The Organization of Phonology : From rule-based approaches to constraint-based approaches [1]

— Rule Ordering in Standard Theory —*

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0. Introduction

This paper is concerned with the organization of generative phonology in its historical perspective, looking back upon some of the ideas addressed in the early 1960s through the 1970s, during which the great development of phonological theory was made based on critical assessments of the so-called Standard Theory typified by Chomsky and Halle (1968). Here, starting with the review of the discussion brought forth by Halle (1964), my discussion focuses on the importance of rule ordering for securing a simpler description of the grammar of a given language as well as that of dialectal variations in a single language.

1. The Simplification of a Grammar by Ordering Rules

First, let us start with the following statement made by Halle (1964) :

(1) Significant simplifications can be achieved by imposing an order on the application of the rules.[1]

Halle discusses the Sanskrit Vowel Sandhi in terms of generative theory. He cites four rules from Whitney's *Grammar*, in which order of application is not considered. The rules are given in (2).[2]

(2) a. Two similar simple vowels, short or long, coalesce and form the corresponding long vowel... (Section 126)

b. An *a*-vowel combines with a following *i*-vowel, to *o*... (Section 127)

c. The *i*-vowels, the *u*-vowels and the *r* before a dissimilar vowel or a diphthong, are each converted into its corresponding semivowel, *y* or diphthong : thus *e* (really *ai*...) becomes *ay* and *o* (that is *au* ...) becomes *av*... (Section 131)[3]

Put into the formalism of standard generative phonology, these rules can be stated as follows :

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(3) a. $V_\alpha V_\alpha \longrightarrow V_\alpha$

b. $\left\{\begin{array}{l} ai \longrightarrow e \\ au \longrightarrow o \end{array}\right\}$

c. $\left\{\begin{array}{l} i \longrightarrow y \\ u \longrightarrow v \\ r \longrightarrow r \end{array}\right\} /\_\_\_\ V$ where $V = \left\{\begin{array}{l} i \\ u \\ r \end{array}\right\}$

d. $\left\{\begin{array}{l} e \longrightarrow ay \\ o \longrightarrow av \end{array}\right\} /\_\_\_\ (V)V$

Though Halle (1964) actually does not give the formal rules as shown in (3), he suggests that three of them should be applied in the order (3a), (3c) and (3b), for if we apply them in such an order, rule (3d) can be dispensed with. If there are any descriptions in a grammar that have equivalent forms, functions or predictions, the simplest one should be selected as an adequate grammar by virture of the so-called simplicity criterion. Assuming that the vowel system of Sanskrit consists of five vowels, we can make some combinations of vowels, as represented in the following table:[4]

(4)

V_1 \ V_2	a	i	u	e	o
a					
i					
u					
e					
o					

First, let us apply rule (3a) to obtain (5):

(5)

V_1 \ V_2	a	i	u	e	o
a	ā				
i		ī			
u			ū		
e				ē	
o					ō

Second, rule (3c) applies, yielding (6).

(6)

V_1 \ V_2	a	i	u	e	o
a	ā				
i	ya	ī			
u	va	vi	ū	ve	vo
e				ē	
o					ō

Notice here that rule (3a) has already changed all sequences of the same vowels into their long counterparts. Since there is no available sequence of identical vowels when rule (3c) applies, we find only sequences of dissimilar vowels ; therefore, we can simplify the statement "before a dissimilar vowel" to "before a vowel" for rule (2), allowing rule (3c) to be reformulated as in (7) :

(7) $\left\{ \begin{array}{l} i \longrightarrow y \\ u \longrightarrow v \\ r \longrightarrow r \end{array} \right\} \; / \_\_\_\_\_ \; V$

Finally, the result of applying rule (3b) is shown in (8).

(8)

V_1 \ V_2	a	i	u	e	o
a	ā	e	o		
i	ya	ī	yu	ye	yo
u	va	vi	ū	ve	vo
e				ē	
o					ō

If we assume the ordering of the Vowel Sandhi rules proposed above, we see that rule (3d) is no longer necessary. Neither (3d) turns /ai/ into /e/ nor /au/ into /o/ in a position followed by a vowel, because rule (7) has already changed /i, u/ into /y, v/. Hence, there is no possibility of /e/ or /o/ arising in the environment in which rule (3d) applies.

Consider the following derivation :

(9)	/naia/	/b^haua/	Underlying
	_____	_____	Rule (3a)
	naya	b^hava	Rule (7)
	_____	_____	Rule (3b)
	[naya]	[b^hava]	Output

Also, the derivation of words without the suffix /a/ proceeds as follows :

(10)

/nai/	/b^hau/	Underlying
____	____	Rule (3a)
____	____	Rule (7)
ne	b^ho	Rule (3b)
[ne]	[b^ho]	Output

If we ignored the order of application for /naia/ and /b^hau/, we would expect the following processes:

(11) a.

/naia/	/b^haua/	Underlying
____	____	Rule (3a)
nea	b^hoa	Rule (3b)
____	____	Rule (3c)
naya	b^hava	Rule (3d)
[naya]	[b^hava]	Output

b.

/nai/	/b^hau/	Underlying
____	____	Rule (3a)
ne	b^ho	Rule (3b)
____	____	Rule (3c)
____	____	Rule (3d)
[ne]	[b^ho]	Output

Comparing the derivations in (9) with those in (11a), we see that (9) is obviously simpler because the processes in (11a) take more steps.

To summarize, it should be noted that four rules are needed in Whitney's *Grammar* to describe the Vowel Sandhi in Sanskrit in spite of the fact that both Whitney and Halle (1964) make the same prediction. When those rules are applied in an appropriate order as proposed in Halle (1964), we can reduce their size and render the form of rule (3c) even simpler, as shown in (7).

2. Dialectal Variations and Rule Ordering

There are some cases where differences among dialects can be captured by different orderings of the same rules. Halle (1964 : 643) states that differences among grammars are due to one or both of the following:

(12) a. Different grammars may contain different rules.

b. Different grammars may have differently ordered rules.

That is, variations among dialects result from differences in the application of rules that have the same forms at the underlying level.[5] To illustrate this, let us cite Halle's (1964) treatment of Pig Latin.[6]

(13)

General American	Pig Latin
/str'īt/	/'ītstrē/
/strīts/	/'ītstrē/
/kæt/	/'ætkē/
/kæts/	/'ætskē/
/r'ōz/	/'ōzrē/
/r'ōziz/	/'ōzizrē/

Apparently the two dialects have no relation with each other on phonetic grounds, but they are connected by a morphophonemic rule from a more abstract phonological viewpoint. Thus, Halle (1964 : 343) proposes the following morphophonemic rule :

(14) Shift the minimal consonant cluster to the end of the word and add /ē/.

This rule seems to be decomposable into two subrules, as stated in (15):

(15) a . Shift the minimal consonant cluster to the end of the word.
b . Add /ē/ to the end of the word.

Let us see how derivations proceed for /strīt/, /strīts/ and /kæt/, respectively.

(16) /str'īt/	str'īts/	/k'æt/	Underlying
'ītstr	'ītsstr	'ætkē	Rule (15a)
'ītstrē	'ītsstrē	'ætkē	Rule (15b)
———	'ītstrē	———	Degemination
['ītstrē]	['ītstrē]	['ætkē]	Output

As (16) indicates, the grammar of Pig Latin consists of the grammar of General American and two additional rules. The facts about Pig Latin can be captured successfully only when we apply the relevant rules in the order (15a) and (15b). If they were applied to /str'īt/, /str'īts/ and /k'æt/ in the reverse order, incorrect output representations would result, as illustrated in (17).

(17) /str'īt/	str'īts/	/k'æt/	Underlying
str'itē	'str'ītsē	kætē	Rule (15b)
'itestr	'ītsestr	'ætēk	Rule (15a)
* ['ītēstr]	* ['ītsēstr]	* ['ætēk]	Output

Here too, the ordering of rules plays an important role in securing the required results.

Halle (1964 : 343) further cites Joos' (1942) discussion of Canadian English as an instance of (12b).

According to Joos, Canadian English can be divided into two major groups with respect to the pronunciation of words like *typewriter*: Group A says [tʌyprʌytəɹ] while Group B says [tʌypraytəɹ]. And Group A distinguishes *writer* from *rider*, *clouting* from *clouding* due to the difference of diphthongs. To account for this fact, Joos (1942) suggests rule (18) :[7]

(18) /a/ is a lower-mid vowel ... in diphthongs followed by fortis consonants.

In addition to rule (18), Halle (1964 : 3439) proposes rule (19) :

(19) ... in inter-vocalic position /t/ is voiced and lenis /d/.[8]

For the Group A dialect, we need to make rule (18) precede rule (19) while the reverse order is necessary for the rules to give the correct result for the Group B dialect:

(20)

Group A		Group B	
/taypraytəɹ/	Underlying	/taypraytəɹ/	Underlying
tʌyprʌytəɹ	Rule (18)	taypraydəɹ	Rule (19)
tʌyprʌydəɹ	Rule (19)	taypraydəɹ	Rule (18)
[tʌyprʌydəɹ]	Output	[taypraydəɹ]	Output

Finally, let us see how the *write/ride* and *clouting/clouding* contrasts, which are due to the quality of their diphthongs, are accounted for as a consequence of rule ordering.

(21)

writer	rider	
/raytəɹ/	/raydəɹ/	Underlying
rʌytəɹ	———	Rule (18)
rʌydəɹ	———	Rule (19)
[rʌydəɹ]	[raydəɹ]	Output

clouting	clouding	
/klawtiŋ/	/klawdiŋ/	Underlying
klʌwtiŋ	———	Rule (18)
klʌwdiŋ	———	Rule (19)
[klʌwdiŋ]	[klawdiŋ]	Output

3. Some Principles that Govern the Ordering of Phonological Rules

This section reviews some of the principles which were proposed in the early 1970s to determine the order of rule application. First, let us start with the terms 'extrinsic ordering' and 'intrinsic ordering'. Extrinsic ordering refers to the relationship which holds between R_i and R_j by means of a stipulation that

forces the rules to apply in a certain order to give a desired result. There are no self-governing ties among rules. On the other hand, intrinsic ordering indicates a relationship whereby a condition for R_j is satisfied only when R_i applies first.

Chomsky and Halle (1968) suggest that not only do phonological rules apply only sequentially but some of them must be ordered extrinsically. However, it should be noted that to say that rules are ordered extrinsically is tantamount to saying that no matter how rules A and B are ordered, rule ordering will not affect the evaluation of the grammar. Moreover, an employment of intrinsic rule ordering implies that only a certain order of rules is permitted, or more natural than the other type of ordering in describing a grammar.

Kiparsky (1968) remarks that some changes of rule ordering have happened in the historical changes of languages. He says that there are two types of phonological rules : marked and unmarked.

Now, suppose that we have rules (22a) and (22b) :

(22) a. [ ] ⟶ [$]
b. [$] ⟶ [ ]

In the order given above, the application of rule (22a) creates an environment for the application of rule (22b). Kiparsky calls this order 'a feeding order' and states that this type of order tends to be maximized.[9]

Next, consider the type of relationship that is illustrated in (23) :

(23) a. [ ] ⟶ [~$]
b. [$] ⟶ [ ]

In the order stated above, the application of rule (23a) deprives rule (23b) of the environment for its application. Kiparsky calls this order a bleeding order and suggests that bleeding order tend to be minimized. He further unifies these tendencies and makes the following statement as a generalized principle :

(24) Rules tend to shift into the order which allows their fullest utilization in the grammar.

In pursuit of naturalness of rule ordering, Koutsoudas, Sanders, and Noll (1974) and Kiparsky (1973) suggest that the order of rules must be determined by a universal principle, and extrinsic ordering that is arbitrary and language-specific should be excluded from the description of grammar. Thus, Koutsoudas, Sanders and Noll (1974 : 8) propose the following condition :

(25) Proper Inclusion Precedence

For any representation, which meets the structural description of two rules A and B, A takes applicational precedence over B with respect to R if and only if the structural description of A properly includes the structural description of B.

Let us see how this principle achieves the correct result. In Kiparsky (1968 : 18-20), Umlaut and Lowering are proposed for certain vowels in the Shaffhausen dialect of Swiss German. The forms of the two rules are :

(26)

a. V ⟶ [−back]

b. $\left\{\begin{matrix} V \\ -high \\ +back \end{matrix}\right\}$ ⟶ [+low] / ___ $\left\{\begin{matrix} +cons \\ +cor \\ -lat \end{matrix}\right\}$

Kiparsky (1968) asserts that rule (26a, b) should apply to the underlying forms /bog/, /bod/, /bog + *pl.*/ and /bod + *pl.*/ in the bleeding order. To this end, he proposes that rule (26a) be extrinsically ordered before (26b). Given this ordering, the derivation will proceed as follows :

(27)	/bogə/	/bodə/	/bogə+*pl.*/	/bodə+*pl.*/	Underlying
	_____	_____	bögə	bödə	Rule (26a)
	_____	bɔdə	_____	_____	Rule (26b)
	[bogə]	[bɔdə]	[bögə]	[bödə]	Output

Koutsoudas, Sanders and Noll (1974), on the contrary, claim that it is preferable to derive the correct representations in conformity with the Proper Inclusion Precedence. They also introduce rule (28).

(28) $\left\{\begin{matrix} V \\ +back \\ -round \end{matrix}\right\}$ ⟶ [−low]

With rule (28) added, the system produces the following derivational processes for the same set of underlying forms :

(29)	/bogə/	/bodə/	/bogə+*pl.*/	/bodə+*pl.*/	Underlying
	_____	bɔdə	bögə	bədə	Rule (26a, b)
	_____	_____	_____	bödə	Rule (28)
	[bogə]	[bɔdə]	[bögə]	[bödə]	Output

Kiparsky (1973) suggests that Chomsky and Halle's (1968) way of determining rule ordering by collapsing phonological rules by means of parentheses or angled brackets be abolished. Thus, he sets up an independent condition that mediates the relationship between rules. This condition he calls the Elsewhere Condition :

(30) The Elsewhere Condition[10]

Two adjacent rules of the form

$A \longrightarrow B \ / \ P \_\_\_\_\_ Q$

$C \longrightarrow D \ / \ R \_\_\_\_\_ S$

are disjunctively ordered if and only if :

a . the set of strings that fit PAQ is a subset of the set of strings that fit RCS, and

b . the structural change of the two rules are either identical or incompatible.

The Elsewhere Condition governs disjunctive relations among rules with a shared environment by stipulating that the one that has the narrowest structural description applies first. Let us see how the Elsewhere Condition works for Yawelmani cases. Dinnsenn (1974 : 36) discusses the alternation of CV : CiC-/CVCC- in this language.

(31)

NON-FUTURE	DUBIATIVE
ʔa : mil - hin	ʔaml - al 'help'
de : yil - hin	deyl - al 'guard'
ho : min - hin	homn - al 'welcome, greet'

To account for the alternation in (31), Dinnsen (1974) proposes the following two rules :

(32) Epenthesis

$$\emptyset \longrightarrow i \ / \ C \_\_\_\_\_ C \begin{Bmatrix} \# \\ C \end{Bmatrix}$$

(33) Shortening

$$V \longrightarrow [-long] \ / \ \_\_\_\_\_ C \begin{Bmatrix} \# \\ C \end{Bmatrix}$$

Rule (32) says that /i/ is inserted between two consonants if followed by a third consonant or a word boundary while rule (33) states that a vowel is shortened if followed by two consonants or a word boundary. Dinnsen (1974) suggests that Epenthesis must precede Shortening to obtain the desired phonetic output. Applied in this order, the two rules generate the following processes :

(34)

/ʔa:ml - hin/	/ʔa:ml - al/	Underlying
ʔa:mil - hin	_____	Epenthesis (32)
_____	ʔaml - al	Shortening (33)
[ʔa:milhin]	[ʔamlal]	Output

On the other hand, if we apply these rules in the reverse order, the resulting representations would be incorrect, as illustrated in (35) :

(35)	/ʔa:ml - hin/	/ʔa:ml - al/	Underlying
	ʔaml - hin	ʔaml - al	Shortening (33)
	ʔamil - hin	_____	Epenthesis (32)
	*[ʔamilhin]	[ʔamlal]	Output

To secure the correct surface forms, a bleeding relation must hold between rule (32) and (33). And what is emphasized is that it is the Elsewhere Condition that automatically predicts this ordering of application : Epenthesis ⟶ Shortening, because the structural description of Epenthesis includes that of Shortening.

4. Summary

Thus far I have traced some of the discussions as to the significance of appropriate rule ordering and how it is determined in constructing a simple and concise grammar of a language as well as in explaining dialectal differences, in terms of the standard theory of generative phonology. Finally, let us close this article by pointing out that although the devices proposed in the early days of generative phonology may look rather outdated, the effects they produce must always be somehow secured no matter what framework is adopted.

Notes

* Thanks go to Darren Lingley for proofreading the paper and pointing out stylistic errors. However, all the remaining inadequacies are my own.

1 See Halle (1964 : 388).

2 See Halle (1964 : 388). Though I assume that a phoneme is composed of distinctive features, I will use phonemic notations in this article for convenience's sake.

3 Note that Whitney uses in his *Grammar* the symbol /v/ for the semivowel /w/ sound.

4 For a diphthong, I use the symbol V_1 for its first member and V_2 for its second member.

5 Other analyses that regard the sources of dialectal disparities as differences of rules have been presented in Chomsky and Halle (1968), Rubach (1984), and Halle and Mohanan (1985).

6 See Halle (1964 : 342).

7 See Halle (1964 : 343).

8 For discussions of the question whether the voicing of /t/ is triggered by a rule that changes the length of vowel before /t/ or another rule that changes the quality of the vowel, see Chomsky (1964), Chomsky and Halle (1968) and Donegan (1974).

9 See Kiparsky (1968 : 39).

10 See Kiparsky (1973 : 94). For the revised version of the Elsewhere Condition, see Kiparsky (1982 : 136-137), in which it is stated as follows :

Rules A, B in the same component apply disjunctively to a form Φ if and only if

(i) The structural description of A (the special rule) properly includes the structural description of B (the general rule)

(ii) The result of applying A to Φ is distinct from the result of applying B to Φ

In that case, A is applied first, and if it takes effect, the B is not applied.

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