



A Constraint on Variables in Phonology

John T. Jensen

Language, Vol. 50, No. 4, Part 1 (Dec., 1974), 675-686.

Stable URL:

<http://links.jstor.org/sici?sici=0097-8507%28197412%2950%3A4%3C675%3AACOVIP%3E2.0.CO%3B2-9>

Language is currently published by Linguistic Society of America.

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/about/terms.html>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.jstor.org/journals/lsa.html>.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

JSTOR is an independent not-for-profit organization dedicated to creating and preserving a digital archive of scholarly journals. For more information regarding JSTOR, please contact jstor-info@umich.edu.

A CONSTRAINT ON VARIABLES IN PHONOLOGY

JOHN T. JENSEN

University of Colorado

Two kinds of variables have been used in generative phonology: ABBREVIATORY VARIABLES, which have only one expansion in the application of a given rule to a string; and ESSENTIAL VARIABLES, which have many values simultaneously, e.g. the 'star notation' of *SPE*. Essential variables can be dispensed with entirely if rules are allowed to apply iteratively rather than simultaneously. Abbreviatory variables can be severely constrained by the RELEVANCY CONDITION proposed here, which allows only IRRELEVANT material to intervene between the FOCUS and DETERMINANT of a rule. The result is a more highly constrained and more explanatory theory of phonology.

The majority of familiar phonological rules act in an entirely local way, in that some segment has an effect on an immediately adjacent segment. A rule of this type that is frequently encountered is one to palatalize a consonant if a high front vowel follows:

$$(1) C \rightarrow C^y / \text{--- } i$$

In many equally common rules, some intervening material is permitted or required between the DETERMINANT (segment causing the change) and the FOCUS (segment undergoing the change).¹ At some stage the West and North Germanic languages had an umlaut rule of approximately this form:

$$(2) V \rightarrow [-\text{back}] / \text{--- } C_0 i$$

In this rule, a vowel affects another vowel across any number of consonants. We express the fact that the intervening material can contain only consonants by means of the notation C_0 . However, it is not an accident that only consonants can intervene in this rule. It is a general property of umlaut rules (and vowel harmony rules, to be discussed later) that only consonants can intervene between the relevant vowels. Adopting this idea as a general convention, we can rewrite rule 2 as follows:

$$(3) V \rightarrow [-\text{back}] / \text{--- } X i$$

where the content of X is determined by the general convention.

Variables like X in 3 have been used in both syntax and phonology since the advent of generative grammar, with a variety of interpretations. Let us first try to clarify some of the confusion found in variable notation. The notation C_0 used in rule 2 exemplifies what may be called an ABBREVIATORY VARIABLE, to distinguish it from a second type, the ESSENTIAL VARIABLE (to be discussed shortly). Abbreviatory variables are interpreted UNIQUELY, with at most one value, which is the maximal possible value. Since X in 3 replaces C_0 in 2, it too is an abbreviatory variable.

¹ The terms DETERMINANT and FOCUS, which I take from Howard 1972, are not yet standard in phonological discussions. The terms used here are defined by the following schematized rule:

[]	→	[]	/	[]	X	_____
input		structural		deter-	inter-	= focus
= focus		change		minant	vening	
				material		

Without a general convention to determine the contents of X, it can represent anything at all. For instance, rule 1 might be rewritten with an X variable:

$$(4) C \rightarrow C^y / \text{---} X i$$

Rule 4 is a perfectly legitimate rule in the conventions of current phonological theory, although I am not aware that anyone has ever proposed such a rule. The reason is obvious. With the convention of maximal expansion, rule 4 will derive 5b, given 5a as input:

- (5) a. katalani
b. k^yatalani

since the maximal possible value of X is *atalan*. It is clear that we do not want to be able to have rules like 4, since such processes are never found in natural languages. One thing wrong with 4 is that it allows the intervening material X to contain possible inputs to the rule. In 5a, the segments *t*, *l*, and *n* are all possible inputs, but they do not undergo the rule, since by the principle of maximal expansion they must be included in X. A weak form of a constraint that would eliminate rules like 4 has been proposed by Howard 1972, and called the CROSSOVER CONSTRAINT; it is paraphrasable as follows:

- (6) Intervening material must not contain any possible focus.

I shall argue that a much stronger constraint is possible, which will both prevent rules like 4 and determine the correct application of the majority of segmental rules in phonology.

In rule 2, a vowel affects another vowel across only intervening consonants. VOWEL HARMONY rules are similar in this respect. In addition, they have the property of acting not once, but as many times as possible in a given string; i.e., they PROPAGATE. Rule 7 is typical of such rules:

$$(7) V \rightarrow [\alpha_{\text{back}}] / \left[\begin{array}{c} V \\ \alpha_{\text{back}} \end{array} \right] C_0 \text{---}$$

But as it is stated, rule 7 can operate only once, unless we adopt the convention that propagating rules ITERATE, i.e. apply successively to each possible input, working left-to-right through the string. In Turkish, given an input like 8a, rule 7 produces 8b by iteration:

- (8) a. *kol + ler + in + iz + den*
b. *kollarinizdan* 'from your (pl.) arms'

It is clear that iterative application conforms to the Crossover Constraint, since each vowel acts as the determinant for the next application. It is equally clear that simultaneous application, as proposed in SPE, violates this constraint. In SPE notation, the rule would be written:

$$(9) V \rightarrow [\alpha_{\text{back}}] / \# C_0 \left[\begin{array}{c} V \\ \alpha_{\text{back}} \end{array} \right] (C_0 V)^* C_0 \text{---}$$

This rule allows the first vowel (the *o* of *kol*) to act as the determinant for all the other vowels in the word. With this convention, every application except the first violates the Crossover Constraint.

The notation $(C_0 V)^*$ in 9 represents a different kind of variable, which we call an ESSENTIAL VARIABLE. Essential variables differ from abbreviatory ones in two

respects. First, they are not unique, but stand for a SCHEMA of values, in this case \emptyset , C_0V , C_0VC_0V etc. Second, they have no maximal value, but instead take successively the SMALLEST value (which is always \emptyset), then the next value (here C_0V) etc. Many criticisms have been leveled against this notation, the most serious of which is that the material within ()^{*} must duplicate material from other parts of the rule.² Recently Halle (personal communication and class lectures, spring 1973) has proposed replacing star notation with an equivalent notation that circumvents the problems of the ()^{*} environment while preserving the spirit of simultaneous application. Rule 9 is stated in this new notation as follows:

$$(10) V \rightarrow [\alpha_{\text{back}}] / \left[\begin{array}{c} V \\ \alpha_{\text{back}} \end{array} \right] X \text{ — } Y \#$$

In rule 10, X and Y represent essential variables. Since there may be more than two essential variables in a rule, Halle defines those closest to the focus bar on each side as CENTRAL VARIABLES. In 10, X and Y are central variables. The word boundary written to the right of Y in 10 CONNECTS it to the variable.³ By a further convention, elements which are connected to a central variable may not be contained in the variable: essentially this means that the rule never crosses a word boundary. The possible expansions of 10 applied to the string 8a are:

$$(11) \quad k \quad o \quad l + l \quad e \quad r + i \quad n + i \quad z + d \quad e \quad n \quad \#$$

a.	$\begin{array}{c} V \\ \alpha_{\text{back}} \end{array}$	$\underbrace{\hspace{10em}}$	$\underbrace{\hspace{10em}}$	#
		X	—	Y
b.	$\begin{array}{c} V \\ \alpha_{\text{back}} \end{array}$	$\underbrace{\hspace{10em}}$	$\underbrace{\hspace{10em}}$	#
		X	—	Y
c.	$\begin{array}{c} V \\ \alpha_{\text{back}} \end{array}$	$\underbrace{\hspace{10em}}$	$\underbrace{\hspace{10em}}$	#
		X	—	Y
d.	$\begin{array}{c} V \\ \alpha_{\text{back}} \end{array}$	$\underbrace{\hspace{10em}}$		#
		X		Y

In line 11a, X abbreviates everything between the determinant vowel *o* and the focus vowel *e* (indicated by the environment bar), i.e. *l+l*; Y abbreviates everything after the focus vowel up to the word boundary, i.e. *r+in+iz+den*; and similarly in lines b, c, and d.

Once all the expansions of 11 have been identified, they are applied simultaneously. Since X in 11b-d contains possible foci, it is clear that this convention violates the Crossover Constraint just as much as does the star notation rule 9. It should be noted that nothing in the form of rule 10 requires the *o* of *kol* to be identified with the determinant. Any other vowel of 8a might have been so identified, and would have affected the vowels following it (if any) by a schema similar to 11. However, in that case, the schema of 11 would have applied anyway later, to override the effect of choosing a non-initial vowel for the first schema. We can ignore this additional complication here.

² See Jensen & Stong 1973 for discussion. Since star notation is no longer required for simultaneous propagating rules, such rules lose much of their notational complexity, although the basic argument remains valid.

³ The notion of CONNECTEDNESS is discussed more fully in forthcoming work by M. Halle and J. R. Vergnaud.

Complementary to vowel harmony rules are rules affecting consonants, which act across vowels. Two familiar examples are Finnish consonant gradation, and Grassmann's Law in Greek and Sanskrit. Finnish gradation degeminates geminate stops and weakens simple stops (for simplicity, we will consider only degemination):

$$(12) C_1C_1 \rightarrow C_1 / \text{---} \left[\begin{array}{c} V \\ \text{str} \neq 1 \end{array} \right] C \left\{ \begin{array}{c} C \\ \# \end{array} \right\}$$

Rule 12 operates on the input 13a to produce 13b:

- (13) a. *rokko+tt+utta+tte*
 b. *rokotutatte* 'you (pl.) are having (someone) inoculated'

This rule operates left-to-right, since right-to-left application would produce an alternating pattern of geminates, **rokottutatte*. It should be observed that the direction of application of iterative rules is not arbitrarily marked for each rule, but is predictable on general grounds (see Jensen & Stong for details). Unlike vowel harmony rules, consonant dissimilation rules do not violate the Crossover Constraint if they apply simultaneously. In his directional theory, Howard stipulates simultaneous application for these dissimilation rules, while requiring iterative application for rules like vowel harmony. However, a theory that allows both simultaneous and iterative rules can give no unified generalizations. I assume therefore that all propagating rules apply iteratively.

Examples like vowel harmony and Finnish gradation have led some phonologists (e.g. Stong 1971, Palacas 1971) to propose the ADJACENCY PRINCIPLE as a constraint on phonological rules:

- (14) In a rule where consonants affect other consonants, only vowels may intervene. In a rule where vowels affect vowels, only consonants may intervene. If a vowel affects a consonant (or conversely), no segment may intervene.

It is clear that this principle is stronger than Howard's Crossover Constraint, which is a subcase of it. This principle, like the Crossover Constraint, leads us to conclude that rules like vowel harmony are iterative.

There are many counter-examples to 14. Grassmann's Law in Greek de-aspirates a stop if the following syllable begins with a stop, but both vowels and liquid consonants are permitted to intervene:

$$(15) C \rightarrow [-\text{asp}] / \text{---} [-\text{obst}]_1 \left[\begin{array}{c} C \\ +\text{asp} \end{array} \right] \quad (\text{left to right})$$

The operation of 15 is illustrated below:

- (16) *t^het^hrop^ha* underlying
tet^hrop^ha GL first application
tetrop^ha GL second application

Latin has a rule which changes *l* to *r* in the suffix *-ālis* if there is a lateral earlier in the word:

- (17) $l \rightarrow r / lX \text{ ---}$ Condition: X contains no liquids.

The rule accounts for the following data:

(18)	<i>navālis</i>	'naval'	from <i>nāvis</i>	'ship'
	<i>militāris</i>	'military'	from <i>mīles</i>	'soldier'
	<i>lūnāris</i>	'lunar'	from <i>lūna</i>	'moon'
	<i>lupānāris</i>	'whorish'	from <i>lupān-ar</i>	'brothel'

These two examples violate 14 in the literal sense, but seem to preserve its spirit. Liquids are sufficiently similar to vowels to merit the feature [+vocalic] in the feature system proposed in Chapter 7 of *SPE*. In fact, in languages like Proto-Indo-European and modern Czech, liquids can function as vowels.

In Grassmann's Law in Greek, consonants (which are [+cons, -voc]) affect other consonants across liquids, vowels, and glides. In Latin liquid dissimilation, liquids ([+cons, +voc]) affect other liquids across consonants, vowels, and glides. In vowel harmony, vowels affect vowels across consonants, liquids, and glides. This suggests the following revision of the Adjacency Principle:

- (19) If the determinant and focus of a phonological rule are NOT of the same major class [α voc, β cons], then the intervening material must be null. If the determinant and focus ARE of the same major class [α voc, β cons], then the intervening material may contain only segments which are NOT of that class.

Note that 19 includes the Crossover Constraint, as did 14. We can say intuitively that what both versions of the Adjacency Principle do is define the notion of RELEVANT SEGMENT. They constrain rules so that only those segments which are IRRELEVANT to the operation of a rule may intervene between the focus and determinant. The Crossover Constraint expresses this notion partially, since the focus is relevant to the rule. But it does not specify the full set of relevant segments, as I have shown. The simultaneous theory does not contain the notion of relevant segment at all.

However, 19 still fails to define adequately the notion of relevant segment. Many vowel harmony rules have NEUTRAL VOWELS which may intervene between harmonizing vowels, but which themselves neither cause nor undergo harmony. Such is the case in Finnish vowel harmony, which skips over the neutral vowels *i* and *e*:⁴

$$(20) \left[\begin{array}{c} + \text{syll} \\ \{ [+ \text{low}] \} \\ \{ [+ \text{round}] \} \end{array} \right] \rightarrow [\alpha \text{back}] / \left[\begin{array}{c} + \text{syll} \\ \alpha \text{back} \\ \{ [+ \text{low}] \} \\ \{ [+ \text{round}] \} \end{array} \right] (C_0 \left[\begin{array}{c} + \text{syll} \\ - \text{low} \\ - \text{round} \end{array} \right])_0 C_0 \text{ ---}$$

⁴ I am ignoring the fact that neutral vowels appear to condition harmony in polysyllabic words containing all neutral vowels: e.g., *mies* 'man' + *uus* gives *miehuus* 'manhood,' but *esimies* 'foreman' + *uus* gives *esimiehyys* (vowel-initial suffixes only). Paul Kiparsky has proposed that neutral vowels condition harmony if they are the only vowels in the word, with a special backing rule applying to vowel-initial suffixes after monosyllabic all-neutral stems. This formulation does not allow the correct operation of the Relevancy Condition, since neutral vowels are no longer irrelevant in the obvious sense. An alternative solution has vowel harmony as I have stated it, with a special rule of fronting applying to all suffixes after polysyllabic all-neutral stems. This solution has a number of exceptions, and requires suffixes to be entered lexically as they appear after monosyllabic all-neutral stems. However, it accounts for an historical change in which the suffixes *-moinen* and *-lainen*, which are invariable in standard

It is obvious that neutral vowels are irrelevant to the operation of Finnish vowel harmony; but 19 fails to capture this fact because there is no way, using only major class features, to distinguish neutral vowels from non-neutral vowels.

A similar case is Sanskrit *n*-retroflexion. This rule changes dental *n* to retroflex *ṇ* provided the *n* is followed by a vowel or glide, if there is a preceding *r* or *ṣ* in the same word (cf. Whitney 1891:64-5). Retroflexion takes place across vowels, glides, and non-coronal consonants, but is blocked by coronal consonants:

(21)	<i>devá-</i>	'god'	<i>devánām</i> (with gen. pl. <i>-nām</i>)
	<i>vāri-</i>	'water'	<i>vāriṇām</i>
	<i>rathī-</i>	'charioteer'	<i>rathīṇām</i>
	<i>pitṛ-</i>	'father'	<i>pitṛṇām</i>
	<i>kriyá-</i>	'be made'	<i>kriyámāṇa</i> 'being done' (with <i>-māṇa</i> , pass. prtc.)

The rule can be written as follows:

$$(22) \begin{bmatrix} + \text{cons} \\ - \text{syll} \\ + \text{nas} \\ + \text{cor} \end{bmatrix} \rightarrow [- \text{ant}] / \begin{bmatrix} + \text{cons} \\ + \text{cor} \\ - \text{ant} \\ - \text{nas} \\ + \text{cont} \\ - \text{lat} \end{bmatrix} \left\{ \begin{array}{l} [- \text{cons}] \\ [- \text{cor}] \end{array} \right\}_0 \text{ — } [- \text{obst}]$$

For this rule, the Crossover Constraint says only that *n* may not intervene. This is true, but insufficient, since no other coronal consonant can intervene either. But the (revised) Adjacency Principle says that nothing may intervene, since the input *n* is a consonant and the determinant, *r* or *ṣ*, is either a consonant or a liquid, which may be syllabic or non-syllabic. We need another mechanism to predict the fact that coronal consonants are what are relevant to the rule. If we examine the feature matrices of the input and determinant, we see that they have in common the major class feature [+cons] and the place of articulation feature [+cor]. These features together define the class of relevant segments. Note that the class defined by these features, [+cons, +cor], is precisely the complement of the class indicated as intervening material in 22. This suggests that the correct condition is the following, which we will now call the RELEVANCY CONDITION:

- (23) Only IRRELEVANT segments may intervene between focus and determinant in phonological rules. The class of segments defined by the features common to the input and determinant of a rule is the class of segments RELEVANT to that rule, provided at least one of the common features is a major class feature. If there is no common major class feature, then ALL segments are relevant.

Since the Relevancy Condition does not depend on any specific theory of major class features, it is valid either for the old system, with [consonantal] and [vocalic], or for the revised system with [consonantal], [syllabic], and [obstruent]. With this

Finnish, are fronted after front-vowel pronouns in some dialects. This fronting does not occur after monosyllabic pronouns with neutral vowel, so these dialects have *selläinen* 'of this sort', not **selläinen*. Kiparsky's analysis would predict the latter, since backing cannot apply to consonant-initial suffixes. Whichever analysis turns out to be correct, there are still many additional problems with vowel harmony.

condition added to the theory of grammar, we no longer need to state the disjunction $\{[-\text{cons}], [-\text{cor}]\}$ in rule 22. We can replace this disjunction by X, where X is defined by the Relevancy Condition as containing only irrelevant segments. It is indeed surprising that a relatively simple condition like the Relevancy Condition can correctly define the intervening environment in a rather complex rule like Sanskrit *n*-retroflexion. The Relevancy Condition also defines correctly the intervening environment in Finnish vowel harmony (20). The matrix of features common to focus and determinant in that rule is $[+\text{syll}, \{[+\text{low}], [+\text{round}]\}]$, which is just the class of non-neutral vowels. The Relevancy Condition makes the correct claim that neutral vowels and consonants may intervene freely in Finnish vowel harmony; thus the intervening class need not be explicitly stated in the rule. In this case, the claim made by the Relevancy Condition is the same as that made by the Crossover Constraint, since the set defined by the common features is just the class of non-neutral vowels. However, since the Crossover Constraint is too weak to predict the correct intervening environment in Sanskrit *n*-retroflexion, while the Relevancy Condition makes the correct claim in both cases, the latter is to be preferred. The Relevancy Condition, like the two versions of the Adjacency Principle, includes the Crossover Constraint as a subcase.

The revised Adjacency Principle was defined in terms of the older feature system in which the major class features are [consonantal] and [vocalic], whereas the Relevancy Condition, as noted above, is neutral with respect to feature systems. It is clear that if we write Latin liquid dissimilation in the older system, the Relevancy Condition makes the correct prediction:

$$(24) \begin{bmatrix} +\text{cons} \\ +\text{voc} \end{bmatrix} \rightarrow [-\text{lat}] / \begin{bmatrix} +\text{cons} \\ +\text{voc} \\ +\text{lat} \end{bmatrix} \text{ X } \text{---}$$

The Relevancy Condition says that X cannot contain any segment of the form $[+\text{cons}, +\text{voc}]$, i.e. any liquids. This rule is characterized in the revised feature framework of *SPE* at somewhat greater cost:

$$(25) \begin{bmatrix} -\text{syll} \\ +\text{cons} \\ -\text{obst} \\ -\text{nas} \end{bmatrix} \rightarrow [-\text{lat}] / \begin{bmatrix} -\text{syll} \\ +\text{cons} \\ -\text{obst} \\ -\text{nas} \\ +\text{lat} \end{bmatrix} \text{ X } \text{---}$$

The Relevancy Condition makes the correct prediction for 25, since the features shared by input and determinant are $[-\text{syll}, +\text{cons}, -\text{obst}, -\text{nas}]$, which define the class of (non-syllabic) liquids. However, this feature system creates a problem for the Relevancy Condition. The feature [nasal] is needed to distinguish liquids from nasals. In a more general form of the rule, $[-\text{nas}]$ would not be specified, since only liquids are lateral in Latin. But to make the Relevancy Condition work, $[-\text{nas}]$ must be stated in the rule. Since this was not a problem in 24, the fault must lie in the feature system and not in the Relevancy Condition. The main problem is that the new feature system fails to characterize liquids as a major class, but includes them with nasal consonants. The real question is not the validity of the Relevancy Condition, but the status of liquids as a major class.

We encounter additional problems if we consider that the most non-redundant form of liquid dissimilation is:

$$(26) [\] \rightarrow [-\text{lat}] / [+ \text{lat}] \left\{ \begin{array}{l} [-\text{cons}] \\ [-\text{voc}] \end{array} \right\}_0 \text{ —}$$

Here the Relevancy Condition wrongly predicts that X is null, since determinant and focus have no major class features in common in this formulation. Similarly, Grassmann's Law can be made more general as follows:

$$(27) [\] \rightarrow [-\text{asp}] / \text{ — } X [+ \text{asp}]$$

Since only stops can be aspirated (voiced stops in Sanskrit, voiceless ones in Greek), the major class is redundant. (Non-stops are vacuously de-aspirated by 27.) In 27 the Relevancy Condition requires X to be null, since determinant and input share no major class features. But since this prediction is wrong, X must be specified:

$$(28) [\] \rightarrow [-\text{asp}] / \text{ — } [-\text{obst}]_1 [+ \text{asp}]$$

To conform to the Relevancy Condition, Grassmann's Law must be written as:

$$(29) \left[\begin{array}{l} -\text{syll} \\ +\text{cons} \\ +\text{obst} \end{array} \right] \rightarrow [-\text{asp}] / \text{ — } X \left[\begin{array}{l} -\text{syll} \\ +\text{cons} \\ +\text{obst} \\ +\text{asp} \end{array} \right]$$

The Relevancy Condition applied to 29 says that X may contain anything except obstruents. Although this is the correct prediction, 28 is, in terms of simplicity criteria, a more highly valued formulation of Grassmann's Law than 29, since it contains fewer feature specifications. This presents us with a dilemma, since many rules such as Finnish vowel harmony and Sanskrit *n*-retroflexion are considerably simplified if the intervening material is specified as X, its content being predicted by the Relevancy Condition. We could, on the one hand, assert that rules are written in the form that requires the fewest feature specifications. In some rules, like 28, the intervening environment is specified; in others, like 22, it is indicated by X. But this choice forces us to lose the generalization contained in the Relevancy Condition. Rather than functioning as a constraint on phonological rules, the Relevancy Condition would be reduced to a minor clause in the evaluation measure. Moreover, it is generally agreed that the status of feature counting in evaluating phonological descriptions is very much in doubt. To preserve the explanatory power of the Relevancy Condition, I have chosen the second alternative. I propose that all phonological rules be written in the form that allows the intervening environment to be predicted by the Relevancy Condition. This theory claims that the intervening environment in phonological rules is not arbitrary, but is related directly to the feature composition of the input and determinant: it selects 29 rather than 28 as the correct description of Grassmann's Law in Sanskrit and Greek.⁵ The Relevancy Condition requires a condition on the statement of rules: that the input

⁵ Grassmann's Law in Sanskrit operates across nasals as well as liquids, vowels, and glides, as shown by *bandh-* from */b^hand^h/*. This is allowed by the Relevancy Condition applied to rule 29. The revised Adjacency Condition would also give the correct result with the major class feature [obstruent], but this would cause problems with Latin liquid dissimilation. As we have seen, the Relevancy Condition operates correctly in both cases.

and determinant of a rule be specified for redundant major class features (and in some cases other features as well).

One rather striking confirmation of the Relevancy Condition is the Navajo rule of strident assimilation.⁶ In Navajo, strident obstruents occur in two series:

- (30) [+anterior]: *c dz c' s z*
 [-anterior]: *č dž č' š ž*

By a regressive rule of strident assimilation, strident obstruents within a word agree in anteriority:

- (31) a. *ši + má* → *šimá* 'my mother' (no change)
 b. *ši + züiz* → *sizüiz* 'my belt'

In the paradigm below, the rule applies across strings of non-strident segments. Here *si* is the perfective aspect marker, *š* is the 1st person singular marker, *l* is a classifier, and *niš* 'to work' is a verb root:

- | | | |
|------|------------------|-----------------|
| (32) | SINGULAR | NON-SINGULAR |
| 1 | <i>nšišniš</i> | <i>nšilniš</i> |
| 2 | <i>nšinilniš</i> | <i>nšoolniš</i> |
| 3 | <i>naašniš</i> | <i>naašniš</i> |

Compare *hasistih* 'I am old', where the perfective marker *si* appears in underlying form. Strident assimilation can be formulated as follows:

- $$(33) \begin{bmatrix} +\text{obst} \\ +\text{strid} \\ +\text{cor} \end{bmatrix} \rightarrow [\alpha\text{ant}] / \text{--- X} \begin{bmatrix} +\text{obst} \\ +\text{strid} \\ +\text{cor} \\ \alpha\text{ant} \end{bmatrix}$$

It is clear from the Relevancy Condition that X cannot contain segments that are [+obst, +strid, +cor].⁷

If the determinant and focus of a rule share no major class features, the Relevancy Condition allows no intervening material, whether or not there are articulatory features in common. I shall illustrate this with two rules: Velar softening in English, and the palatalization rule 1.

Velar softening in English turns certain cases of *k* to *s* in derived forms; so we have *electric* with final [k], but *electricity* with [s] before the suffix *-ity*. But Velar softening never applies if any segment intervenes between *k* and *i*: thus from *elect* we have *election* [ilekšən], where *t* turns to *š* before *i*; but the *k* before the *t* remains [k], so we do not have *[ileššən]. Velar softening can be written:

- $$(34) \begin{bmatrix} +\text{cons} \\ +\text{obst} \\ +\text{back} \\ -\text{cont} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{cor} \\ +\text{cont} \\ +\text{strid} \\ +\text{ant} \end{bmatrix} / \text{---} \begin{bmatrix} +\text{syll} \\ +\text{high} \\ -\text{back} \end{bmatrix}$$

⁶ I am grateful to Ken Hale for the Navajo data and for discussion of this example.

⁷ Strident assimilation reverses direction in certain cases: underlying /ha + si + š + tih/ is surface *hasistih*, not **haššitih*. This reversal is apparently conditioned by a tendency toward paradigmatic regularity, since the perfective marker *si* has the initial consonant *s* in all other forms of the paradigm. Regressive application of strident assimilation would change this *s* to *š* only in the 1st person singular under the influence of the person marker *š*.

Since input and determinant of 34 have no major class features in common, the Relevancy Condition claims that 34 can have no intervening material. This is the correct claim.

The palatalization rule 1 can be written in features as follows:

$$(35) [+cons] \rightarrow [+high] / \text{---} \begin{bmatrix} +syll \\ +high \\ -back \end{bmatrix}$$

Here again the Relevancy Condition requires no intervening material, thereby correctly disallowing the process illustrated in 5. However, suppose that palatalization were restricted to $[-back]$ consonants, as in 36:

$$(36) \begin{bmatrix} +cons \\ -back \end{bmatrix} \rightarrow [+high] / \text{---} \begin{bmatrix} +syll \\ +high \\ -back \end{bmatrix}$$

In this version of the rule, the input and determinant share the articulatory feature $[-back]$. But we would not wish to conclude from this that $[+back]$ segments are allowed to intervene between determinant and focus, thereby producing outputs 37b from inputs 37a:

- (37) a. *atki tuki teki atpi*
 b. *at^vki t^vuki teki atp^vi*

It is clear that we must require at least one of the shared features in the definition of relevancy to be a major class feature.

Some rules are even more strictly constrained than the Relevancy Condition allows. Consider Hungarian voicing assimilation, which assimilates an obstruent cluster in voicing to its last member:

- (38) a. *viz* 'water' + *től* 'away from' → [vi:stö:l]
 b. *kút* 'well' + *ban* 'in' → [ku:dbøn]
 c. *küzd* 'fight' + *t* 'past' + *em* '1st sg.' → [küsttem]
 d. *füst* 'smoke' + *ben* 'in' → [füzdben]

Voicing assimilation is a right-to-left iterative rule:

$$(39) [+obst] \rightarrow [\alpha voice] / \text{---} \begin{bmatrix} +obst \\ \alpha voice \end{bmatrix}$$

Since the input and determinant of 39 share the feature $[+obst]$, the Relevancy Condition predicts that non-obstruents can intervene. But this is wrong, since obstruents do not assimilate in voicing across vowels. If the Relevancy Condition were strengthened to exclude intervening segments in 39, it would not be able to predict correctly the intervening environment in Grassmann's Law and other rules discussed above.

Stampe 1972 has suggested that phonological operations consist of two types: RULES and PROCESSES. The majority of cases that we have considered here are rules, but voicing assimilation is a process. Rules are learned, but processes are automatic operations that are innate rather than learned and can be reversed only with difficulty. The majority of languages with voicing assimilation (Hungarian, Russian, Turkish) have no surface exceptions to the process. Navajo is a language which has

surface exceptions to voicing assimilation for a definite functional reason (see Jensen & Stong, 10–11). I suggest that rules are subject to the Relevancy Condition, whereas processes are subject to a stronger constraint that we may call the STRICT ADJACENCY CONDITION. This condition disallows ANY intervening material between determinant and focus in processes.

It may be difficult to maintain a strict distinction between rules and processes in this respect: i.e., there may be rules whose form allows intervening material by the Relevancy Condition but which do not in fact allow intervening material. Similarly, there may be processes which do allow intervening material where it is predicted by the Relevancy Condition. Thus it may be necessary, for both rules and processes, to specify the possibility of intervening material by use of the variable X, and to indicate where no intervening material is allowed by not writing X, even if intervening material would be allowed by the Relevancy Condition. When X appears in a rule, its contents are defined by the Relevancy Condition.⁸

The Relevancy Condition is a very strong claim about the nature of phonological operations. To the extent that the claim is true, it warrants revision of the theory of phonology along the lines sketched here.⁹

REFERENCES

- BRIGHT, W. 1957. The Karok language. (University of California publications in linguistics, 13.) Berkeley & Los Angeles: University of California Press.
- CHOMSKY, N., and M. HALLE. 1968. The sound pattern of English. New York: Harper & Row.
- HOWARD, I. 1972. A directional theory of rule application in phonology. MIT dissertation.
- JENSEN, J., and M. STONG. 1973. Ordering and directionality of iterative rules. Presented at the Conference on Rule Ordering, Indiana University. Published in *Papers in Linguistics* 6.66–90.
- PALACAS, A. 1971. Iteration of rules vs. infinite schemata in phonology. Presented at LSA Winter Meeting, 29 December 1971.

⁸ Two potential problems with this theory have been brought to my attention. M. Halle notes that the second palatalization in South and East Slavic palatalizes *k* to *ts* in spite of an intervening *v*: so the original form represented by Polish *kwiat* 'flower' appears in Russian (East Slavic) as *tsv²et*. A reasonable explanation in terms of relevancy theory is that the whole cluster *kv* palatalizes to *k^vv^v*. There is some support for this hypothesis in the fact that, in Russian, whole clusters palatalize before the front vowels *i* and *e*. By a later change, *k^v* changes unconditionally to *ts*.

A similar fact in Karok has been pointed out to me by William Bright. Karok has a rule $s \rightarrow \tilde{s} / i(C) \text{ ---}$. This rule accounts for such alternations as *mú-spuk* 'his money', *išpuk* 'money'; *ʔárip* 'to cut a strip', *-sur* 'off', *ʔáripšur* 'to cut a strip off' (all data from Bright 1957). When *ss* occurs after *i*, both palatalize, as *pišši-p* 'first'. This suggests that the intervening consonant is palatalized (non-distinctively) as well, thus *arip^všuru*. This is a possible synchronic analysis since *s-š* is the only alveolar-alveo-palatal contrast in the language. Thus I suggest that the rule is $C \rightarrow C^v / \{i, C^v\} \text{ ---}$ and operates iteratively left-to-right (see Jensen & Stong).

⁹ This article was written while I was a post-doctoral fellow at MIT during 1972–73. An earlier version was presented to the LSA Summer Meeting in Ann Arbor, 3 August 1973. I am grateful to M. Halle, P. Kiparsky, and D. G. Miller for discussion of the issues raised here, and especially to my wife Margaret for endless hours of discussion and typing. All errors are my own. This work was supported in part by grant number 5 T01 HD00111-08 from the National Institutes of Health.

STAMPE, D. 1972. How I spent my summer vacation. (Dittoed.) [Also known by the title Dissertation on natural phonology, U. of Chicago dissertation, 1973.]

STONG, M. 1971. On the concept ADJACENCY in phonological theory. Presented at the second meeting of the Northeast Linguistic Society, Montréal, 23 October 1971.

WHITNEY, W. D. 1891. Sanskrit grammar. Boston: Ginn.

[Received 24 August 1973.]