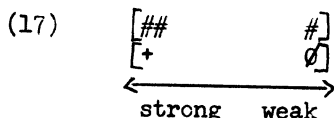
(13) /##méh##/	mé[$\emptyset$]	'bee'
/méh#kas/	mé[$\emptyset$]kas	'bee hive'
/méh+nál/	mé[$\emptyset$]nél	'at (the) bee'
/méh+unk/	mé[h]ünk	'our bee'

In fact, all the low level regressive assimilation rules of Hungarian apply across # as well as ##. If # implies ##, then

Kaisse dismisses the analysis which posits a rule like (16).⁹ Instead, she adopts the analysis which posits rules (14) and (15) as an "expedient". But it is obvious that the latter analysis is not in any significant sense superior to the former. In fact, if compounds are analyzed as ##XY## and not as ##X##Y##, then it is necessary to mention the category 'clitic' in the vowel elision rule: compounds are not subject to mirror image vowel deletion.

In brief, the mirror image vowel elision process of Modern Athenian Greek is not a genuine counterexample to the claim that # implies ##.

To sum up the discussion of the synchronic evidence, the facts that ## does not imply # (and +, Ø), that # does not imply + (and Ø), and that + does not imply Ø are consistent with the hierarchy in (1). This hierarchy explains the well known fact, made clear in SPE, that there can be processes which take place inter-morphemically but not intra-morphemically. However, the fact that Ø and + do not imply # and ## contradicts part of the hierarchy in (1).¹⁰ These synchronic facts suggest that the hierarchy in (1) should be broken up into two independent sets:¹¹



3. Diachronic Evidence for the Hierarchy of Boundaries.¹²

If boundaries are hierarchically organized, then changes in word structure and morphology should, in general, adhere to the hierarchy. This section presents this type of evidence from the realm of vowel harmony in Hungarian. The diachronic facts will establish a hierarchical link between the two independent sets of boundaries in (17).

For present purposes, the following two rules of Vago (1976) are assumed to account for vowel harmony in suffixes: (Rule (19) was presented previously in (9).)

$$(18) \text{ Marked Vowel Harmony } ((m)VH) \\ [+syll] \Rightarrow [+back] / \begin{bmatrix} +syll \\ +back \end{bmatrix} C_0 \left(\begin{bmatrix} +syll \\ -back \\ -round \end{bmatrix} C_0 \right)_1 \text{ ---}$$

$$(19) \text{ Unmarked Vowel Harmony } ((u)VH) \\ [+syll] \Rightarrow [\alpha back] / \begin{bmatrix} +syll \\ \alpha back \end{bmatrix} C_0 \text{ ---}$$

The rule of (m)VH derives a back vowel suffix after so-called "mixed vowel roots" which contain a back vowel followed by at least one neutral vowel (i í e é) in the final syllable(s). In all other cases, the rule of (u)VH, applying after (m)VH in a disjunctive manner, derives suffix vowels which have the same value for backness as the last root vowel. Underlying root vowels undergo

neither rule.

A full word boundary is reduced to an internal word boundary when two independent words become a compound word, or when an independent word develops a prepositional/postpositional variant or becomes a preposition/postposition itself. One example of postposition formation will suffice.

The temporal case marker -kor 'at the time of' developed from the noun kor 'age, era'. It is no longer identical semantically (though still identical phonologically) to the noun kor. In the present day language -kor is an enclitic postposition, preceded by #. This analysis explains two facts: -kor does not alternate harmonically, and a preceding low vowel is not lengthened: e.g. ötkor, öt órakor 'at five o'clock' (öt 'five', óra 'hour'). Thus, forms like /öt#kor/ are postpositional rather than compound structures.

Compounds or prepositions/postpositions may further undergo weakening by respectively developing into "reduced" compounds or prefixes/suffixes. These changes typify the reduction of # to +.¹³

The root nő 'woman' (< 'wife') developed the variant -né which formed compounds with nouns indicating wives' names. These compounds became reduced: in the present day language -né forms compounds with the boundary + and not #. E.g.: Vajda 'proper name' Vajdáné 'Mrs. Vajda', Vajdánénak 'to Mrs. Vajda'; a word boundary preceding -né would block the application of LVL and (m)/(u) VH.¹⁴

The elative suffix -ból/ből 'from the inside', the inessive suffix -ban/ben 'in(side)', and the illative suffix -ba/be 'into' developed from the noun bél 'intestine' through a postpositional structure (Károly 1972:107-8). At the postpositional stage, these elements did not alternate harmonically. The reduction of # to + brought about the harmonic alternations characteristic of suffixes.¹⁵

The morpheme boundary is reanalyzed as Ø when a suffix (prefix) fuses with a preceding (following) root so that it is no longer identified as a meaningful unit. This is apparently what happened in the following cases:

(20)	Locative	Ablative	Lative
'next to'	mellett	melől	melle
'below'	alatt	alól	alá
'above'	fölött	fölül	föle
'in front'	előtt	elől	elé
'behind'	mögött	mögül	möge
'between'	közt	közül	köze

The above forms used to be composed of a root and the locative suffix -tt, the ablative suffix -l, or the lative suffix -á/é (Károly 1972:106-7). Today, however, they are monomorphemic adverbs used as independent postpositions. A bimorphemic analysis could not be maintained for all the forms. For example, no general

rule can derive mellöl from /mell+l/ or mögül from /mög+l/. The synchronic relationship between the supposed stem mell- 'next to' in mellett, etc., and the independently occurring stem mell 'breast' is highly suspect; the hypothetical stem mög- 'behind' in mögött, etc., does not occur independently.

Originally, the nouns hátvéd 'fullback', honvéd 'Hungarian soldier', and húsvét 'Easter' were compounds, most likely: /hát#véd+ó/ 'back' + 'protector', /hon#véd+ó/ 'homeland' + 'protector', and /hús#vét+ek/ 'meat' + 'sin'. Through time, these forms lost their compositional meanings. This loss triggered a gradual reduction of boundaries: ex hypothesi, first to /hát+véd/, /hon+véd/, and /hús+vét/, and later to /hátvéd/, /honvéd/, and /húsvét/.

In present day conservative dialects the above roots govern front harmony in suffixes. This reflects their original compound structure: the second components contained front vowels. When the compounds became reduced, their front harmonic character was kept; however, it was then necessary to mark these roots as lexical exceptions to (m)VH. This exceptionality persisted through the unanalyzed stage found today. In innovative dialects this exceptionality has become optional: the above roots may take either front harmonic or back harmonic suffixes.¹⁵

Decompounding is further seen in the development of ünnep 'holiday', Hejő (name of a Hungarian river), and jámor 'pious'. These forms originally were compounds: /igy#nap/ > /id#nap/ 'holy' (old form) + 'day', /heü#jou/ 'warm (old form) + river' (old form) (Kálmán 1972:64), and /jó#ember/ 'good' + 'man' (Hetzron 1972:81, fn. 4). At this point, all the vowels of a root, apparently including compounds, must have had to agree in backness (Hetzron *ibid.*). Progressive assimilation changed the vocalism of the second members: /id#nep/, /heü#jöü/, and /jó#ombor/.¹⁶ Now the associative bond between nap, jou, ember, and the respective compound variants nep, jöü, ombor was severed and the compounds became reduced: /id+nep/, /heü+jöü/, /jó+ombor/. At this stage the first members were still identifiable. This realization gradually faded away; restructuring and phonological changes give the present day forms /ünnep/, /Hejó/, and /jámor/.

In sum, we see that there exist examples for the progressive weakening of boundaries: ## > # > + > ∅. These changes can be explained. The boundary ## weakens to # as a result of two general historical processes: compounding, which is a wide spread device of word formation, and (enclitic) preposition/postposition formation, which is the first stage of grammaticalization. The boundary # is further reduced to + when the relationship between a preposition/postposition and its source element is obscured, that is a preposition/postposition becomes a prefix/suffix, or when the compositional meaning of a compound becomes less obvious. The boundary + is lost through fusion, when there ceases to be evidence for internal structure.

4. Conclusion.

The synchronic and diachronic evidence discussed in the pre-

ceding sections suggest the following modification of the boundary hierarchy in (1):

$$(21) \quad \begin{array}{ccccccc} \#\# & > & \# & > & + & > & \emptyset \\ & \Leftarrow & & & & & \Leftarrow \end{array}$$

where $>$ represents diachronic development,
 $\Leftarrow$ represents synchronic implication

Some well known aspects of rule formalism fall out directly from the implicational relations in (21). If a rule applies in the context of boundary B but not in the context of boundary B', that is B does not imply B', then B must be stated explicitly in the formulation of the rule. Thus, if a rule applies inter-morphemically but not intra-morphemically, then the + boundary must be included in the rule. Similarly, if a rule applies in absolute word final or word initial position then $\#\#$ must be provided for in the rule. Since the boundary $\#$ is implied by no other boundary, it must be mentioned in a rule which is conditioned by it. Further, if a rule applies in the context of boundary B and boundary B', where B implies B', then only boundary B need be stated. Thus, the correct abbreviation of + and $\emptyset$ is +, not ($+$), and that of $\#\#$ and $\#$ is $\#$, not $\#(\#)$.

Footnotes

¹This is a substantially revised version of a paper which appeared in CUNYForum Number 2, 1977.

²The pause boundary, which Hyman places on top of the hierarchy, will be ignored; ditto for the phonologically relevant syllable boundary, and higher level boundaries associated with sentences, phrases, and so on. It appears that in agglutinative languages the morpheme boundary is further broken down into a root boundary, stem boundary, and affix boundary. The placement of these boundaries on the hierarchy is beyond the scope of this paper.

³The notion of hierarchical ranking of boundaries is not new; see McCawley (1968) and Stanley (1973) in particular.

⁴There is another function of boundaries: to define the domains of rules (and constraints). In this sense, rules "apply only within the domain of a given boundary, but not across this boundary or across any other boundary that takes precedence over it in the hierarchy" (Chomsky and Halle 1968:371). Thus, to use Chomsky and Halle's example, stress rules can apply in the context $\#X\#$ (more properly $\#\#X\#\#$), where X may not contain $\#$ ($\#\#$), but may contain boundaries lower in the hierarchy.

⁵Many of the analyses given here are justified more fully in Vago (in press). In citing Hungarian forms, segments are given as they are spelled. Vocalic length is marked by " over rounded front vowels, ' over other vowels.

⁶It will be shown below that $\#$ does not imply + and that + does not imply $\emptyset$. Thus, in the linear hierarchy model, by transitivity

we conclude that ## does not imply + and Ø either. Accordingly, the initial syllables of suffixes and morpheme-internal syllables are not stressed.

⁷Hyman (to appear) claims that the morpheme boundary does not have phonological consequences. This is not true in the case of LVL. For arguments against the alternative analysis of Final Vowel Shortening, see Vago (1978).

⁸See Vago (1976:259-60) for arguments that alternations like bokor/bokr- are derived by epenthesis and not syncope.

⁹Káisse's formulation of rule (16) does not include #. Without the readjustment rule (15), and without # implying ##, the boundary in rule (16) has to be stated as #(#).

¹⁰Again, by transitivity we conclude that if Ø implies +, + does not imply #, and # implies ##, then Ø does not imply # and ##, and + does not imply ##.

¹¹In the final analysis, the previous transitivity arguments are valid: the boundaries will be arranged linearly. See the final section.

¹²I am grateful to Robert Hetzron and Larry Hyman for comments on material relevant to this section.

¹³The hypothesis that root > (enclitic) postposition > suffix, i.e. ## > # > +, explains the fact that, in Hungarian, suffixes on the whole are older historically than postpositions.

¹⁴It is not obvious that -né is a root as opposed to a suffix. However, there are two facts which seem to suggest that it is a root. Forms with -né are often confused with genuine compounds containing nó (compare tanárné 'teacher's wife', tanárno 'woman teacher'). In innovative dialects suffixes following -né vacillate: e.g. Vajdánénak/Vajdánének. The description of these variants would be cumbersome if -né were a suffix: this form would have to be exempted from conditioning (m)VH. See Vago (to appear).

¹⁵The verbal prepositions be- 'in' and bele- 'into' also developed from the noun bél. In these cases the # boundary is kept: e.g. behoz 'bring in' belevág 'cut into'.

¹⁶Similarly, férfi 'man' developed from a compound consisting of férj 'husband' and fi 'son'. The harmonizing behavior of férfi is interesting; see Vago (in press).

¹⁷Thus, loanwords often underwent harmony: e.g. hercog > herceg 'prince', from German (Kálmán, ibid.).

¹⁸Disharmony was resolved alternatively by regressive assimilation. For example, the Slavic loanword milost became malaszt 'divine grace'; the compound /heű#jou/ is the origin of the name of another river, Hájó (Kálmán, ibid.).

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