Rule Application to Its Own Output

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Since the beginning of generative phonology, the principle of linear ordering has been assumed which was given in *The Sound Pattern of English* (hereafter *SPE*) as follows.

(1) *Principle of linear ordering*

Rules are applied in linear order, each rule operating on the string as modified by all earlier applicable rules. (*SPE* 341)

For any number of phonological rules to follow this principle means that they should not violate the requirement of linearizability given below.

(2) *Requirement of linearizability*

(a) Assymetric: No rule both precedes and follows the same rule; that is, if (aRb), then it is not also the case that (bRa).

(b) Irreflexive: No rule precedes itself; that is, there is no element *a* such that (aRa).

(c) Transitive: Given the three rules R_1, R_2, and R_3, then if R_1 precedes R_2, and R_2 precedes R_3, then R_1 must also precede R_3; that is, if (aRb) and (bRc), then (aRc). (Anderson 1969).

Principle (1) and Requirement (2) assert that rules be arranged in a single sequence and be applied one at a time from the beginning of the list toward the end, always to the results of the preceding rule without re-applying any rule which has already been applied.

However, natural languages make the strict observance of this Markovian mode of rule application difficult. We find the relaxation of this principle already in *SPE*. In case rules are formally related by parentheses, angled brackets, or variables, then the rules are applied disjunctively. When two rules are related by one of the above devices, then neither rule may be allowed to apply to the output of the other. The need of the principle of disjunctive ordering is attested by empirical data. Without this principle, for instance, the application so-called alpha switching rules will not terminate.

The requirement (2b) (Irreflexive Condition) requires that no rule should apply to its own output. (2b) can be violated in two ways: (1) by applying a rule iteratively, i.e., consecutively to the same string at one point of the derivation, or (2) by re-applying a rule after the application of other rule(s). Clearly these violate the principle of linear ordering and the requirement of linearizability requirement (b). The need of eliminating the second way of application is again empirically attested by the examination of natural languages. The often quoted example is the two rules of Lardil, i.e., word-final vowel deletion rule and word-final non-apical consonant deletion rule. Given the underlying form (3) and with the second mode of reapplication of these two rules, they will take turn in applying to the string to "eat away" the whole string as shown in (3).

(3) /ŋawuŋawu/

ŋawuŋaw	Apocope
ŋawuŋa	N-Ap D
ŋawuŋ	Apocope
ŋawu	N-Ap D
ŋaw	Apecope
ŋa	N-Ap D
ŋ	Apecope
ϕ	N-Ap D

The correct output is *ŋawuŋa*. One way to block the incorrect derivation is to eliminate the second type of re-application as violating the requirement of (2b).

Our examination of natural languages, however, shows that the first type of rule application, i.e., iterative application does not give us the wrong forms. As this mode of application also violate the requirement (2b), Chomsky and Halle proposed new conventions (4) and (5) together with two infinite schemata to substitute the iterative rule application.

(4) To apply a rule, the entire string is first scanned for segments that satisfy the environmental constraints of the rule. After all such segments have been identified in the string, the changes required by the rule are applied simultaneously.

(5) In the case of a sehema standing for an infinite set of rules, convention (4) is applied to each rule of the set and all changes are made simultaneously rather than in sequence (*SPE* 344).

The two infinite schemata are sub-zero notation and star notation. A very simple example is provided for each as rule (6) and (7).

(6) $C \rightarrow \phi$ / ——— C_0#

(7) V→[stress]/#CV (CVCV)*C———

Rule schemata (6) and (7) stand for (8) and (9), respectively.

(8) $C \rightarrow \phi$/——— #

$C \rightarrow \phi$/———C#

$C \rightarrow \phi$/———CC#

$C \rightarrow \phi$/———CCC#

⋮

(9) V→[stress]/#CVC…………
V→[stress]/#CVCVCVC…………
V→[stress]/CVCVCVCVCVC…………

In other words, rule (6) deletes word-final consonant clusters of arbitrary length and rule (7) assigns stress to every even numbured syllable. According to conventions (6) and (7), these rules apply simlutaneously to the string.

Notice, however, that the same result can be effected by rules (10) and (11) if they are allowed to apply iteratively to their own outputs.

(10) $C \rightarrow \phi / \underline{\quad\quad} C\#$

(11) $V \rightarrow [\text{stress}] / \left\{ \begin{array}{l} \#CVC \underline{\quad\quad} \\ \acute{V}CVC \underline{\quad\quad} \end{array} \right\}$

Chomsky and Halle's infinite schema notations are a middle-of-the road solution to satisfy both the principle of linear ordering and the empirical data that demand or allow the iterative application of the rules.

Several dissatisfaction with Chomsky and Halle's two notations and simultaneous rule application principle has been voiced in recent literature. (Johnson 1972, Anderson 1969) We can argue against the infinite schemata on the following empirical data.

First, the infinite sehema tends to miss the generalization and rule simplification. An example is from Yawelmani. If rules are allowed to apply to their own outputs, then the Vowel Harmony Rule can be written as follows.

(12) $$\begin{bmatrix} V \\ \alpha\text{high} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{round} \\ +\text{back} \end{bmatrix} / \begin{bmatrix} V \\ +\text{round} \\ \alpha\ \text{high} \end{bmatrix} Co \underline{\quad\quad}$$

But according to Chomsky and Halle, this rule must be complicated as (13).

(13) $$\begin{bmatrix} V \\ \alpha\text{high} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{round} \\ +\text{back} \end{bmatrix} / \#Co \begin{bmatrix} V \\ +\text{round} \\ \alpha\ \text{high} \end{bmatrix} \left(Co \begin{bmatrix} V \\ \alpha\text{high} \end{bmatrix}\right)^{*} Co \underline{\quad\quad}$$

As Kenstowicz and Kisseberth point out, besides the complication of the rule by inserting the parentheses with the star notation, this rule does not tell us why the feature of the vowel in the parentheses is [α high]. (Kenstowicz & Kisseberth 1973)

The second argument against infinite schema comes from the ad hocness this rule entails. Consider the case of Turkish vowel harmony described in Anderson (1969). In this language, affix vowels assimilate to the backness of the stem vowels. But there are some suffixes that contain vowels not subject to the operation of the rules like /Iyor/ whose *o* is not sujbect to vowel harmony. If this suffix is added to a stem, the stem vowel decides the backness of *I* but it does not affect *o*. When this suffix is followed by other suffix like /-Im/, *o* affects the vowel of the following suffix *I*. Thus we have two different harmonic domains. If we formulate this phenomena as an infinite schema, we will get (14).

(14) $$[+\text{syl}]\rightarrow[\alpha\text{back}]/\begin{bmatrix}+\text{syl}\\ \alpha\text{back}\end{bmatrix}\text{Co}+(\text{Co}\begin{bmatrix}+\text{syl}\\ +\text{HARM}\end{bmatrix})\text{oCo}\text{———}$$

The only function of the arbitrary feature of [±HARM] is to define the harmonic domain. The ad hocness of this feature could be seen from the fact that no other rule changes this feature or is sensitive to this. If iterative application is allowed, we can formulate the rule as follows.

(15) $$[+\text{syl}]\rightarrow[\alpha\text{back}]/\begin{bmatrix}+\text{syl}\\ \alpha\text{back}\end{bmatrix}\text{Co}+\text{Co}\text{———}$$

The *o* in *Iyor* will simply be marked as an exception to vowel harmony rule.

The last argument is on the conjunctive application of the simultaneous rule. Consider Anderson's (1969) Tübatulabal Stress Assigning Rule.

(16) $$[+\text{syl}]\rightarrow[+\text{stress}]/\text{———}((?\begin{bmatrix}+\text{syl}\\ -\text{stress}\end{bmatrix}))\text{Co}(\begin{Bmatrix}?\\ \begin{bmatrix}+\text{syl}\\ -\text{long}\\ -\text{stress}\end{bmatrix}\end{Bmatrix})\text{CoVCo})^*$$

As the rule shows, the part which should be iterated contains braces. By the definition of the brace notation, the rules abbreviated by them must apply conjunctively. This means that the second part of the braces has to apply to the output of the first subrule, contrary to the principle of simultaneous application.

So far we have seen that Chomsky and Halle's claim that a rule cannot apply to its own output was not made as an empirical issue. Their principle of simultaneous application and infinite schemata are only the makeshift compromise to satisfy both the linear order principle and the empirical data. We have also seen that their infinite schemata are not satisfactory on empirical grounds. If there is not *a priori* reason that the mark indicating a rule must apply iteratively is not more costly than the star notation or sub-zero notation, we have to relax the requirements of linearizability and incorporate the iterative applicaticn while eliminating the mode of reapplication where rules are put back after the application of other rules. It is a different empirical issue whether iterative rule application can replace the infinite schemata.

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