

WORKING PAPERS IN LINGUISTICS NO. 14

STUDIES IN PHONOLOGY AND METHODOLOGY

By

James W. Hutcherson, Ronald L. Weeld,
Mieko Ohso, Lawrence Schourup, Holly Semiloff-Zelasko,
Clare M. Silva, and Arnold M. Zwicky

Department of Linguistics
The Ohio State University
Columbus, Ohio 43210

April 1973

Introduction

The contributions to this volume are collected from several sources: Ohso's work is a revision of her 1971 master's thesis; the next two papers, Schourup on binarity and Neeld on palatalization, as well as the ninth article, are versions of Linguistic Society of America papers (Schourup at the winter 1972 meeting, the other two at the preceding summer meeting); the following four short exploratory studies (on palatalization, complete consonantal assimilation, and metatheses) grew out of an Ohio State phonology seminar in the fall of 1971; 'The Strategy of Generative Phonology' was read before the International Phonology Conference in 1972; and 'Homing In' began as an inaugural lecture the year before. Many of the papers reflect the influence of David Stampe's ideas on natural phonology, and several concern themselves with phonological hierarchies. The final three are predominantly methodological.

Arnold M. Zwicky

Table of Contents

	Page
Introduction	ii
Mieko Ohso, A Phonological Study of Some English Loan Words in Japanese	1
Lawrence Schourup, Where Binariness Fails	27
Ronald Neeld, Remarks on Palatalization	37
Ronald Neeld, On Generative Studies of Slavic Palatalization	50
James W. Hutcherson, Notes on Complete Consonantal Assimilation	58
Holly Semiloff-Zelasko, Glide Metatheses	66
Clare M. Silva, Metathesis of Obstruent Clusters	77
Arnold M. Zwicky, The Strategy of Generative Phonology . .	85
Arnold M. Zwicky, Taking a False Step	100
Arnold M. Zwicky, Homing In: On Arguing for Remote Representations	113

A Phonological Study of Some English

Loan Words in Japanese*

Mieko Ohso

1. Principles of borrowing

Loan words sometimes bring into a language new sounds or new sequences of sounds, but in many cases foreign sounds are changed to conform to the native phonological system. Furthermore, the manner of nativization is quite regular. People don't simply substitute an arbitrary native segment for a foreign sound. An adequate theory of phonology has to explain the process of adaptation of foreign words, and their nativized phonological and phonetic representations.

That they cannot be explained adequately in terms of a 'phonetic approximation' hypothesis or by 'phonemic approximation' based on the theory of taxonomic phonemics was convincingly demonstrated by Hyman (1970). Hyman attempted to view the phenomena of borrowing in the light of generative phonology. Working with loan words in Nupe, a Kwa language of Central Nigeria, he proposed principles which account for his data, but do not seem adequate for borrowing processes in general. That is, there seem to be some cases where his principles allow several alternative substitutions for certain foreign segments, but without any principled way of choosing among them. Since the data suggest that the process of nativization does not allow so many alternatives, his principles need revision. In the following section I will first discuss the cases where Hyman's hypotheses result in indeterminacy and then some alternative principles which seem to account for borrowing more adequately.

1.1. Hyman's hypotheses

Hyman's principles of borrowing are:

1. Foreign sounds are perceived in terms of underlying forms. (19)
2. Foreign segments equivalent to native segments derived by rule are lexicalized as the corresponding native underlying forms. (39)

There is a partial contradiction between these two hypotheses. If a language has phonetic sequence yz which is derived from the underlying xz by a rule $x \rightarrow y / _z$ and it also has an underlying

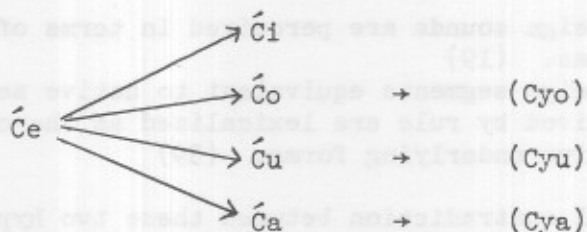
sequence yz, does the language lexicalize the borrowed sequence yz as xz or yz? When the opposition of underlying x and y completely neutralizes in the environment z, the sequence will be lexicalized as yz according to his first principle, but as xz according to his second principle. Hyman gives no resolving principle.

Secondly, his principles cannot give a sufficient explanation for why Nupe speakers create an epenthetic vowel in borrowing a consonant cluster inadmissible in the native system. He says it is because the morpheme structure of Nupe is (V)CV(CV). But this doesn't tell why Nupe speakers insert a vowel rather than simplify the consonant cluster. Either process would change an inadmissible cluster to conform to the native (V)CV(CV) pattern.

Finally I would like to consider his third principle:

3. When a foreign segment appears in an environment in which the equivalent native derived segment does not appear, then the form of the incoming foreign word is modified so that the structural description of that rule is met and the segment in question is then derived in the appropriate environment. (40)

It means that when a language which has a rule $x \rightarrow y / _z$ borrows a sequence yw where w is distinct from z, w is changed to z so that y is derived in the appropriate environment by the rule $x \rightarrow y / _z$. This principle is too strong, because it allows more than one substitution for the segment or segments denoted by w above, and doesn't predict what will actually happen. For example, Japanese has a rule which palatalizes a consonant before the high front vowel i and the high front glide y. By this rule, there are the sequences $\acute{C}i$, $\acute{C}ya$, $\acute{C}yo$ and $\acute{C}yu$, but no $\acute{C}e$. There are no $\acute{C}yi$ or $\acute{C}ye$, since the glide y is deleted before the front vowels, before the palatalization rule applies. $\acute{C}ya$, $\acute{C}yo$ and $\acute{C}yu$ become $\acute{C}a$, $\acute{C}o$ and $\acute{C}u$, respectively, by the rule which deletes y after palatalized consonants. In summary, Japanese has the sequences $\acute{C}i$, $\acute{C}a$, $\acute{C}o$, $\acute{C}u$, but no $\acute{C}e$. Now, according to Hyman's hypothesis 3, when Japanese borrows a sequence $\acute{C}e$, speakers would change its vowel e to some other segment, so that the palatalized consonant is derived in the appropriate environment by the palatalization rule of Japanese. What is unclear here is how a new environment will be chosen when there are several alternatives. In this case all the following substitutions are possible.



It seems that he tacitly assumes that the segment closest to the original one (in distinctive features) is chosen in such a case.

i and o are closer to e than u and a, because they differ from e by only one feature, while u and a differ from e by two, so that i or o would be chosen.¹ But still there is no way to choose one of them systematically. Furthermore, Japanese data show that the change of environments indicated by principle 3 is very rare. In the case of Ce , the consonant is depalatalized when nativized. But the vowel insertion in Japanese observed in the borrowing of words with consonant clusters or with a word-final consonant suggests that some weaker version of the principle is necessary. The Nupe data which required Hyman to set up principle 3, on the other hand, could be explained without it, as I shall show in the following section.

1.2. Borrowing in natural phonology

I now examine borrowing based on the theory of natural phonology (Stampe 1968, 1969). It is possible to view the borrowing process as parallel to children's acquisition of phonological representations. If incoming foreign sounds are admissible underlying segments in the native phonological system they will be represented in the lexicon without change. That is, the foreign phonetic representations will be adopted as underlying forms. In this case there will be no conflict between Hyman's principles 1 and 2. In the case I cited, yz will be lexicalized as yz unless some information is available which prevents this underlying representation. If, on the other hand, some foreign sounds are underlyingly inadmissible, they will be analyzed by suitable native rules to obtain admissible representations. That is, segments will be analyzed (according to certain rules) only when they are inadmissible in the lexicon. I will refer to the operative rules, which constrain underlying representation, as 'dominant'. Suppose that the native phonological system of a language has a dominant rule $x \rightarrow y$ eliminating x from the lexicon. If it has a rule $w + x / _ z$, dominated by the above rule and allowing a superficial x , the foreign sequence xz will be analyzed as wz , since x is an inadmissible underlying segment.² If wz , obtained after analysis, is still inadmissible, further analysis will be carried out until some admissible segment is obtained, provided that there is a rule available in the native system to cope with it.

If some foreign segments cannot be analyzed as admissible underlying representations in the native system, they will be registered as violations of the rules which prohibit them. Since those rules do apply to them, no hearer would ever have the chance to notice the irregular representation in the lexicon of the borrower. He will, therefore, treat them just like the native forms in learning and represent them in the lexicon without any of the irregularity observed in the borrower's lexicon.

The children who are learning a language will finally revise the innate system of rules so that admissible representations will be achieved for all the forms they hear from adults. But it seems to be very difficult for adults who have once acquired a phonological

system to revise it to comprise new segments or new sequences of segments. In many cases perception itself seems to be constrained by the native system, so that speakers perceive foreign sounds in terms of the native phonological system. Thus when some segments have to be registered in violation of native rules, the borrower will change his inadmissible underlying representations to admissible ones sooner or later, unless he learns to revise the native system to allow them. In other words, the inadmissible forms which were first registered in the lexicon will be changed to admissible ones by the application of the dominant rules which constrain them--a process I refer to as the 'restructuring of underlying representations'.

In summary, foreign segments will be put in the lexicon as they are on the surface unless they are inadmissible underlying segments. If they are inadmissible, they will be analyzed by the native rules until some admissible representation is obtained. If a segment cannot be analyzed as an admissible form in the native system, it will be represented in the lexicon as it is and finally will be restructured by the dominant native rules.

1.3. Re-examination of Hyman's data

Let us re-examine some of the Nupe data under the new hypotheses. The foreign phonetic sequence *si* which Hyman gives to exemplify his principle 1 will be put in the lexicon as it is, according to our principle, since it is an admissible underlying sequence of Nupe. Consequently it becomes subject to the phonological rules of Nupe, and will be realized as *śvi* by the application of the Nupe spirant palatalization rule and the general assimilation rule.

The next problem concerns an epenthetic vowel, for which there are at least two possible explanations. First, suppose that the fact that Nupe doesn't have consonant clusters is explained by an epenthesis rule of the form $CC \rightarrow CVC$, and that Nupe doesn't have a rule which derives superficial CC . Then CC in foreign words will be put in the lexicon as such, in violation of the rule $CC \rightarrow CVC$, because CC cannot be analyzed as an admissible sequence in the native system. In the realization of this CC , the rule $CC \rightarrow CVC$ will apply and create CVC . The epenthetic vowel is subject to the other constraints Hyman discusses.

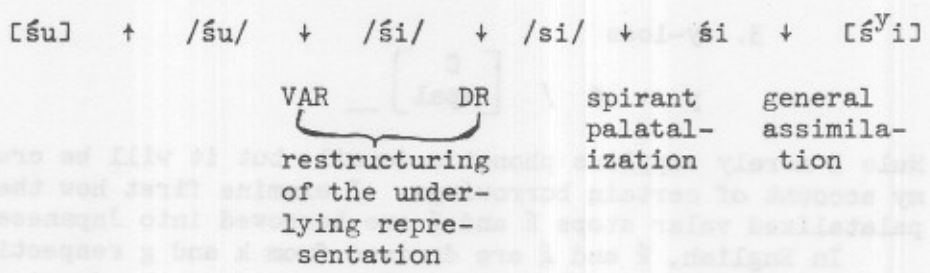
A second explanation is possible. Suppose that Nupe morpheme structure is constrained by a rule like $CC \rightarrow C$, and that Nupe has a rule $CVC \rightarrow CC$, dominated by the former rule. The latter rule might not appear at the normal speed of speech, but (according to Stampe) it is a quite common rule in fast speech, so that it would be plausible for Nupe to have such a fast speech rule. Then CC would be analyzed as admissible CVC . Whatever the case is, there is an explanation for the fact that consonant clusters are broken up by vowels, rather than in some other way. We need more facts about Nupe phonology to determine exactly what is going on here, of course.

One of the facts which leads Hyman to set up principle 3 is the substitution of vowels after labialized and palatalized

consonants in some loan words; there, Nupe speakers change unrounded front vowels into rounded back ones after labialized consonants, and rounded back ones into unrounded front ones after palatalized consonants. Nupe has an assimilation rule of the form:

$$[+cons] \rightarrow \left[\begin{array}{c} +high \\ around \\ \beta back \end{array} \right] / _ \left[\begin{array}{c} V \\ around \\ \beta back \end{array} \right]$$

But this assimilation rule doesn't apply to a foreign sequence like *śu*; rather, the vowel *u* in it is converted into *i*, so that *ś* is derived in an appropriate environment by the assimilation rule. Thus, Hyman concludes that a principle like 3 is necessary. What he assumes here is that Nupe has a consonant assimilation rule but not a rule assimilating features of a vowel to those of a preceding consonant. But it is possible to assume that Nupe has such a rule, for there are other languages which have this rule and there is no reason why Nupe speakers cannot employ it. We merely cannot observe it normally, since it is ordered before the consonant assimilation rule, and since the palatalized and labialized consonants arise only by the consonant assimilation rule. If we assume that Nupe has such a vowel assimilation rule (VAR), and a depatalization-delabialization rule (DR) which prohibits underlying palatalized and labialized consonants, then the borrowing of *śu* will be explained as follows: *śu* will be put in the lexicon in violation of VAR and DR. VAR and DR apply to it in this order to derive *si*. That is, *si* is the restructured underlying representation. The spirant palatalization and general assimilation rule apply to it in the process of derivation, and it will be realized as *ś^vi*. I show the process of analysis and realization in the diagram below. The upward arrow indicates an analysis of foreign segments as native underlying representation (including a direct transfer of foreign phonetic representation) and the downward arrow the realization process in the native system.



In the following section, I will discuss some English loan words in Japanese according to the above principles of borrowing, as a further validation of them.

2. English loan words in Japanese

In addition to numerous Chinese loan words, Japanese has borrowed many words from Western languages--English, German, French, Dutch, Italian and Russian. Modern Japanese is especially full of English loan words, which sometimes make language purists frown.

In this section I examine some English loans in Japanese to see whether the hypotheses in the previous section give a correct account of the actual borrowing process. And at the same time I discuss some properties of the system of Japanese phonology which are revealed in the process of borrowing. All the rules will be presented quite informally.

2.1. Palatalization

In Japanese, consonants are palatalized before the high front vowel *i* or the high front glide *y*. This is expressed by the following rule:

1. Palatalization

$$C \rightarrow [+pal] / _ \begin{bmatrix} -cons \\ +high \\ -back \end{bmatrix}$$

Since all superficially palatalized consonants can be derived by rule 1, we can assume that Japanese has, ordered before rule 1, a rule which depalatalized underlying consonants:

2. Depalatalization

$$C \rightarrow [-pal]$$

Rule 2 does not manifest itself in substitutions; it merely requires underlying consonants to be nonpalatal. The glide *y* is lost after superficially palatalized consonants.

3. *y*-loss

$$y \rightarrow \emptyset / \begin{bmatrix} C \\ +pal \end{bmatrix} _$$

Rule 3 merely supplies phonetic detail, but it will be crucial to my account of certain borrowings. I examine first how the English palatalized velar stops \bar{k} and \bar{g} are borrowed into Japanese.

In English, \bar{k} and \bar{g} are derived from *k* and *g* respectively by the process of palatalization before and after the front vowels (Bach 1968, 128-9). When velars occur between two vowels, the second vowel determines their value; consequently \bar{k} and \bar{g} don't occur before a nonfront vowel even if they are preceded by a front vowel (instead *k* and *g* occur there). Thus palatalized velars occur in such words as [k̄ip] 'keep', [k̄ik̄] 'kick', [k̄eyk̄] 'cake', [t̄ik̄et] 'ticket', [k̄ændi] 'candy', [ġift] 'gift', [bowġi] 'bogie', [ġeym] 'game',

[gɛst] 'guest', [gæp] 'gap'. I will discuss in this section only how the palatalized velar stops followed by front vowels are borrowed, leaving those preceded by front vowels to the section on vowel insertion.

ĸ or ġ followed by the high front vowel in such words as [ĸip, ĸIK, bowġi, ġift] will be interpreted as underlying k and g by undoing rule 1, in order to eliminate the palatalized consonants which are banned by rule 2. Since the ki and gi are admissible, they are not subject to further analysis. They will be represented as such in the lexicon and realized as ĸi and ġi phonetically by the application of rule 1. The analysis and realization of these consonants thus exactly parallels that of native words like [ĸinu], underlying /kinu/ 'silk' and [ġimu], underlying /gimu/ 'duty'.

Palatalized velars before a nonhigh front vowel cannot be analyzed as nonpalatal by rule 1 because it applies only before high front vowels. This would require such consonants to be registered as underlyingly palatal, in violation of rule 2. However, rule 3 furnishes a way of avoiding this. By rule 3 a sequence such as CE, where E is a nonhigh front vowel, can be analyzed as ĸyE, thus furnishing the high front segment which permits further analysis as CyE by rule 1. Thus such sequences as ĸæ and ġæ will be analyzed as ĸyæ and ġyæ by rule 3, and further as kyæ and gyæ by rule 1. æ in kyæ and gyæ will be replaced by rules determining the vowel system of Japanese.³ The following diagram shows the process of borrowing and realization of ĸæ and ġæ.

[ĸæ]	+	ĸyæ	+	/kyæ/	+	/kya/	+	ĸya	+	[ĸa]
[ġæ]	+	ġyæ	+	/gyæ/	+	/gya/	+	ġya	+	[ġa]
		3		1		1				3

Examples:⁴

English		Japanese
[ĸændi]	'candy'	[ĸandii]
[ĸæp]	'cap'	[ĸappɰ]
[ġæp]	'gap'	[ġappɰ]
[ġæġ]	'gag'	[ġagu]

As described above, ĸæ and ġæ in many words come out as ĸa and ġa in Japanese, but there are also numerous words where they come out as ka and ga, with plain stops, as in the following examples:

English		Japanese
[kæləndəʳ]	'calendar'	[karendaa]
[kætəlog]	'catalog'	[katarogu]
[gæs]	'gas'	[gasɰ]
[gælən]	'gallon'	[garoN] ⁵

I think this is because the palatality of the velar stops before æ in English is relatively weak and sometimes is not perceived by speakers of Japanese, who consequently represent the stops as underlying k and g, without the analysis described above.⁶

To account for the borrowing of *ke* and *ge*, we have to take into consideration a rule of Glide Deletion in Japanese:

4. Glide deletion

$$\left[\begin{array}{c} G \\ \text{aback} \end{array} \right] \rightarrow \emptyset / _ \left[\begin{array}{c} V \\ \text{aback} \\ \text{-low} \end{array} \right]$$

That is, y is deleted before the nonlow front vowels i and e, and w before the back nonlow vowels u and o. This rule constrains underlying representation, so that there can be no underlying *ye* vs. *e*. *ke* and *ge* can be analyzed as *kye* and *gye* by rule 3 and then as *kye* and *gye* by rule 1, thereby conforming to the prohibition against palatalized consonants (rule 2). But *kye* and *gye* violate the prohibition against underlying *ye* imposed by rule 4. The English sequences *ke* and *ge* cannot be analyzed, therefore, as any representation which is admissible in the Japanese system. If they are registered as *kye* and *gye*, rule 4 is violated; if as *ke* and *ge*, rule 2 is violated. In either treatment, the sequences will be pronounced as *ke* and *ge*:

$$\begin{array}{l} /kye/ \quad + \quad /ke/ \quad + \quad [ke] \\ \quad \quad \quad 4 \\ /k\acute{e}/ \quad + \quad /ke/ \quad + \quad [ke] \\ \quad \quad \quad 2 \end{array} \qquad \begin{array}{l} /gye/ \quad + \quad /ge/ \quad + \quad [ge] \\ \quad \quad \quad 4 \\ /g\acute{e}/ \quad + \quad /ge/ \quad + \quad [ge] \\ \quad \quad \quad 2 \end{array}$$

The learner's representation will thus be restructured to *ke* and *ge*, unless he learns to manage the foreign sounds by changing the native system in some way. The following examples confirm the above discussion.

English		Japanese
[tɪkɛt]	'ticket'	[t͡ɕiket̚to]
[keɪk]	'cake'	[keek̚i]
[gɛst]	'guest'	[ges̚t̚to]
[gɛɪm]	'game'	[geemu]

Next I discuss how the English alveopalatal obstruents *ʃ*, *ç*, *ʝ* are borrowed.

The voiced sibilant *z* in Japanese has the tendency to be affricated. For some speakers *z* and *dz* are in free variation, and for others they are in complementary distribution. Mieko Han reports on her own speech, where *dz* occurs word initially and *z* in other positions (Han, 50). The palatalized voiced sibilant, *ʝ*, on the other hand, is affricated everywhere, though the unaffricated *ʝ* might appear occasionally in very limited environments. The affrication of the voiced sibilant in the same dialect as Han's could be formulated as follows:

5. Affrication of the voiced sibilant

$$\left[\begin{array}{l} -\text{son} \\ +\text{cont} \\ +\text{voi} \\ <-\text{pal}> \end{array} \right] \rightarrow [+del \text{ rel}] / <\# _ >$$

The coronal stops t and d are affricated before the high vowels, i and u, and the glide y.

6. Affrication of coronal stops

$$\left[\begin{array}{l} -\text{son} \\ -\text{cont} \\ +\text{cor} \end{array} \right] \rightarrow [+del \text{ rel}] / _ \left[\begin{array}{l} -\text{cons} \\ +\text{high} \end{array} \right]$$

This means that the opposition between z and d neutralizes in certain environments.

The derived (i.e. systematic phonetic) \acute{s} , \acute{dz} , and \acute{ts} are phonetically more like the alveopalatal obstruents $[\acute{s}]$, $[\acute{j}]$, $[\acute{c}]$ than like the palatalized alveolar obstruents $[\acute{s}]$, $[\acute{dz}]$, $[\acute{ts}]$. The points of articulation of these segments are in the prepalatal region. Hence I propose rule 7, which converts \acute{s} , \acute{dz} and \acute{ts} into \check{s} , \check{j} and \check{c} , respectively. This rule merely supplies phonetic detail, but it plays a role in borrowing the \check{s} , \check{c} and \check{j} of English.

$$7. \left\{ \begin{array}{l} \acute{s} \\ \acute{dz} \\ \acute{ts} \end{array} \right\} \rightarrow \left\{ \begin{array}{l} \check{s} \\ \check{j} \\ \check{c} \end{array} \right\}$$

English $\acute{s}i$ will be interpreted as $\acute{s}i$ by rule 7, hence as underlying si by rule 1. It will be realized as $\check{s}i$ by the application of these rules. $\acute{c}i$ will be analyzed as $\acute{ts}i$ by rule 7, further as ti by rule 6 and rule 1; it will be realized as $\check{c}i$ by the application of these rules.

There are two possible interpretations for $\check{j}i$, shown in the following diagram:

$$\begin{array}{cccccccc} \text{(A)} & [\check{j}i] & + & \acute{dz}i & + & \acute{z}i & + & /zi/ & + & \acute{z}i & + & \acute{dz}i & + & [\check{j}i] \\ & & & 7 & & 5 & & 1 & & 1 & & 5 & & 7 \\ \text{(B)} & [\check{j}i] & + & \acute{dz}i & + & \acute{d}i & + & /di/ & + & \acute{d}i & + & \acute{dz}i & + & [\check{j}i] \\ & & & 7 & & 6 & & 1 & & 1 & & 6 & & 7 \end{array}$$

(In case (B), $\acute{dz}i$ could first be depalatalized (rule 1) and then deaffricated (rule 6), since the palatalization and the affrication of coronal stops are not in an ordering relation, but there is no difference in the resultant form.) There is no empirical evidence as to whether the underlying form of $\check{j}i$ is $/zi/$ or $/di/$, since in either case the superficial form is $[\check{j}i]$.

The remarks appropriate to $\check{k}e$ and $\check{g}e$ should apply to $\check{s}e$, $\check{c}e$ and $\check{j}e$ as well. That is, we expect them to be depalatalized as se , te , and ze or de , respectively. But, unlike $\check{k}e$ and $\check{g}e$, they are not completely nativized in many cases; the palatality of the consonants before e is kept here against the native rule. The problem of what kind of native rules are easily modified in borrowing is an interesting one, but it is not in the scope of this paper. I couldn't find any example where $\check{c}e$ is completely nativized as te ,⁷ but I have some examples where $\check{s}e$ and $\check{j}e$ are completely nativized. I consider $\check{j}e$ here, since there are two possibilities in nativization, namely ze and de .

After analysis by rule 7 as $\check{d}ze$, $\check{j}e$ could be registered either as $/\check{d}e/$ or $/\check{z}e/$ in violation of rule 2, or $/\check{d}ye/$ or $/\check{z}ye/$ in violation of rule 4. Let us examine the latter cases first.

(C) $[\check{j}e] \rightarrow \check{d}ze \rightarrow \check{z}e \rightarrow \check{z}ye \rightarrow /zye/ \rightarrow /ze/ \rightarrow [dze]$

7 5 4 1 4 5

(D) $[\check{j}e] \rightarrow \check{d}ze \rightarrow \check{d}e \rightarrow \check{d}ye \rightarrow /dye/ \rightarrow /de/ \rightarrow [de]$

7 6 4 1 4

The y -insertion might apply before deaffrication in analysis, since they are not in an ordering relation, but the resulting underlying forms would be the same. The phonetic outcome $[dze]$ of (C) appears usually word-initially in the dialect with which I am concerned. Now the data show that the analysis (C) is actually employed by Japanese.

English

$[\check{j}e\text{lat}+n]$

$[\check{j}e\text{li}]$

$[\check{j}e\text{sc}\check{t}]$

Japanese

'gelatin'

'jelly' →

'gesture' →

$[dzerac\check{i}n]$

$[dzeri\check{i}]$

$[dzes\check{u}caa]$

This might be because dze is phonetically closer to $\check{j}e$ than de is, being different from it only by one feature, namely $[+anterior]$, but from de by two, $[+anterior]$ and $[-delayed\ release]$. Or it might be because the affrication of the coronal stops is ordered before the affrication of the voiced sibilant, though this ordering doesn't manifest itself in the native system. Then the analysis would be the reverse of the order for generation, dze analyzed as ze rather than de . But at present I have no independent support for this ordering.

There is one fact in dialects of Japanese which suggests that $\check{j}e$ is more closely related to ze than to de . There are some dialects in Kyuusyuu where the sibilants, s and z are palatalized not only before i and y but also before e . That is, they are palatalized before front vowels and a glide. But this palatalization before e

doesn't affect the dental stops, t and d. This means we have ʒe (and often ʒe as a free variant) in these dialects for ze (dze) in the Tookyoo dialect and suggests a close relation between ʒe and ze (rather than de). And as I mention in footnote 7, Japanese spirants might have developed from affricates historically.

Let us consider next whether we can get the same result if ʒe is registered as de or ze in violation of rule 2.

(E)	[ʒe]	+	dze	+	/ʒe/	+	/ze/	+	[dze]
	7		5		1		5		
(F)	[ʒe]	+	dze	+	/de/	+	/de/	+	[de]
	7		6		1				

The adoption of the analysis (E) can be explained as above.

ʒa , ʒo , ʒu , ʒa , ʒo and ʒu will be analyzed as ʒa , ʒo , etc., with y in the underlying representation, as in kæ and gæ . Some examples:

English		Japanese
[ʒa:p]	'sharp'	[ʒaapʲ]
[ʒat]	'shot'	[ʒotto]
[ʒut]	'shoot'	[ʒuuto]
[ʒa:tʃ]	'charter'	[ʒaataa]
[ʒɔk]	'chalk'	[ʒookʲ]
[ʒuɪŋ gʌm]	'chewing gum'	[ʒuuiŋgamu]
[ʒʌmp]	'jump'	[ʒampʲ]
[ʒɔwk]	'joke'	[ʒookʲ]
[ʒus]	'juice'	[ʒuusʲ]

2.2. Vowel insertion

McCawley (1968, 131-4) has claimed that standard Japanese is a mora-counting syllable language, in which the syllable functions as the prosodic unit and the mora as the unit of phonological distance. A mora consists of a consonant plus a vowel, a glide plus a vowel, a vowel alone, a mora nasal, or a mora obstruent,⁸ so that [kiɪ] 'key', [pen] 'pen', [yotto] 'yacht' are respectively two, two and three moras. Among these moras, the mora nasal and the mora obstruent don't constitute syllables, but rather each constitutes a syllable with a preceding mora. Thus [pen] 'pen' and [yotto] 'yacht' have respectively one and two syllables. A long vowel which is phonologically two identical short vowels also counts as one syllable, as does a diphthong (although both of them are two moras), so that [kiɪ] 'key' and [tai] 'tie' are both one-syllable words.

There are constraints on the distribution of some of the syllables. The syllable (C)VC, where the last C is the mora obstruent, cannot

occur word-finally. Moreover, the syllable which follows must begin with the same obstruent as the mora obstruent. Thus, there are only two kinds of consonant clusters in Japanese, namely the cluster of two identical voiceless obstruents (pp, tt, kk, ss) and of the mora nasal plus a consonant.

The above facts about syllable structure will be described by the following set of rules:

8. $CC \rightarrow C / [.] *9$
9. $C \rightarrow [-son] / _.$
10. $\begin{bmatrix} -son \\ +voi \end{bmatrix} \rightarrow [+nas] / _.$
11. $[+nas] \rightarrow [+son]$
12. $C \rightarrow [-son] / [-son] _$
13. $\begin{bmatrix} C \\ <-son> \end{bmatrix} \rightarrow \begin{bmatrix} \alpha ant \\ \beta cor \\ <\gamma cont> \end{bmatrix} / _ \begin{bmatrix} C \\ \alpha ant \\ \beta cor \\ <\gamma cont> \end{bmatrix}$
14. $C \rightarrow \emptyset / _ \#$

Rule 8 says that there is no consonant cluster before or after the syllable boundary. Rules 9 and 10 state that a syllable-final consonant is an obstruent and that a voiced obstruent becomes nasal in this position.¹⁰ Rule 11 changes the nasal obstruent into a sonorant. That the mora nasal thus generated is homorganic with the following consonant is stated by rule 13. Rules 12 and 13 insure that a syllable-final voiceless obstruent is identical to the following obstruent. Rule 14 says that there is no word-final consonant.

Now I examine what processes apply to a consonant cluster or a word-final consonant of English in borrowing. If there were no rule which derived a syllable-final consonant and which was dominated by rules 8 through 14, then medial consonant clusters would be simplified by 8, after which there would be nasalization and assimilation by 9 through 13, and a word-final consonant would be deleted by 14. But Japanese has a so-called 'devoicing' rule, which provides Japanese speakers with the way to cope with numerous consonant clusters or word-final consonants in English.

The phenomenon of vowel devoicing in Japanese is quite complicated, and an exact description has not been worked out yet. The following devoicing rule is given by McCawley (127) as an approximation.

15. Devoicing

$$\left[\begin{array}{c} v \\ +\text{high} \end{array} \right] \rightarrow [-\text{voi}] / [-\text{voi}] \text{ ___ } \left\{ \begin{array}{c} [-\text{voi}] \\ \# \end{array} \right\}$$

That is, the high vowels are devoiced between voiceless consonants or between a voiceless consonant and a word boundary. The above rule does not express the fact that when several consecutive syllables each contain a high short vowel between voiceless consonants, only alternate vowels become voiceless, the choice of the syllables to be devoiced depending on several factors (such as the particular vowels affected, the consonants of the environment, and the pitch of the syllable). Devoicability also varies with the speed of speech. According to an acoustic study by Mieko Han (1962, 20) only the high vowels *i* and *u* are devoiced at the normal speed of speech, as in McCawley's formulation. The other vowels are often weakened under certain circumstances but, they are usually not devoiced at 'normal speaking tempo'. Han's experiment doesn't treat fast speech extensively, but at one point she mentions that such a sequence as /susuki/ 'Japanese pampas grass' is reduced to [s:s:ki] or even [s::ki] and /huhuku/ 'discontent' to [h:h:ku] or even to [h::ku] in fast speech.¹¹ That is, the high vowels are actually deleted, rather than merely devoiced, under certain conditions. Among the consonants, fricatives show the greatest effect on devoicing, then affricates and finally stops. Since a vowel is inserted in borrowing where there is none in the original word, a stronger form of rule 15, that is, a rule of deletion rather than just devoicing, is the one I consider to be reversed. I assume the following fast speech rule is used to analyze borrowed words which have consonant clusters or word-final consonants.¹²

16. Deletion of high vowels (fast speech)

$$\left[\begin{array}{c} v \\ +\text{high} \end{array} \right] \rightarrow \emptyset / [-\text{voi}] \text{ ___ } \left\{ \begin{array}{c} [-\text{voi}] \\ \# \end{array} \right\}$$

The high vowels are usually devoiced or deleted only between voiceless obstruents or a voiceless obstruent and a word boundary, but the insertion is carried on after voiced consonants, too. Hence I will suppose that rule 16 is expanded to the environment of voiced consonants in borrowing.

The next problem concerns which of the two high vowels *i* and *u* is chosen as the epenthetic vowel. Here we notice that the environments of devoicing for these two vowels are not actually the same, because palatalization precedes devoicing; we have [k̟i̟sa] 'train', [s̟i̟ka] 'deer', etc., but not [ki̟sa] or [si̟ka]. That is, the consonant before *i* which is subject to devoicing is always palatalized. Thus rule 16 can be decomposed as follows:

16. a. $\left[\begin{array}{c} V \\ +\text{high} \\ -\text{back} \end{array} \right] \rightarrow \emptyset / \left[\begin{array}{c} -\text{voi} \\ +\text{pal} \end{array} \right] _ \left\{ \begin{array}{c} [-\text{voi}] \\ \# \end{array} \right\}$
- b. $\left[\begin{array}{c} V \\ +\text{high} \\ +\text{back} \end{array} \right] \rightarrow \emptyset / [-\text{voi}] _ \left\{ \begin{array}{c} [-\text{voi}] \\ \# \end{array} \right\}$

u can occur after both palatalized and plain consonants, since y-loss (rule 3) precedes devoicing. For example, we get [sʲsoo] 'prime minister' from the underlying /syusyoo/ by the application of palatalization, y-loss and devoicing, in this order. Because of the nature of rule 16 discussed above, when the consonant after which a vowel is to be inserted is not palatalized or palatal, rule 16a cannot be used, since its environment is inappropriate; then 16b will be reversed, and we get an epenthetic u. Some examples:

English		Japanese
[sup]	'soup'	[suupʲ]
[plat]	'plot'	[purotto]
[klʌb]	'club'	[kurabu]
[blu]	'blue'	[buruu]
[fɔrk]	'fork'	[fɔokʲ]
[kɹim]	'cream'	[kɹiimu]
[gæɡ]	'gag'	[gagu]
[ɡɹɪl]	'grill'	[ɡuriru]
[naɪf]	'knife'	[naiɸʲ]
[seɪf]	'safe'	[seeɸʲ]
[stovv]	'stove'	[sʲtoobu]
[kɹʲv]	'curve'	[kaabu]
[bæθ]	'bath'	[basʲ]
[θɹɪl]	'thrill'	[suɹiru]
[blaws]	'blouse'	[burausʲ]
[tɔwstɹ]	'toaster'	[toosʲtaa]
[tʃiz]	'cheese'	[tʃizu]
[kæʃ]	'cash'	[kassʲ]
[hæm]	'ham'	[hamu]
[mɪlk]	'milk'	[mɪrukʲ]

After the palatalized or palatal consonants, either u or i could be inserted, since both can occur in this environment. But there is some phonetic difference between the palatalized consonant before i and the one before u which doesn't allow an arbitrary choice between them. I will refer to the one before i as bright and the one before u as dark, though there might be a better term to characterize this difference. The palatalized consonants before a and o have the same quality as the one before u. I suppose that Japanese has a low-

level phonetic rule that darkens the palatalized consonants before back vowels. This difference is important, since Japanese speakers don't confuse [s̥i:soo] 'obstacle' and [s̥y̥:soo] 'prime minister' even when the vowel in the first syllable is devoiced or virtually deleted. The same phonetic difference exists between ku, pu, cu and ki, pi, ci respectively. In the case of the palatalized velars and palatal affricates, those before i are phonetically closer to the corresponding English sounds, while in the case of the palatal spirants, those before u are closer. Thus i is inserted in the former environment and u in the latter.

English		Japanese
[dæʃ]	'dash'	[dass̥ʃ]
[kæʃ]	'cash'	[kass̥ʃ]
[frɛʃ]	'fresh'	[fures̥ʃ]
[mætʃ]	'match'	[mac̥tʃ]
[pɪnʃ]	'pinch'	[pi̯nc̥ʃ]
[tʌtʃ]	'touch'	[tacc̥ʃ]
[sɔ:sɪʃ]	'sausage'	[sooseeʃi]
[peɪʃ]	'page'	[peeʃi]
[spʌnʃ]	'sponge'	[sɥpoɲʃi]
[keɪk]	'cake'	[keek̥ʃ]
[straɪk]	'strike'	[sutoraik̥ʃ]
[breɪk]	'brake'	[bureek̥ʃ]

One further point about the palatalized velars: the data show that after the palatalized velars either u or i is inserted. When u is inserted the palatality of the velar stops in the original English word is not carried over to Japanese. That is, a plain velar is substituted for the palatalized one. As I mentioned in section 2.1, the palatality of the palatalized velars before the low front vowel is sometimes neglected in borrowing; because of the subtlety of the palatalization in this environment, Japanese speakers often perceive fronted stops as plain velars. The same situation happens here. The palatalization of the velar stops in English is a mirror-image rule. Bach has pointed out that in a mirror-image rule the influence of the following segment is stronger than that of the preceding one. In particular, a velar which follows a front vowel is more weakly palatalized than a velar which precedes a front vowel; and it may be that Japanese speakers often do not perceive the weaker palatality of the velar position after a front vowel. When they miss the palatality of a velar, they insert u, and when they perceive it, they insert i. The following list illustrates insertion of u after palatalized velars (with consequent loss of palatality):

English		Japanese
[kɪk]	'kick'	[kikk̥ʃ]
[tɪk]	'teak'	[ciik̥ʃ]
[pæk]	'pack'	[pakk̥ʃ]

English		Japanese
[bɪg liɡ]	'big league'	[ʔɪɡgu fiigu]
[bæɡ]	'bag'	[bæɡgu]
[pɪkɪnɪk]	'picnic'	[pɪkuɲikkɪ]

The vowel after t and d must be mentioned next. Here neither i nor u, but rather o, is usually inserted. The underlying t and d are affricated before u and are both palatalized and affricated before i in Japanese. The choice of o after them, therefore, seems designed to keep the processes of affrication and palatalization from applying to them. Thus, the weaker version of Hyman's third principle seems to be necessary. This principle predicts a change in the environment of a segment so that it will be derived in an environment appropriate for the borrowing language. It was pointed out in section 1.1 that this principle is too powerful, in that it allows more than one substitution in the environment. But in the present case, the epenthetic vowel is chosen so that some processes will not apply to the preceding consonant and so that the quality of the consonant will be kept as close as possible to the original one. So I admit that something like Hyman's third principle is necessary in such cases, where new segments are created rather than substitutions made for existing segments. Why o rather than e or a is chosen still needs explanation.

Mieko Han's experiment shows that the u is more readily devoiced than i in the same environment. This correlates with the fact that u is inherently shorter than i in Japanese (Han, 23). Her investigation also shows that o is the third shortest vowel, following u and i. If it is the case that the shorter a vowel is, the easier it is for it to be devoiced or deleted, then o would follow u and i in its ability to be devoiced. It is usually the high vowels that are devoiced, but o could be devoiced in fast speech. And it would be devoiced more easily than e or a. Following are some examples with o inserted after t and d.¹⁴

English		Japanese
[hɪt]	'hit'	[hɪtto]
[bɛlt]	'belt'	[beruto]
[strɔ]	'straw'	[sɔtoroo]
[strayk]	'strike'	[sɔtoraikɪ]
[bænd]	'band'	[bando]
[bɛd]	'bed'	[beddo]
[drɪŋk]	'drink'	[doŋiŋkɪ]
[drɪbl]	'dribble'	[doŋɪburu]

Finally, I would like to make one comment on the relation between devoicing and accent. The accented syllable is usually not devoiced (Han, 25) (that is, not deleted in fast speech).¹⁵ The loan words are generally accented on the syllable containing the third-from-last mora (Josephs 1970).¹⁶ When this syllable contains the vowel inserted

in the process of borrowing, the accent is often moved one mora to the left.

English		Japanese
[eprən]	'apron'	epūron → [ēpuron]
[dʌbls]	'doubles'	dabūrusu → [dāburusu]
[sɪlvə]	'silver'	sirūbaa → [sīrubaa]
[pæstəl]	'pastel'	pasūteru → [pāsūteru]
[fɪksən]	'fiction'	fikūson → [fīkūson]
[bɪznɪs]	'business'	bijinesu → [bījinesu]

Thus, with regard to accent, the epenthetic vowel is placed in the most favorable environment for deletion by rule 16.

2.3. Gemination of consonants

In adopting words with a consonant cluster or a word-final consonant, the gemination of a consonant is observed in certain cases in addition to the vowel insertion. That is, such English words as [tɪp] 'tip', [hɪt] 'hit' and [kɪk] 'kick' come out as [çippu], [hitto] and [kikkū], respectively.

In English both the short vowel and the following consonant of word-final stressed syllables are considerably lengthened, and this lengthening of the consonant is especially conspicuous when it is released (the word-final consonant is usually unreleased, but it could be released in careful speech).¹⁸ Thus [tɪp] and [hɪt], for example, are pronounced as [tɪp:] and [hɪt:], respectively, in careful speech.¹⁹ I assume that these are the forms that were borrowed into Japanese.

In Japanese the first consonant of a geminate (that is, the syllable-final obstruent) is characteristically unreleased. CC is phonetically a long C. The first consonant is released in the other environments, so [çippu] 'tip' is pronounced [çip:] after the final vowel is devoiced, or rather deleted. This phonetic output is very close to the original English form.

One fact which supports the above explanation of geminates is that the final consonant preceded by a long vowel or a diphthong, which is not lengthened in English, is not geminated when borrowed into Japanese. The argument is not very strong, however, since this fact could also be explained by the condition on Japanese morpheme structure that VV cannot be followed by CC.

If Japanese speakers borrow some English words from casual speech, where the word-final consonants are unreleased, they might not perceive the existence of the final consonant and would probably delete them (this may be more true for voiceless obstruents than voiced ones). We have some loans which suggest that this situation has actually happened:

[hwaɪt ʃɹt]	'white shirt'	[waɪʃatsɯ]
[ɔʊtəʊbaɪk]	'autobike'	[oʊtobai]
[kæbənɪt]	'cabinet'	[kæbɪne]

Voiced obstruents are sometimes geminated and sometimes are not.

[bɪg]	'big'	[bɪggu]
[bed]	'bed'	[beddo]
[gæɡ]	'gag'	[gæɡu]
[klʌb]	'club'	[kurabu]

We also have a couple of examples where a voiced obstruent is geminated and then devoiced.

[hænd bæɡ]	'hand bag'	[handobakku]
[bʊldɔɡ]	'bulldog'	[burudokku]
[bed]	'bed'	[betto]

These forms all have doublets with voiced obstruents. Since voiced geminates are inadmissible in Japanese, Japanese speakers have to revise the native system to allow voiced geminates; if they fail to do it, voiced geminates will either be degeminated or devoiced by the process of restructuring of inadmissible underlying representations.

What has been discussed so far can explain the gemination of final voiceless consonants (and the occasional gemination of voiced ones) in word-final stressed syllables, but not the gemination in unstressed or medial syllables.

The consonant might be lengthened even in final unstressed syllables, if speakers of English articulated it very carefully with release, so that foreigners could perceive it. But the medial consonants are usually not lengthened and in any event they would not need to be lengthened to be audible, because they are admissible in Japanese (or in any language). So gemination of medial consonants requires some other explanation.

What is peculiar about medial consonants is that they are sometimes geminated and sometimes not, as the following data show:

With gemination:

English		Japanese
[zɪpɹ]	'zipper'	[ʃippaa]
[flæpɹ]	'flapper'	[ɸurappaa]
[kʌtɹ]	'cutter'	[kattaa]
[ʃʌtɹ]	'shutter'	[ʃattaa]
[lʌki]	'lucky'	[rakki]
[kʊki]	'cookie'	[kukki]

Without gemination:

English		Japanese
[kapi]	'copy'	[kopi:]
[pʌti]	'putty'	[pate]
[çikɪn]	'chicken'	[çikiN]

I have at the moment no clear idea of what distinguishes the two classes of loan words. Perhaps we have to consider the influence of spelling, which I totally neglected in this paper. All the examples I have found with the geminated medial consonant--except one (cookie)--have double letters (including ck for [k]) in English orthography. But the loans without the gemination of a medial consonant have either a single letter, as in copy, or doubled ones, as in putty. So we could say that if borrowing is strictly from hearing, the medial consonant would not be geminated, but that the borrowing of some words is influenced by this spelling with double letters. On the other hand, perhaps we shouldn't totally give up looking for a phonetic explanation; English-speaking children sometimes syllabify such words as batter and zipper (where a short vowel is followed by a short consonant) as bat.ter and zip.per. Further study of English phonetics might suggest some explanation for the way in which Japanese borrows such words.

The gemination of a word-final single consonant discussed before does not hold for s. As I mentioned in section 2.2, s constitutes the optimal environment for vowel devoicing in Japanese. The high vowels are usually deleted when they follow s and precede another voiceless consonant or word boundary, in fast speech and often even at the normal speed of speech. Han (43) mentions that when the final vowel is deleted, s is almost doubled in length. Thus the copula /desu/ comes out as [des:]. This phenomenon may provide some explanation for why Japanese doesn't have a contrast between /-ssu#/ and /-su#/: the phonetic difference between overlong [ss:] and merely long [s:] may be too subtle to allow differentiation of words. At any rate, when Japanese borrows words with -s#, phonetic similarity to English is guaranteed without gemination, since /-su#/ (after the nativizing vowel insertion discussed in 2.2) is realized as [s:] by vowel deletion plus the low-level process of s lengthening.

One fact about the sibilants which I can't explain is that a word-final s is geminated, even though s isn't: [kæssʏ] 'cash' and [puʃssʏ] 'push'. Perhaps this has to do with the fact that ss and s contrast before a word-final high vowel, as in [iʃssʏ] 'one arrow' vs. [iʃʏ] 'doctor' and [iʃssʏ] 'one kind' vs. [iʃʏ] 'different kind', whereas plain ss and s do not contrast in this position.

Finally, I have a few comments on the word-final consonant clusters. When the first C of CC# is s, there is no gemination:

[tɛst]	'test'	[tesʏto]
[læst]	'last'	[rasʏto]
[dɛsk]	'desk'	[desʏku]
[mæsk]	'mask'	[masʏku]

This is presumably the same phenomenon as the failure of s to geminate discussed above. Contrast this case with that in which the C of a word-final sC cluster is a liquid or a nasal. Here s is geminated; since the inserted u is not devoiced in this environment, no 'compensatory lengthening' of s takes place.

English		Japanese
[hʌsɫ]	'hustle'	[hassuru]
[lɛsn]	'lesson'	[ressuɴ]

In the case of a stop followed by s, the stop is geminated. This could be explained in the same way as the gemination of a word-final single stop.

[tʃɪps]	'chips'	[tʃippusɯ]
[saks]	'socks'	[sokkusɯ]
[mɪks]	'mix'	[mikkusɯ]
[ɪndɛks]	'index'	[indekkusɯ]
[slæks]	'slacks'	[surakkusɯ]

What I cannot explain at present about word-final consonant clusters is that neither consonant is geminated when both of them are stops:

[tækt]	'tact'	[takuto]
[sɛkt]	'sect'	[sekuto]
[skɾɪpt]	'script'	[sukuriputo]

2.4. Glides

It is a well-known fact that the distribution of the glides w and y is quite limited in Japanese. w occurs only before a, and y only before u, o, and a. The restriction can be explained by postulating the following rules.

17. Glide deletion

$$(A) \quad G \rightarrow [-\text{back}] / _ \left[\begin{array}{c} V \\ -\text{back} \end{array} \right]$$

$$(B)^{20} \quad \left[\begin{array}{c} G \\ \alpha\text{back} \end{array} \right] \rightarrow \emptyset / _ \left[\begin{array}{c} V \\ \alpha\text{back} \\ -\text{low} \end{array} \right]$$

That is, w becomes y before the front vowels, and then y is lost before i and e, and w before u and o.

Now I consider how an English sequence GV is treated when it is introduced into Japanese. Since the sequences wa, ya, yo, and yu are

admissible phonological representations, they will be registered in the lexicon as they are.

English		Japanese
[wat]	'watt'	[watto]
[ya:n]	'yarn'	[yaan]
[yo:k]	'york'	[yookʏ]
[yuθ]	'youth'	[yuusʏ]

But since wi, we, wu, wo, yi, and ye are prohibited by rule 17, and since there is no rule which is dominated by 17 which can analyze these sequences, we assume that they are registered in the lexicon in violation of rule 17 and are realized as i, e, u, o, i and e, respectively, by the application of rule 17. But when we examine the loan words which originally had a GV sequence, we see that our prediction is not entirely correct:

[wIt]	'wit'	[uitto]
[wɛt]	'wet'	[uettto]
[wʊd]	'wood'	[uddo]
[wɔtʔ]	'water'	[uootaa]
[yɛlɔw]	'yellow'	[ieroo]
[wIɪk]	'wink'	[uiɪkʏ]
[weyv]	'wave'	[ueebu]
[wul]	'wool'	[uuru]
[wɔk]	'walk'	[uookʏ]
[yɛs]	'yes'	[iesʏ]
[yɪr]	'year'	[iyaa]
[yɪst]	'yeast'	[iisʏto]

As we expected, y before i and w before u are lost. But y and w in the other environments are not deleted, but are instead vocalized as i and u, respectively. If our hypothesis is correct, there must be a rule in Japanese which derives w from u and y from i which can be used to analyze such sequences as wi, we, wo and ye and vocalize the glides in them. There is one other fact which suggests the existence of such a rule: there is a gap in the distribution of vowels, any sequence of two vowels being possible in a single morpheme, except *ia, *ea, *ua and *oa. This gap in distribution, which looks accidental at first glance, could be explained by postulating a rule that converts i and e into y, and u and o into w, before a. It also suggests an explanation for our present problem: that Japanese speakers reverse this rule by expanding its environment so as to vocalize the glides in wi, we, wo and ye. The choice of i and u rather than e and o could be explained by their closeness to y and w. But the problem still remains. I assumed that the analysis of inadmissible foreign forms was carried out only when there are some rules in the native system which generate them and which are dominated by the rules that prohibit them. But if there is a rule like

$$\left[\begin{array}{c} \text{V} \\ -\text{low} \end{array} \right] \rightarrow [-\text{syll}] / \text{---} \left[\begin{array}{c} \text{V} \\ +\text{low} \end{array} \right]$$

it is a dominant rule which constrains the underlying representation. It is not dominated by any other rule. I cannot explain why this dominant rule should be reversed by expansion of its environment (even to a high vowel from a low vowel in case of *wi*) so as to vocalize the glides. Why doesn't rule 17 apply to them? The process of the vocalization of the glides in certain positions is a problem I must leave for further study.²¹

3. Concluding remarks

I have discussed how certain phonological processes of Japanese work in the analysis and realization of borrowed English words. The number of processes treated here is very limited: many others have been left for future study.

Phonological theory must provide an apparatus to describe the process of adopting foreign words, since they are treated with considerable uniformity when they are modified to conform to the native system. I consider ability to nativize loan words to constitute a part of linguistic competence.

Some of the results of this paper suggest that quite subtle phonetic facts may have to be considered to explain borrowing. One of the problems raised in a treatment of borrowing concerns perception. In this work, I have assumed that people can perceive any foreign sound, but I think this assumption is obviously wrong in certain cases. It is very difficult for native speakers of Japanese to hear the difference between the *l* and *r* of English, whereas they can hear the difference between *θ* and *s*, although it is hard for Japanese speakers to distinguish them in production. It seems to me that some rules control perception more than others, though I don't know how to characterize such rules at present. That the glides *y* and *w* are lost only before *i* and *u* respectively, but are vocalized in other positions, appears to have something to do with perception. Speaking impressionistically, it seems to be very difficult for Japanese to hear a *y* before *i* or a *w* before *u*. Japanese speakers can perceive the glides in other positions, though they can't always produce them correctly. Here we have a significant problem which needs much more research.

Footnotes

*This is a revised version of my M.A. thesis. I would like to express my deep gratitude to my thesis adviser, David L. Stampe, for his suggestions, to which this thesis owes a great deal. I also would like to express my thanks to Arnold Zwicky and Patricia Miller for their help in completing this thesis. My thanks are also extended to Gaberell Drachman and Robert Jeffers for their valuable comments.

1. Japanese has five vowels, characterized as follows:

	high	low	back
i	+	(-)	-
e	-	-	-
a	(-)	+	+
o	-	-	+
u	+	(-)	+

2. I will refer to a rule which generates a segment prohibited by a preceding rule as 'dominated' by the preceding rule. The analysis of underlyingly inadmissible foreign segments is carried out only when there is a rule available in the native system which generates them, and which is dominated by the rule which prohibits them.

3. Since Japanese has only five vowels (see fn. 1), each English vowel is replaced by one of them. As I am not talking about substitution for vowels in any detail, I list here typical substitutes which appear in examples in the body of the text. The process of vowel substitution will be omitted as long as it doesn't affect the discussion.

i	→	ii	u	→	uu
I	→	i	ɹ	→	u
e	→	e	o	→	o
ɛ	→	e	ɔ	→	o
æ	→	a	ɔ	→	o
		Λ	→	a	
		a	→	a	
		aa	→	oo	

4. Disregard those segments in the examples which are not relevant to the present discussion. Some of them, such as vowels inserted word-finally and geminate consonants, will be discussed later. The slash over vowels denotes devoicing. Accent will not be indicated unless it is crucial to the discussion.

5. The capital N denotes a 'mora nasal', which sounds like a continuation of the preceding vowel before a vowel or in word-final position. In other positions its point of articulation is assimilated to the following consonant.

6. G. Drachman has pointed out to me that the velar stops are not palatalized before æ in British English; he suggests that words with plain velars before æ might have come in from British English. But there are some words which were obviously borrowed from American

English, like [gasorin] 'gasoline' where the velars are not palatalized in Japanese. There is still a possibility that such words were borrowed from a dialect in which the velars are not palatalized before ɚ .

We can't neglect the possibility of spelling pronunciation of plain k and g in this environment, as Julie Lovins has pointed out to me.

7. I have one example provided by Julie Lovins, where $\text{t}\check{\text{e}}$ is nativized as se rather than te : [sero] 'cello'. I can't explain this in my present scheme, because there is no native rule which affricates a voiceless sibilant. But it is interesting when we look at the history of Japanese. Hideyo Arisaka (1957) has claimed that sibilants in Modern Japanese were affricates in eighth century Japanese. If his claim is valid, the ancient process is going on here.

8. The mora nasal is phonetically either a nasal or a nasalized segment colored by the surrounding segments. The mora obstruent is phonetically the gemination of the following obstruent. The voiceless obstruents that can constitute the mora obstruent are p , t , k and s .

9. \cdot indicates a syllable boundary and $*$ a mirror-image rule.

10. This rule shows up in the derivation of a class of verbs.

/yob-ta/ + yob^m-ta + yom-ta + yonta + [yonda]
 'call'
 'past' 10 11 13

(The process of voicing assimilation which derives yonda from yonta is not discussed in this paper.) The interrelation of voiced obstruents and nasality is also observed in the Toohoku dialect where a word-medial voiced obstruent is prenasalized.

11. Notice here that the vowels of two successive syllables are deleted. This is observed only in the environment of fricatives.

12. It seems to me that so-called devoicing in Japanese could be considered deletion not just in fast speech, but generally. The basic phonetic difference between the result of devoicing and that of syncope seems to be not the existence of a vowel, but rather whether the consonant before a devoiced or syncopated vowel is released or not. That is, the consonant is released when the following vowel is devoiced, but it is not when the vowel is syncopated. And I assume, as I discuss later, that many words were borrowed from rather careful speech of English, where the final consonant is released. Thus the rule of devoicing, rather than syncope, is used to cope with the word-final consonant, the phonetic result of the former being closer to the original English sound, even though Japanese also has a rule of syncope.

The rule of syncope in Japanese deletes high vowels in certain environments (McCawley, 115-20). That is, the final high vowels of Sino-Japanese morphemes ending in $-\text{ki}$, $-\text{ku}$, $-\text{ti}$ and $-\text{tu}$ are lost in forming compounds when they are followed by: voiceless obstruents in the case of $-\text{ti}$ and $-\text{tu}$, by another k in the case of $-\text{ki}$ and $-\text{ku}$. Thus butu-situ 'substance' changes to butsitu (eventually to [bussitsɯ]) iti-pon 'one slender object' to itpon [ippon], gaku-koo 'school' to [gakkoo], etc.

The above discussion of the nature of devoicing is still speculative, and I assume here that the fast speech deletion rule is used to nativize consonant clusters or word-final consonants of English.

13. The high back vowel u in Japanese is phonetically somewhat centralized with very little lip rounding. It has a quality best transcribed as u . Since the high central vowel ɨ in the Munda language Sora is also quite short (Stampe, personal communication), the fact that u is shorter than i in Japanese may be related to its centralized quality and its lack of rounding.

14. There are a few words where u is inserted and t and d have undergone affrication:

[twɪst]	'twist'	[tsuisɨto]
[sɛtʃmɛnt]	'settlement'	[setsurumɛnto]
[sɨt]	'shirt'	[satsɨ]
[kʌtʃɪt]	'cutlet'	[katsuretsɨ]
[drɔʃz]	'drawers'	[dzuroosɨ]

15. The accented syllable is the syllable which contains the last high-pitched mora. Given its location, one can predict the pitch of all moras of the word. Cf. McCawley (133).

16. Josephs gives a number of rules which supplement the basic accentuation rule which places the accent on the third-from-last mora, but some of them could be explained by the fact that the mora which is created by the vowel insertion is not accented.

17. The macron indicates the accented syllable nucleus.

18. This account of English phonetics was provided me by Stampe.

19. : indicates lengthening of the preceding consonant and ' indicates release.

20. This is the same as rule 4 in section 2.1.

21. There is one interesting related fact about glides. All the GV combinations except wu and yi are attested at a stage in the history of Japanese. And all of them, again except wu and yi, still exist in some dialects (some dialects in Okinawa have wu and yi, but they are innovations from wo and ye). Notice that u and i are the environments where w and y, respectively, are lost in borrowing.

References

- Arisaka, Hideyo. 1957. Kokugo On-in Si no Kenkyuu. (A study of history of Japanese phonology), Tookyoo, Sanseidoo.
- Bach, Emmon. 1968. Two proposals concerning the simplicity metric in phonology. *Glossa* 2.2.128-49.
- Han, Mieko Shimizu. 1962. Japanese phonology. Tookyoo, Kenkyuu-sya.
- Hashimoto, Shinkichi. 1950. Kokugo On-in no Kenkyuu (A study of Japanese phonemes). Tookyoo, Iwanamishoten.
- _____. 1966. Kokugo On-in Si. (History of Japanese phonemes). Tookyoo, Iwanamisyoten.
- Hirayama, Teruo. 1968. Nikon no Hoogen. (Dialects in Japan). Tookyoo, Koodansya.
- Hyman, Larry M. 1970. The role of borrowing in the justification of phonological grammars. *Studies in African linguistics* 1.1.1-48.
- Josephs, Lewis S. 1970. Accentual patterns in a class of Japanese borrowed words. *Working papers in linguistics* 2.8.45-56. University of Hawaii Department of Linguistics.
- Kenyon, John S., and Knott, Thomas A. 1953. A pronouncing dictionary of American English. Springfield, Mass., G. & C. Merriam Co.
- Kindaichi, Haruhiko. 1960. Meikai Akusento Jiten. (Japanese accent and meaning dictionary). Tookyoo, Sanseidoo.
- Kohmoto, Sutesaburo. 1960. Phonetic and sub-phonemic replacement of English sounds by speakers of Japanese. unpublished dissertation, The University of Michigan.
- _____. 1965. Applied English phonology. Tookyoo, Tanaka Press.
- Kunihiro, Tetsuya. 1963. Gairaigo hyooki ni tsuite--Nichi-ei On'in Taikei no Hikaku. (On orthography of loan words--The comparison of the phonemic systems of Japanese and English). *Nichi-Ei Ryoogo no Hikaku Kenkyuu Jissen Kiroku*. (A report on the comparative study of Japanese and English). Tookyoo, Taisyukan, 27-48.
- McCawley, James D. 1968. The phonological component of a grammar in Japanese. The Hague, Mouton.
- Nishihara, S. O. 1970. Phonological change and verb morphology of Japanese. unpublished dissertation, The University of Michigan.
- Okuda, Kunio. 1970. Review of McCawley (1968). *Language* 46.3.736-53.
- Saxton, Dean. 1963. Papago phonemes. *International Journal of American Linguistics* 29.1.29-35.
- Stampe, David. 1968. The acquisition of phonological representation. unpublished paper.
- _____. 1969. The acquisition of phonetic representation. Papers from the fifth regional meeting of the Chicago Linguistic Society. Department of Linguistics, University of Chicago.
- Umegaki, Minoru. 1966. Gairaigo Jiten. (A dictionary of loan words). Tookyoo, Tookyoodoo.
- Yazaki, Genkuroo. 1964. Nihon no Gairaigo. (Loan words in Japan). Tookyoo, Iwanamisyoten.

Where Binarity Fails

Lawrence Schourup

0. Introduction.

The Sound Pattern of English calls for gradual conversion of most binary feature specifications into nonbinary numerical coefficients. It is claimed that phonological rules carry out this work of debinarization and that the task is not done exclusively by last-ordered surface rules but also by sequentially ordered rules of the phonology. Possibly because Chomsky and Halle only used this aspect of their theory when writing stress rules, subsequent writers, if they have assumed underlying binarity, have conservatively refused to use any but binarily specified features except in the output of final rules. In fact, even final rules assigning numerical coefficients are almost always omitted from phonological descriptions. This is perplexing since the reason Chomsky and Halle provide for the absence of nonfinal numerical values to characterize segmental phenomena in The Sound Pattern of English is that their study is restricted, for the most part, to higher level rules.

This paper will criticize the claim that nonbinarity must be limited to the output of final 'rules of phonetic interpretation', as they are often called, and argue for the contrary claim that nonbinarity should be extended to the structural descriptions of rules and to the output of nonfinal rules. These arguments are not intended to bear directly on the debate over whether features should be specified binarily in underlying representations, and, for purposes of argument, they do not question the appropriateness of feature notation for all processes, nor the appropriateness of discrete feature coefficients--the outcome of these issues should not effect the present claims.

1. Rule Ordering.

The first example is contingent on the assumption that extrinsic rule ordering costs something. Consider rules (1) and (2) posited for Akan by Schachter and Fromkin.

$$1. \quad [-\text{voc}] \rightarrow [+nas] \ / \ \left\{ \begin{array}{l} [+cons] \\ [+vcd] \\ [-cons] \end{array} \right\} \ / \ \text{---} \ \left[\begin{array}{l} +voc \\ +nas \end{array} \right]$$

2. $\left[\begin{array}{l} +\text{voc} \\ +\text{high} \end{array} \right] \rightarrow [+nas] / _ \left[\begin{array}{l} +\text{cons} \\ +\text{nas} \end{array} \right]$

3. $\begin{array}{l} /b\bar{a}/ \rightarrow [m\bar{a}] \quad \text{'give'} \\ /d\bar{a}/ \rightarrow [n\bar{a}] \quad \text{'and'} \\ /j\bar{a}/ \rightarrow [j\bar{a}] \quad \text{'receive'} \\ \quad \quad \sim [nj\bar{a}] \\ /wad\bar{ɪ}/ \rightarrow [w\bar{a}n\bar{ɪ}] \quad \text{'scrape'} \\ \quad \quad \sim [ɲ\bar{a}n\bar{ɪ}] \\ /hu/ \rightarrow [h\bar{u}] \quad \text{'fear'} \end{array}$

4. $\left[\begin{array}{l} -\text{vcd} \\ -\text{nas} \\ C \end{array} \right] V \quad [nsa] \text{ 'hand'}, [pam?] \text{ 'sew'}$

$\left[\begin{array}{l} -\text{vcd} \\ -\text{nas} \\ C \end{array} \right] \tilde{V} \quad [ns\bar{a}] \text{ 'liquor'}, [p\bar{a}m?] \text{ 'confederate'}$

$\left[\begin{array}{l} +\text{vcd} \\ -\text{nas} \\ C \end{array} \right] V \quad [ba] \text{ 'child'}$

* $\left[\begin{array}{l} +\text{vcd} \\ -\text{nas} \\ C \end{array} \right] \tilde{V} \quad \text{---}$

5. $dum \rightarrow [d\bar{u}m] \text{ 'extinguish'}$
 $diŋ \rightarrow [d\bar{i}ŋ] \text{ 'difficult'}$

Rule (1) nasalizes voiced consonants and the glides h, y, and w before underlying nasal vowels, as shown in (3). There are two reasons why one would not want to set up the surface forms on the right in (3) as basic. First, this would fail to account for the distributional facts in (4), and second, without rule (1) we would be forced to set up the dubious underlying segments \bar{h} , \bar{y} , and \bar{w} . Since this second motivation would require experimental confirmation of the surface phonetics, and the first motivation is purely distributional, the existence of rule (1) appears somewhat doubtful, but we will content ourselves with showing that even if (1) is a rule of Akan, there is a better solution than the one proposed by Schachter and Fromkin, but a solution that is only available if the standard working assumption of binarity above the surface is abandoned. Rule (2) nasalizes high vowels before syllable-final nasal consonants, as shown in (5).

Consider the ordering of these two rules. To express the fact that underlying nasal vowels, as in (3), trigger consonant nasalization.

while contextually nasalized vowels, as in (5), do not, the order (1), (2) is required. This is the solution proposed by Schachter and Fromkin. But suppose we were to mark contextual vowel nasalization as distinct from underlying nasalization. Then we could eliminate rule ordering by writing rules (6) and (7).

$$6. \quad [-\text{voc}] \rightarrow [+nas] / \left\{ \begin{array}{l} \left[\begin{array}{l} \text{---} \\ +\text{cons} \\ +\text{vcd} \end{array} \right] \\ \left[\begin{array}{l} \text{---} \\ -\text{cons} \end{array} \right] \end{array} \right\} / \text{---} \left[\begin{array}{l} +\text{voc} \\ +\text{nas}_u \end{array} \right]$$

$$7. \quad \left[\begin{array}{l} +\text{voc} \\ +\text{high} \end{array} \right] \rightarrow [+nas_c] / \text{---} \left[\begin{array}{l} +\text{cons} \\ +\text{nas} \end{array} \right]$$

Of course, this solution requires apparently ad hoc markers to distinguish two types of nasalization, but there is evidence for such a distinction. Regressive contextual nasalization is apparently always weaker than distinctive nasalization. This is attested in, for example, Ayutla Mixtec, Navaho, Pame, Picuris, and Guarani. I know of no counterexamples. Second, there is the language-specific limitation of nasalization in Akan to high vowels. If the velum is simply lowered a given small amount, it stands to reason that high vowels will be nasalized since proportionally more vibrating air will be shunted through the nasal passages for these vowels. Although languages generally tend to nasalize low vowels more readily than high, the opposite hierarchy operates not only in Akan, but also Sora and other Munda languages in which, according to Stampe (personal communication), high vowels are heavily nasalized, mid vowels less so, and low vowels least. In Akan the velum must be lowered more completely for underlying nasal vowels since there are underlying low nasal vowels in the language.

We can now substitute the specifications '+nasal' and '+nasal' for the ad hoc markers in (6) and (7) respectively, yielding rules (8) and (2), also unordered. No importance is attached to the coefficients '++' and '+'--what is important is that there is a distinction in degree.

$$8. \quad [-\text{voc}] \rightarrow [+nas] / \left\{ \begin{array}{l} \left[\begin{array}{l} \text{---} \\ +\text{cons} \\ +\text{vcd} \end{array} \right] \\ \left[\begin{array}{l} \text{---} \\ -\text{cons} \end{array} \right] \end{array} \right\} / \text{---} \left[\begin{array}{l} +\text{voc} \\ ++\text{nas} \end{array} \right]$$

$$2. \begin{bmatrix} +\text{voc} \\ +\text{high} \end{bmatrix} \rightarrow [+nas] / - \begin{bmatrix} +\text{cons} \\ +\text{nas} \end{bmatrix}$$

It is worth noting that in the binary solution the rule ordering is marked no matter what criterion is chosen. The order (1), (2) is anti-feeding, renders rule (1) opaque, and would make for less paradigmatic regularity.¹

2. Scapegoat Features.

Portuguese denasalizes the first vowel of the combinations in (9), while leaving those in (10) alone. Vowel quality and morphological conditioning aside, we would have to write rule (11), and this is essentially the rule Saciuk writes.

$$9. \text{ãá} \quad \text{ěa} \quad \text{õa} \quad \text{ũa} \quad \text{õo} \quad (\text{õo in verbs only})$$

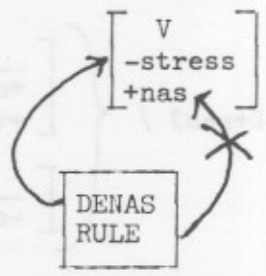
$$10. \text{ãa} \quad \text{ía} \quad \text{ío}$$

$$11. V \rightarrow [-nas] / \begin{bmatrix} \text{---} \\ -\text{stress} \end{bmatrix} V$$

The problem is that (11) is at one remove from its phonetic motivation, for there is, beyond the common sense argument that stress intensifies all parameters, evidence that nasalization is heavier on stressed vowels than on unstressed. This shows up in the willingness of unstressed, but not stressed, vowels to lose all perceptible nasalization, as in Upper Austrian German, Breton, and early Icelandic, and is directly attested in Island Carib. If (11) were to directly capture the fact that Portuguese loses weak nasalization in certain environments, it would be written as (12), which doesn't affect stressed vowels because they are specified heavily nasal. As the diagram in (13) shows, the assumption of pure binarity above the surface forces sidestepping of the relevant phonetic parameter. Consider the standard solution in more detail.

$$12. V \rightarrow [-nas] / \begin{bmatrix} \text{---} \\ +\text{nas} \end{bmatrix} V$$

$$13. \begin{bmatrix} V \\ +\text{stress} \\ +\text{nas} \end{bmatrix}$$



Can't refer to nasality since this would force the rule to distinguish between degrees of nasality. Refers instead to a correlated feature.

Rule (11) would be needed and also a last-ordered rule to state that stressed vowels are heavily nasal. But this solution first provides for denasalization of unstressed vowels, then, only in a later rule, provides the factor that makes stress relevant in the first rule; this kind of globalness in low level rules is highly suspect, especially when it disguises phonetic motivations.

Consider a clearer example of almost the same thing. Neeld has established that palatalization is primarily conditioned by height of adjacent (usually front) vocoids; thus, a language will palatalize adjacent to front vocoids of a specifiable language-particular height and higher, but not lower. Now consider the environment of the rule usually written for languages that palatalize only before j, which is the uppermost member of the height hierarchy. Some such languages are given in (14). The rule would be written as (15) which, however, completely misses the generalization that height is the relevant parameter since it uses extraneous features to explain why high front vowels don't palatalize while j does. Clearly, what is needed is an environment statement with a nonbinary coefficient on a height feature higher than the coefficient for high front vowels.

14. English:

dɪd ju → dɪʒ(j) u 'did you'

dɪd iən → *dɪʒ iən 'did Ian'

also:

$$\left[\begin{array}{c} -\text{sonor} \\ +\text{cor} \end{array} \right] \rightarrow \left[\begin{array}{c} -\text{ant} \\ +\text{strid} \end{array} \right] / _ \left[\begin{array}{c} -\text{back} \\ -\text{voc} \\ -\text{cons} \end{array} \right] \left[\begin{array}{c} -\text{con} \\ -\text{stress} \end{array} \right]$$

(SPE, 230)

Oneida:

s → j / _ j

Spanish

$$\left[\begin{array}{c} +\text{obst} \\ +\text{cor} \\ +\text{S} \end{array} \right] \rightarrow [+high] / \left[\begin{array}{c} -\text{voc} \\ -\text{back} \\ +\text{high} \end{array} \right] _ \text{ (part of a more general rule: Harris)}$$

East Slavic:

$$[+\text{cor}] \rightarrow [+high] / _ \left[\begin{array}{c} -\text{voc} \\ -\text{cons} \\ -\text{back} \\ +\text{high} \end{array} \right] \text{ (SPE, 429)}$$

Italian:

$$\left[\begin{array}{c} +\text{cons} \\ -\text{voc} \\ -\text{cnt} \end{array} \right] \rightarrow [+shp] / _ + \left[\begin{array}{c} -\text{voc} \\ -\text{cns} \\ +\text{grv} \end{array} \right] \text{ (palatalization?; Saltarelli)}$$

15. $C \rightarrow [+high] / _ \left[\begin{array}{l} -cons \\ -voc \\ +high \end{array} \right]$

3. Rule Collapsibility.

In Portuguese vowels are nasalized before and after nasals, as in (16).

16. [kãmä] 'bed', [sĩnõr] 'mister', [kõmẽj] 'they eat'

Progressive nasalization is weak, as determined, Saciuk tells us, 'by mechanical devices'. Not unexpectedly, a rule raising low nasalized vowels acts only on regressively nasalized vowels. In a binary solution, the failure of progressive nasalization to trigger this rule must be explained by rule ordering, as in (17).

17. (i) Regressive Nasalization
 (ii) Raising
 (iii) Progressive Nasalization

In the nonbinary solution the fact that progressive nasalization is physically distinct from regressive nasalization is used to eliminate the ordering of progressive nasalization after raising, thus admitting the possibility of collapsing regressive and progressive nasalization into a single rule. This nasalization rule would assign more than one degree of nasalization, a point for which evidence will be given later.

But this argument can be made much stronger. There are a few words in Portuguese that exhibit heavy progressive nasalization. Since the degree is different from that for ordinary progressive nasalization, it appears reasonable to write a separate rule for these aberrant forms, as Saciuk does. But Saciuk might have had another reason for nasalizing these forms by a separate rule--they undergo raising. This necessitates the ordering in (18).

18. (i) Regressive Nasalization, Minor Progressive Nasalization
 (ii) Raising
 (iii) Progressive Nasalization

If we could show that minor progressive nasalization (the rule providing heavy progressive nasalization) is a subpart of the major progressive nasalization rule, we would be forced to the conclusion that a single progressive nasalization rule assigns at least two degrees of nasalization and that raising follows this rule and discriminates between these two degrees of nasalization. There are good reasons to write only one progressive nasalization rule for Portuguese. First notice that the minor rule nasalizes vowels only after nasals--thus its environment is a subset of the environments in which ordinary

progressive nasalization occurs. Second, consider the particular forms in question, listed exhaustively in (19).

19. [nĩnũ]	'nest'	[mũjntu]	'much, very'
[mũj]	'very'	[mãj]	'mother'
[mĩña]	'my'	[mĩ]	'me, myself'

It is immediately clear that there are in fact phonetic conditioning factors which Saciuk failed to notice. The vowel to be nasalized must be stressed, and it must follow an initial nasal. Moreover, if the vowel is not the only vowel in the word, it must be both preceded and followed by a nasal. Now all of these conditions are conducive to increased nasality. Position between two nasals is extremely conducive to nasalization; structuralist grammars often comment that there is nasalization between two nasals even in a language which has no clearly distinguishable nasalization elsewhere. The contributions of monosyllabicity and position after an initial *m* are exemplified in Hindi-Urdu which, according to a recent analysis (Narang and Becker), nasalizes words whose phonetic shape is *mã*, *mẽ*, and *mẽ̃*, by a separate rule, and in Warao, which has extra heavy nasalization on the words *mĩ*, *mẽ*, *mã*, *mõ*, and *mũ*. It appears, therefore, that rule division is unfair in this case.

4. Extra Rule.

If we choose a binary solution like (17) to the Portuguese raising problem, we are faced with the necessity of stating somewhere in the grammar that regressive and progressive nasalization differ in degree. Under current working assumptions such degrees could only be specified in the output of final rules. The solution in (17) would thus be able to state the degree of progressive nasalization, but would require a new last-ordered rule to state the degree of regressive nasalization.

5. Universals.

Richard DeArmond claims that 'in Polish there is an inverse relation between vowel nasality and the strength of following syllable-final consonants' as determined by spectrography. He adds that there is a small amount of nasalization in vowels before syllable-initial nasals. There is independent evidence that DeArmond's estimations are essentially correct. In a paper read at this summer's LSA Meeting, I gave comparative evidence from numerous languages to show that the universal schema for vowel nasalization is (20), which is, however, still considerably lacking in detail.

$$20. \begin{bmatrix} V \\ +stress! \\ +low! \\ +back! \end{bmatrix} \rightarrow [+nas] / _ N \left\{ \begin{array}{l} [-seg] \\ \begin{bmatrix} C \\ +cont \end{bmatrix} \\ \begin{bmatrix} C \\ -cont \end{bmatrix} \\ V \end{array} \right\} (_ \text{ i.e. / } _ N.)$$

The hierarchy of postnasal conditioning factors is strict and predicts that if a language has nasalization before a given element of the hierarchy, it will also nasalize vowels before all elements above that one in the hierarchy. This schema also predicts that the degree of nasalization will be greater before elements higher up in the hierarchy. If DeArmond's statements are correct (and it would be quite strange if they are not), Polish appears to obey this hierarchy to the extent that the appropriate environments occur in Polish.

Now consider a rule lowering nasalized vowels in Polish; this rule lowers all nasalized vowels except those before syllable-initial nasals. To express this fact within current working assumptions, DeArmond writes one nasalization rule that nasalizes all prenasal vowels except those before syllable-initial nasals, then orders lowering after this rule, and finally allows nasalization to occur before syllable-initial nasals. Now, since it is necessary to state the degrees of nasalization anyway, and since, if this could be done by the nasalization rule itself, there would be at least one less rule in the grammar, and since the single nasalization rule in question would incorporate the postnasal hierarchy of the universal schema for vowel nasalization, there are good reasons to write a nonbinary solution here. But there is even an additional compelling reason to abandon binarity in this case, for if Polish vowel nasalization is broken into two rules, one of these will have the form of no rule known to exist in any natural language--and in fact a form which research into the form of nasalization rules shows to be extremely unlikely since in the universal schema vowels preceding syllable-initial nasals are at the very weakest point in the hierarchy.

6. Power.

One might argue that extending the domain of nonbinarity upward in derivations increases the power of phonological rules beyond the excessive power they already possess. But this would only be the case if nonbinary specifications were used as ad hoc markers without any phonetic basis. In fact, it is likely that revision of working assumptions along the lines suggested here would further constrain phonological theory. Consider, for example, what was until recently² the clearest example of a global phonological rule--that governing the alternation of vowel length in Klamath. A rule was posited to change certain glides to vowels, and these vowels were claimed to alternate

between long and short. But it is difficult to write a rule shortening long derived vowels since there exist underlying long and short vowels that the rule would have to ignore. Kisseberth concluded that, therefore, the rule changing vowel length must look back to the source of the segments it affects and apply only to derived vowels. But if the assumption of pure binarity above the surface is abandoned, Kisseberth's solution requires for its adequate defense exact determination of the vowel lengths in Klamath. Even a small distinction between underlying vowel length and the length of derived vowels would permit a nonbinary solution which would eliminate the globalness. As a reminder of the dangers of audio-impressionistic determination of vowel length, we have the case of the misanalysis of German spotted by Dinnsen and Garcia-Zamor, who did their experimental homework.

But regardless of what the right analysis of Klamath is, this discussion of power brings to light an important point: phonology with pluses and minuses is a lot easier to do than phonology with additional possible specifications. The assumption of pure binarity legitimatizes the phonologist's disregard of phonetic detail and makes it possible to draw conclusions without the help of experimental phonetics; carrying this one sentence further, it is the binarity assumption that makes it possible to trust structuralist grammars as a sufficient source for phonological data.

7. Conclusion.

Probably no one has questioned the need for nonbinary specification at the surface. I have argued that fear of extending nonbinarity to higher points in derivations has led to illicit use of rule ordering to avoid stating phonetic motivations that cannot be directly stated using binarily specified features, to the use of scapegoat features to the same end, to positing extra rules of phonetic interpretation, to the division of single rules into two, and has nicely complemented the unwarranted assumption of the irrelevance of phonetic detail.

It is tempting, and I think correct, to draw an analogy here between, on the one hand, the dichotomy phonological rule/phonetic interpretation rule and, on the other, syntactic rule/semantic rule. It was possible until recently in syntax to push troublesome matters into the semantic component, excluding them from present consideration. Syntacticians have become uncomfortable about the size of the bulge under that carpet. This paper suggests that phonologists should become more self-conscious about sweeping things under the carpet of 'phonetic interpretation'.

Footnotes

1. A similar situation exists in Sango (Samarin) in which derived nasal vowels which are only lightly nasal fail to lower, while underlying nasal vowels (or at least those not adjacent to surface nasals) do lower:

[wɛ̃^v] 'iron', [yɛnɛ̃] 'anus'

2. This paper was read at the winter LSA meeting, Dec. 27, 1972, in Atlanta, Georgia. On the same day, in the morning, a paper by Robin Barbara White was read in which she presented a viable nonglobal reanalysis of the Klamath problem.

References

- Chomsky, N., and M. Halle. 1968. The sound pattern of English.
- DeArmond, R. 1972. Reinterpretation of Polish nasal segments.
Paper presented to the 11th International Congress of Linguists.
- Dinnsen, D., and M. Garcia-Zamor. 1971. The three degrees of vowel length in German. PIL 4.1.
- Dressler, W. 1972. Allegroregeln rechtfertigen lentoregeln. To Appear as a volume of Innsbrucker Beiträge zur Sprachwissenschaft.
- Harris, J. 1969. Spanish phonology. M.I.T.
- Keller, R. 1961. German dialects. Manchester.
- Kisseberth, C. 1973. On the alternation of vowel length in Klamath. To appear in Issues in phonological theory, eds., Kenstowicz and Kisseberth.
- Lounsbury, F. 1953. Oneida verb morphology.
- Narang, G., and D. Becker. 1971. Aspiration and nasalization in the generative phonology of Hindi-Urdu. Lg. 47.3.
- Neeld, R. 1973. Remarks on palatalization. This volume.
- Osborn, H. 1966. Warao: phonology and morphophonemics. IJAL 32.2.
- Saciuk, B. 1970. Some basic rules of Portuguese phonology. Studies presented to Robert B. Lees by his students.
- Saltarelli, M. 1970. A phonology of Italian in a generative grammar. Mouton.
- Samarin, W. 1967. A grammar of Sango. Mouton.
- Sapir, E., and H. Hoijer. 1967. The phonology of the Navaho language. UCPL, Berkeley.
- Schachter, P., and V. Fromkin. 1968. A phonology of Akan. Working papers in phonetics 9, UCLA.
- Schourup, L. 1972. Characteristics of vowel nasalization. Working Papers in linguistics.
- Taylor, D. 1951. Morphophonemics of Island Carib. IJAL 17.4.

Remarks on Palatalization

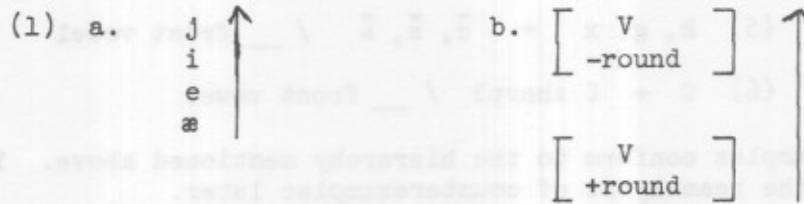
Ronald L. Neeld

1. The Nature of the Process.

Here I investigate a phonological process which assimilates a consonant to some of the properties of a nearby vowel. It most commonly takes the form of an assimilation to the position [+high] [-back]. However, there are also cases of dental palatalization, in which the consonant is already [-back] and assumes only the feature [+high].

There are several conditions on the application of this process. I will discuss first hierarchies of environments which condition the application of the process. I will then discuss restrictions arising from the assimilatory nature of palatalization, and finally I will discuss the relation of palatalization to rule opacity.

It seems to me that the palatalization process is restricted by the following hierarchies.



The arrows point toward more favored environments. In the most favored form of the rule the environment is the glide j; the rule is less favored with i, still less with e, etc. Palatalization before e implies palatalization before i.¹ In other words there is no language with a rule

(2) $C \rightarrow C' / _ e$

Of course, if a language has no high front vowel or glide such a rule may ostensibly appear; but if high front vowels occur, rule (2) may not hold in the language. The hierarchy in (1b) is to be read as meaning that palatalization before a rounded vowel implies palatalization before the corresponding unrounded vowel. If a language has palatalization before y, it will also have palatalization before i. (1b) is not intended to mean that palatalization before a rounded front vowel implies palatalization before all unrounded front vowels. A language may have palatalization before i and y but not before e. This is apparently the case with Chinese, as we shall see below.

Zwicky (1972) discusses a case of a phonological hierarchy in English, with evidence for the hierarchy drawn from a number of rules. The hierarchy in (1), however, does not seem to have cross-rule generality, but is relevant only to the process discussed here. Of course, (1) has an obvious phonetic plausibility. Palatalization is assimilation to a high front position. *j* is closest to this position, *i* less close, *e* even less close. For phonological evidence for the hierarchy we have to examine languages which exhibit palatalization (as an active rule)² and show that: (a) all languages conform to the hierarchy, (b) apparent counterexamples can be reanalyzed so that they conform to the proposed condition.

Now, some examples of the process in unrelated languages. Lukoff (1945) presents evidence that in Korean there is a rule

$$(3) s \rightarrow \check{s} / _ \{i, e\}$$

Data from Lounsbury (1953) indicates that in Oneida there is a rule

$$(4) s \rightarrow \check{s} / _ j$$

Hodge (1947) states that in Hausa, $t \rightarrow \check{c}$, $s \rightarrow \check{s}$, $w \rightarrow j$, $z \rightarrow \check{j}$ before *i* and *e*. This is a palatal shift, but simple palatalization also occurs, the environment being {*j*, *i*, *e*}.

Lightner (1972:ch. 1) mentions that in Russian there is motivation for the following rules:

$$(5) k, g, x \rightarrow \check{c}, \check{z}, \check{s} / _ \text{front vowel}$$

$$(6) C \rightarrow [\text{sharp}] / _ \text{front vowel}$$

These examples conform to the hierarchy mentioned above. I shall discuss the reanalysis of counterexamples later.

The distinction between rounded and unrounded vowels seems to play a part in restrictions on palatalization. One of the highly favored environments for palatalization is the high front vowel *i*. Now if this is a highly favored environment we might expect that the front rounded vowel *y* would be also. I think it is fair to say that front rounded vowels are quite unlikely environments for the rule. Consider the case of French. At a very early date Latin *u* became *y*. Subsequently, French palatalized certain consonants before *i*. For example, régime [reʒim] arises from a Latin stem /reg/, so that *g* has shifted to \check{z} . But this has not happened in the word regularité [regylarite], where the velar stood before a rounded front vowel. Many similar examples can be constructed for French. The point is that we know palatal formation operated before *i*, but not before *y*. The feature [round] must therefore be relevant to a statement of restrictions on the process.

The restriction due to rounding cannot be an absolute one, because there are languages where palatalization has occurred before front rounded vowels. Popperwell (1963) states that in Norwegian g is pronounced [j] and k is pronounced [s] initially before *i*, *y*, and *ei*. The orthography indicates that there was a velar at an earlier stage of the language which has since shifted to a palatal

point of articulation. If historical palatalization is involved here, it appears that y was one of the environments.³ Björkhagen (1948) states that in Swedish g is pronounced as [j] and k is pronounced as [ç] before orthographic i, e, ä, y, ö (phonetically [i], [ɛ], [æ], [y], and [œ], respectively). Examples are kemi [çemi] 'chemistry', kar [çær] 'dear', kedja [çedja] 'chain'. The cognates Eng. chemistry, Lat. carus 'dear' indicate an original k in initial position. Notice also that sk is pronounced [ç] before i, e, y, ä, ö. I do not know if there are synchronic processes involved, but it appears that historically certain consonants were palatalized before rounded vowels.

Cheng (1968), in his discussion of palatalization in Chinese, indicates that it operates before a high front vowel, either rounded or unrounded. It appears that both the velar series and the dental sibilants are merged into palatals. The palatalization rule is:

(7) [= Cheng's rule (83)]

$k, k', x \rightarrow t\phi, t\phi', \phi / _ \text{high front V}$

Another rule creating palatals is:

(8) [= Cheng's rule (84)]

$c, c', s \rightarrow t\phi, t\phi', \phi / _ \text{high front V}$

Chang raises the possibility that his rule (83) might be no longer operative in Modern Mandarin, but rejects this possibility because of the shift of velars to palatals in a secret language observed by Chao:

Moreover, in the system of a secret language which breaks every syllable with initial-final I + F into Iai + kF (e.g. [pei] → [pai - kei]), the [k] becomes [tφ] when the final begins with a high front vowel, as [mi] → [mei-tφi]. (48)

Although both (83) and (84) correspond to historical changes in Mandarin, Cheng mentions support only for (83) as a synchronic rule; it is therefore not certain that (84) still exists in the language.⁴ In any event it is clear in this example that palatalization operates before the front rounded vowel y.⁵

While there are cases where palatalization occurs before a front rounded vowel, in every such case palatalization also operates before the corresponding front vowel of the same height. The restriction imposed by rounding is nonabsolute and unidirectional (i.e. a rounded vowel in the environment implies an unrounded vowel in the environment, but an unrounded vowel in the environment implies nothing about whether there is or is not a corresponding rounded vowel in the environment). The nonabsolute and unidirectional nature of the restriction leads me to believe that it should be expressed by the hierarchy given in (1b).

2. Reanalysis of Counterexamples.

Hyman (1970) mentions that there is a rule in Nupe:

$$(9) C \rightarrow C' / _ \{ \begin{smallmatrix} i \\ e \end{smallmatrix} \}$$

There are, however, occurrences of palatalized consonants before a. We then need to extend the environment of the rule to $_ \{i, e, a\}$, a contradiction to the hierarchy represented by (1a).

It turns out that underlying æ and ɔ are neutralized to a, and only where there is an underlying æ do palatalized consonants appear before a. The rule is:

$$(10) C \rightarrow C' / _ \left\{ \begin{smallmatrix} i \\ e \\ \text{æ} \end{smallmatrix} \right\}$$

Nupe does not contradict the expectation that palatalization occurs in the environment of [-back] segments.

A particularly interesting example is given in Wescott (1965), where certain fast-speech phenomena shed light on the operation of the process. In Bini the segments ç , j , s , z appear only at certain speech tempos. There is a rule, which I will call Palatal Formation, in which $\{z, j\} \rightarrow \text{ç}$, $\{s, \text{rh}\} \rightarrow \text{s}$, $\{d, g\} \rightarrow \text{j}$, $\{t, k\} \rightarrow \text{ç}$.⁶ The question here is the conditioning environment. Wescott says that ç results from prevocalic zi and ji .⁷ It looks as if Palatal Formation applies before an i , after which i drops. For example, *esiasio* at low speed appears as *esaso* at high speed. Some relevant examples:

(11)	rate 1	rate 4	rate 7	gloss
a.	ekuabo	ekuabo	ekwabo	upper arm
b.	igiorlua	igio'a	ija?	water-yam
c.	esiasio	esiasio	esaso	Bristlebill (a bird)
d.	esoosi	esosi	esi?	church
e.	ibieka	ibieka	ibjeka	children

Wescott gives seven different speech rates and their associated characteristics. The important ones here are

- (12) 6. Hurried: $i_3, u_3 \rightarrow j_3, w$ before vowels
7. Slurred: c, j, s, z appear

One might imagine a derivation for form (11c) as follows: *esiasio* \rightarrow *esiasio* \rightarrow *esaso*. I would like to propose, however, that the rule of Palatal Formation has the environment $_ j$. Before this rule applies there is another rule of Glide Formation:⁸

$$(13) \left[\begin{array}{l} +\text{voc} \\ -\text{cons} \\ +\text{high} \end{array} \right] \quad [-\text{voc}] / _ V$$

The Glide Formation rule becomes operative at rate 6. Forms (11a)

and (11e) show the operation of this rule. We know that Glide Formation is needed and operates at fast speed. I would then propose the derivation⁹

Underlying Representation	esiasio
Glide Formation	esjasjo
Palatal Formation	esaso

Since this analysis makes Palatal Formation dependent upon Glide Formation, it explains why the former rule becomes operative only at the rate at which the latter begins to operate.

Furthermore, such an analysis explains why consonants become palatal in just those cases where high vowels become glides. Since a mid-front vowel is never glided, it can never serve in the environment of the rule. In a form where /i/ cannot become /j/, Palatal Formation does not occur, even at high rates of speed. Notice for example (11d), esi?, not *esi?. This would be accidental, unless Palatal Formation depended on Glide Formation. It would also seem to indicate that i is not the environment for the Palatal Formation rule in Bini. In this case, then, we can justify a reanalysis in which the rule actually occurs in the most favored environment.

This is an especially nice example in that it shows how speech rates can split up phonological processes and enable us to see them at work. In this case it is an example of the principle that rules tend to apply in their most favored environments.

The concept of environmental hierarchy is also relevant to the case of Japanese palatalization. According to Schane (1971), palatalized consonants appear before i and plain consonants before e. Historically, palatalization appeared before both i and e. Subsequently, depalatalization occurred before e but not i. Schane's explanation is as follows. Under certain conditions, i and u can be deleted.

kitutuke	→	kit ^s út ^s ki	'woodpecker'
asita	→	ásta	'tomorrow'
kasuka	→	kaska	'faint'
utikatu	→	úkat ^s	'conquer'

i causes palatalization and is then deleted. u is deleted without causing palatalization. The deleted vowel can be recovered on the basis of palatalization. Since nonhigh vowels aren't deleted, they can't cause a contrast, and for this reason depalatalization appears before nonhigh vowels.

But the fact that palatalization does not serve a contrastive function before nonhigh vowels does not explain why it should cease to operate. When the Russian palatalization rules, given in (5) and (6), were first added, they too did not serve a contrastive function.

A preferable explanation would be that the palatalization rule is disappearing from the language. This is indicated by the fact that in borrowings non palatalized consonants appear before i and palatal consonants appear before e: [pātī] 'party', [cēnutōa] 'chainstore'. Recall that the rule earlier operated before i and e.

Now we would expect that when a language begins to lose a rule, it should lose it first in the less favored part of the environment, e in this case. The less favored part of the rule was lost first, and the evidence from loan phonology indicates that the rule is being lost entirely at the present time. If my explanation for the loss of palatalization before e is correct, it provides further support for the hierarchy (1a).

3. Palatalization as Assimilation.

It seems to me that the task of the linguist can only trivially be that of data-classification. The linguist should seek to give a proper characterization of language in the most explicit form possible. The corollary is that as linguists we should attempt to make the strongest claims possible about the form of grammars, and then attempt to substantiate them. If the claims can be maintained, then understanding is gained. If they cannot, then the nature of the failure may lend direction to further research. Explicit criticisms of the way in which a theory fails can serve as guidelines in the search for a better explanation.

One of the reasons for the existence of the hierarchy (1a) is that palatalization is in part assimilation of a consonant to some of the features of a following vowel. The most palatal segments, i.e. the high front unrounded vowel and glide, are the most likely to cause this assimilation. In view of the assimilatory nature of the process, a likely claim concerning palatalization is the following:

- (14) All synchronic palatalization rules are assimilation rules.

This restriction would be in accord with a naturalness condition on phonological rules, inasmuch as it reflects the phonetic basis of assimilation. A difficulty with (14) is brought to light in Naro (1971). In Tuscan $l > \lambda$ in all consonant clusters where l is the second member. A preconsonantal l remains unchanged. That is:

- (15) [= Naro's rule (11)]

[+lateral] → [+high] / [+cons] _

If (15) can be maintained as a phonological rule, then condition (14) is too strong to be maintained. A weaker restriction is indicated by the following facts. Naro cites facts from Rohlfs (1966:239) which show that the l palatalized after velars and spread to other consonants: (1) Ancient documents from the region of Milan have $l > i$ only after velars.¹⁰ (2) Some 'archaic' dialects of Lombardy retain palatal reflexes of l only after velars. Thus the original form of the rule was

- (16) [= Naro's rule (15)]

[+lateral] → [+high] / [+cons
+high] _

This rule expresses an assimilation. (16) then generalizes to (15) by the loss of [+high] from the environment. When the rule was first added to the grammar it embodied restriction (14). It then violated the restriction by bringing about non-assimilatory palatalization of l. The historical development leads us to propose a weaker condition:

- (17) Whenever a palatalization rule is added to a grammar, it must be assimilatory.

This proposal leads to some interesting consequences. It implies that rule (15) is not a possible candidate for addition to a grammar. If a language has rule (15) it could only have gotten it by first adding rule (16) and then generalizing it.¹¹ The claim that palatalization rules are first added as assimilation rules represents a restriction on the possible form of linguistic change, and such restrictions if tenable should be stated in linguistic theory. In addition, (17) is not immediately derivable from a synchronic restriction, in contradistinction to Halle's proposal that the set of possible phonological changes corresponds to the set of possible phonological rules. There might also be consequences for historical reconstruction, since if a language had rule (15), we would be led to postulate an earlier stage where rule (16) operated. There would also be consequences for the proto-forms postulated. The facts here are not entirely clear, and I hope that linguists will look for other cases with the properties discussed.

4. Palatalization and Rule Opacity.

There are historical changes in Slavic and Rumanian involving the interaction of palatalization with other rules in the grammar. The nature of the interaction has consequences for the theory of linguistic change. I shall first discuss the relevance of opacity to rule addition, then give two examples where palatalization is relevant to rule addition.

In most generative models of phonological change it is thought that rules are added by adults, and that children then restructure the system by rule alteration and reordering. A criticism of this view has been given by David Stampe (1969), who wrote:

But Halle's implication that adults might spontaneously add a process is difficult to understand. Halle's general theory is based on the assumption that all phonological processes are rules which are constructed by the child to account for his linguistic experience, and that the phonological system is evaluated according to the simplicity of these rules--so that (other things being equal) the fewer rules, the better. It is not at all clear, given this view, why a process should be added in the first place. (452)

One answer to the problem of rule addition is that so-called

addition is failure to suppress a natural process. For example, there is a process devoicing word-final obstruents, which English children must suppress if they are to exhibit a voicing opposition in this position. But German children need not suppress the process, because German has a rule of final devoicing. If English-speaking children were to fail to suppress the rule devoicing word-final obstruents, a change would result which would appear to be the addition of a rule to a grammar. Natural phonology in this way provides an explanation for one type of rule addition.

I would like to claim that another explanation for rule addition is that a rule can be added to a grammar in order to decrease the opacity of another rule in the grammar. The definition of opacity is, following Kiparsky (1971),

(18) A rule $A \rightarrow B / C_D$ is said to be opaque to the extent that there are surface representations of the form

- (a) A in environment C_D
- (b) B in environment other than C_D

One example where the addition of a rule has decreased opacity is found in Slavic.¹² There is a historical change in Slavic whereby the segments k, g, and x become č, ĵ and š respectively, with the environment being $__ \begin{bmatrix} -\text{cons} \\ -\text{back} \end{bmatrix}$. Darden (1970) discusses a Slavic change fronting back vowels. After palatal consonants and j, all vowels were fronted except for the long nonhigh vowel ə.

*nozj-u > nož-u > noži
 *nozj-omu > nož-omu > nožemu
 *nozj-ā > nož-ā
 *zūd-u > žid-u

Darden discusses a number of details concerning this change that I won't go into, including evidence that the change took place in two stages, involving first low vowels, then high vowels. What I want to focus on here is that a motivation for addition of Vowel Fronting arises from considerations of rule opacity. Consider the rule which produces palatal segments:

(19) $k, g, x \rightarrow \check{c}, \check{z}, \check{s} / __ \begin{bmatrix} -\text{cons} \\ -\text{back} \end{bmatrix}$

When we have cases of palatal segments before back vowels the rule is opaque by case (b) of opacity. This can come about either because the final segments of morphemes have been restructured as underlying palatals, to which new case endings with back vowels may be attached, or because a front vowel preceding a back vowel caused palatal formation and was deleted by a later vowel truncation rule.

Since we have surface occurrences of č, ž, and š before back vowels, one way to reduce the opacity of the rule forming palatals

is to add a rule fronting back vowels after palatals. Then the palatals would always appear on the surface next to their conditioning environment.

However, there is a condition on fronting specifying that it does not apply to a low vowel. In fact historically the long low vowel was backed after palatals and j:

stoj- \bar{a} - > stoja-

m \bar{e} guk- \bar{a} jsisiji > m \bar{e} guc \bar{a} jsisiji > m \bar{e} guc \bar{a} jsisiji

A possible way to treat these facts would be to have a rule fronting all vowels and then a rule ordered after this which backed the low vowel. Darden, however, claims that the fronting rule specifically excluded a and provides a number of arguments to show this.

I agree with him that a fronting rule which excludes the low vowel is the proper form of the rule, and I think this situation represents a conflict between opacity and natural rules. Stampe has proposed that the context-free vocalic process shown by (20) is a natural rule.

(20) [+low] → [+back]

There are two possible forms of the fronting rule. One has [+voc] to the left of the arrow. The other has to mention

$$\left[\begin{array}{l} +\text{voc} \\ -\text{cons} \\ -\text{low} \end{array} \right]$$

In conjunction with (20) it can be seen that the second alternative is the more expected form of the fronting rule. The fronting is presumably a learned assimilation process, whereas backing is a natural rule. In order to get fronting of all vowels, a child would have to suppress rule (20). A rule which fronts all vowels is the less natural form of the rule. I propose, then, that Vowel Fronting was added in order to minimize the opacity of the First Palatalization rule (represented by (19)), and was added in the most expected form. The fact that a does not front is to be expected: the effects of rule opacity are in conflict with a natural rule and here the natural rule takes precedence.

Another case where it seems that a rule has been added to decrease opacity is that of Rumanian. There is evidence that Common Rumanian had a rule:

(21) C → $\left[\begin{array}{l} +\text{high} \\ -\text{low} \end{array} \right]$ / _ i

indicating palatalization before a high front vowel. Soon after this period, a number of dialects extended the rule to apply before all front vowels.

$$(22) C \rightarrow \left[\begin{array}{l} +\text{high} \\ -\text{low} \end{array} \right] / - \left[\begin{array}{l} \text{v} \\ -\text{back} \end{array} \right]$$

According to Vasiliu (1966), Common Rumanian \check{s} ' was sharp, being the product of palatalization of Latin *s* before *i* or Vulgar Latin *j*. All CRum. \check{e} changed into *e* after a palatal consonant:

<u>Common Rumanian</u>	<u>Latin</u>
*pál' \check{e} > pál'e	palea
*kún' \check{e} > kún'e	cunea

This also happened when \check{e} was preceded by \check{s} '; CRum. *kámés' \check{e} > *kámés'e. In many Rumanian dialects \check{s} ' lost its sharpness. When \check{s} ' became \check{s} , *e*, *i* > \check{e} , \check{i} when following it:

$$(23) V \rightarrow [+back] / \check{s} _$$

The palatalization rule states that hard consonants become soft before a front vowel. When soft \check{s} ' preceding a front vowel became hard \check{s} the result was hard consonant + front vowel. A sequence of this sort makes the palatalization rule opaque by case (a) of opacity. We have segments that appear in an environment which normally causes a change, yet these segments appear on the surface in their original form. If there is no way to reorder the rules to remedy this situation, an alternative is to add a rule changing the environmental section of the sequence that makes the rule opaque. In this case we have surface sequences of hard consonant + front vowel and a rule is added making the front vowel back. That is, the environmental section of the sequence making the rule opaque is changed.¹⁴ The palatalization rule becomes opaque when \check{s} ' becomes hard. A possible way to explain the addition of the vowel backing rule is that it reduced the opacity of the palatalization rule.

5. Conclusion.

In this paper I have investigated various restrictions on the operation of the process of palatalization. I have proposed that the nonabsolute and unidirectional character of the restrictions on the application of the process are to be expressed by the hierarchies in (1). There is no absolute restriction against palatalization before low vowels; it is merely a less favored environment. I have also studied some of the consequences for historical change that are indicated by the assimilatory nature of the process. I discussed the interaction of palatalization with other rules and proposed an explanation for certain cases of rule addition.

This investigation has been a study of part of universal grammar. We can list palatalization rules in various languages, but this misses

the universal implications associated with the process, e.g. that palatalization before a mid vowel implies palatalization before a high vowel. Such implications can only be expressed by the use of hierarchies associated with phonological processes, providing evidence that such hierarchies must be incorporated into a universal phonological theory.

Footnotes

*A revised version of section 4 of this paper was presented under the title "Rule Opacity and Rule Addition" at the Summer Meeting of the Linguistic Society of America, Chapel Hill, North Carolina, July 1972. I would like to thank the following people for helping me with this paper: Arnold Zwicky, William Daniels, and Richard Wojcik.

1. The hierarchies given are intended to be relevant to the segment following the consonant to be palatalized. I have not made a study of progressive palatalization, but I would expect that much the same hierarchies would hold.

2. This is actually a non trivial qualification. If the rule is no longer active, then we can have underlying palatal consonants. Suppose a language had a rule $k \rightarrow \check{c} / _ i$, so that underlying ki becomes $\check{c}i$, and that the rule then drops out of the language and a later rule backs i to u . Then we have surface $\check{c}u$, an apparent exception to the hierarchy.

3. The initial palatals in words such as gyllen [jylin] 'golden' have probably been restructured as underlying palatals. There is no evidence for synchronic derivation from underlying g . There are a number of exceptions to the pronunciation of g as [j] in literary and loan words, and it does not occur non-initially (except after certain prefixes). See Popperwell, 85-87.

4. Cheng collapses (83) and (84) as

$$(89) \quad \left\{ \begin{array}{l} k, k', x \\ c, c', s \end{array} \right\} \rightarrow t\check{c}, t\check{c}', \check{c} / _ \left[\begin{array}{l} -\text{cons} \\ +\text{high} \\ -\text{back} \end{array} \right]$$

He mentions no evidence for or against the proposition that the rules should be collapsed in this fashion.

5. See Cheng, 81, for examples.

6. In IPA symbols, $rh = \underset{r}{r}$, $z = \underset{z}{z}$, $s = \underset{s}{s}$, $\check{j} = d\underset{j}{j}$, $\check{c} = t\underset{c}{c}$.

7. I use Wescott's transcription throughout the discussion of Bini, except for the use of j , rather than y , for the high front glide.

8. Zwicky (1972) has discussed an essentially similar rule of English which also operates in fast speech. For example, [lɪθwéjɲniən] ~ [lɪθwéjɲɲ] Lithuanian.

9. There is either a separate rule dropping j after palatals, or the deletion of the glide is part of the rule of Palatal Formation.

10. Presumably what Naro has in mind here is that first $l > \lambda$ and then λ vocalized as i .

11. The generalization involved is interesting in itself. We have to move from a quite natural rule (16) to a rather unnatural rule (15). In spite of the fact that the rule is simplified by dropping a feature it is made more expensive in its functional effects (i.e. in its nonassimilatory nature). This leads to some problems for the evaluation metric presented by Chomsky and Halle (1968). Furthermore, the analogical processes at work in extending the rule to a functionally more expensive form are ill-understood, as is the notion of 'functional expense'.

12. There are two ways in which a rule could decrease the opacity of another rule.

(1) Suppose a rule

(i) $A \rightarrow B / _ D$

is opaque by case (b) of opacity. Then there are surface representations of the form BE. If a rule is added so that $E \rightarrow D / B _$, then rule (i) ceases to be opaque.

(2) Suppose a rule (i) is opaque by case (a) of opacity.

The rule predicts that A occurs before E and B before D. Then surface forms such as AD make the rule opaque. If rule (ii) is added, the opacity of (i) is decreased.

(ii) $D \rightarrow E / A _$

13. See Sala (1970) and Nandris (1963) for historical discussions of palatalization in Rumanian.

14. The notion of 'opaque sequence' is relevant here. Kiparsky proposed that opaque rules are hard to learn. In spite of the difficulty, a child may adopt the strategy that the palatalization rule exists. What happens then is that opaque sequences become hard to produce, and a child may well modify these sequences.

References

- Björkhagen, R. G. 1948. Modern Swedish grammar. Stockholm: Svenska Bokförlaget.
- Bloomfield, Leonard. 1939. Menomini morphophonemics. TCLP 8. 105-15.
- Cheng, Chin-Chuan. 1968. Mandarin phonology. Ph.D. Thesis, University of Illinois.
- Chomsky, Noam, and Morris Halle. 1968. The sound pattern of English. New York: Harper and Row.
- Darden, Bill J. 1970. The fronting of vowels after palatals in Slavic. CLS 6.459-70.
- Hodge, Carlton T. 1947. An outline of Hausa grammar. Supplement to Lg. 23.4.
- Hyman, Larry. 1970. How concrete is phonology? Lg. 46.58-76.
- Kiparsky, Paul. 1971. Historical linguistics. In A survey of linguistic science, ed. W. O. Dingwall, Program in Linguistics, University of Maryland, 576-642.
- Lightner, Theodore. 1972. Problems in the theory of phonology: Russian phonology and Turkish phonology. Edmonton and Champaign: Linguistic Research.
- Lounsbury, Floyd G. 1953. Oneida verb morphology.
- Lukoff, Fred. 1945. Spoken Korean.
- Nandris, Octave. 1963. Phonétique du roumain. Paris.
- Naro, Anthony J. 1971. Directionality and assimilation. Linguistic Inquiry 2.57-67.
- Popperwell, R. G. 1963. The pronunciation of Norwegian. Cambridge.
- Rohlffs, G. 1966. Grammatica storica della lingua Italiana e dei suoi dialetti, fonetica. Torino: Giulio Einaudi.
- Sala, Marius. 1970. Le consonantisme du roumain commun. In Problemes du linguistique roumain, ed. Iorgu Iordan and A. R. Hansen.
- Schane, Sanford A. 1971. The phoneme revisited. Lg. 47.503-21.
- Stampe, David. 1969. The acquisition of phonetic representation. CLS 5.443-54.
- Vasiliu, E. 1966. Towards a generative phonology of Daco-Rumanian dialects. Journal of Linguistics 2.79-98.
- Wescott, Roger W. 1965. Speech tempo and the phonemics of Bini. Journal of African Languages 4.182-90.
- Zwicky, Arnold. 1972. Note on a phonological hierarchy in English. In Linguistic change and generative theory, ed. R. P. Stockwell and R. K. S. Macaulay, Indiana Univ. Press, 275-301.

On Generative Studies of Slavic Palatalization

Ronald Neeld

Historically, there is a set of changes in the Slavic language family whereby the velar segments shifted to their corresponding strident palatals before a front vowel. Dentals show a similar shift in point of articulation. A correlated change is one whereby underlying non-palatalized segments became palatalized. Generative studies of the synchronic phonology of the modern Slavic languages have been concerned with predicting the derivation of palatal stridents from underlying velars and dentals, and of palatalized consonants from non-palatalized consonants.

The articles under review here are Cohen (1969), Darden (1971), and chapter nine of Chomsky and Halle (1968), all of which are concerned with the phonological properties of palatal or palatalized segments. I should like to orient this review towards a discussion of the naturalness of phonological systems and the use of historical evidence in synchronic phonology.

The first study of palatal shift¹ that I would like to discuss is that given by Chomsky and Halle. The historical facts are as follows. Underneath each historical change are given the segments to which this change applies. To the right are given the results of the change in each of the three Slavic dialect groups.

	East Slavic	South Slavic	West Slavic
1st Velar Palatalization			
k, g, x	č, ĵ, š	č, ĵ, š	č, ĵ, š
2nd Velar Palatalization			
k, g, x	c, ʒ, s	c, ʒ, s	c, ʒ, s
Dental Palatalization			
t, d, s, z	č, ĵ, š, ž	t ₁ , d ₁ , š, ž	c, ʒ, š, ž

Chomsky and Halle present a synchronic analysis of modern Slavic in which they order the first palatalization before the second palatalization. Now the second Velar Palatalization can't apply to the output of the first palatalization because if this were the case all the forms given by the output of the first palatalization would be shifted to the forms predicted by the second palatalization. This does not in fact occur. They therefore have to order a rule of diphthong reduction between these rules. For East Slavic the resultant analysis is:

$$(26) [-ant] \rightarrow [-back] / \text{---} \begin{bmatrix} [-cons] \\ [-back] \end{bmatrix}$$

Monophthongization $\left\{ \begin{array}{c} ay \\ oy \end{array} \right\} \rightarrow [\text{nonback vowels}]$

(34) $\left[\begin{array}{c} -\text{ant} \\ -\text{str} \end{array} \right] \rightarrow \left[\begin{array}{c} -\text{back} \\ +\text{ant} \end{array} \right] / _ \left[\begin{array}{c} -\text{cons} \\ -\text{back} \end{array} \right]$

(42) $[\text{+coronal}] \rightarrow [\text{+high}] / _ y$

I shall discuss this analysis in connection with Cohen's criticism of it. Cohen notes that the second Velar Palatalization applies only to underlying velars, so should have to refer only to [-anterior] segments. But if it did, it would incorrectly apply to the output of the first palatalization. Therefore, the ad hoc feature [-strident] must be added to the Structural Description of rule (34). Cohen correctly points out that the only reason Chomsky and Halle proposed the feature was to ensure that rules (26) and (34) were disjunctively ordered. This is, however, a criticism of Chomsky and Halle's discovery procedure, and not of their analysis, for the feature is not in fact ad hoc. Given the fact that the first palatalization precedes the second palatalization, this feature must be used in the statement of the second palatalization. The feature would then be no more ad hoc than using the feature [+high] in a rule that applied only to high vowels. What is really at issue is whether (26) precedes (34). Cohen's feature argument is irrelevant to this issue, for given this order the feature is not in fact ad hoc.

Suppose that we had two classes of underlying segments, class A and class B.

class A

$\left[\begin{array}{c} -\text{ant} \\ -\text{str} \end{array} \right]$

class B

$\left[\begin{array}{c} -\text{ant} \\ +\text{str} \end{array} \right]$

Now if a rule only applies to the first class, we must distinguish the difference in the behavior of the two classes by using the feature of stridency in the rule. The same situation obtains at the point at which rule (34) applies. There are two classes of anterior segments the rule could apply to, and it only applies to one of these classes.

A possible test of the issue would be this: if there are underlying, as well as derived, [-anterior] segments, we could see whether or not the rule (34) applied to them. If it did not, we would know that [-strident] is intrinsic to the rule and thus not ad hoc. If the rule did in fact apply to such underlying segments, but not to segments derived from (27), we would know that the features were used to block (34) from applying to the output of (26).³

We do, in fact, have evidence on this point. Consider the following data from Russian:

/ilyič̣/ 'Ilyich'
 /ilyič + e/ loc. sg., */ilyic + e/

 /obruč̣ + at'/ 'betroth'
 /obruč + enie/ 'betrothal', */obruc + enie/

 /obl'egč̣ + at'/ 'to make easy'
 /obl'egc + is/ 2 sg. 'you facilitate', */obl'egciš/

 /sm'eṣ̌ + at'/ 'to mix'
 /sm'eš + enie/ 'mixture', */smesenie/
 /sm'es + is/ 'you mix', */smesis/

I have seen no discussion of this point, but it appears that when an underlying strident palatal occurs before a front vowel, it is not shifted by the second palatalization. Therefore, the feature strident is intrinsic to rule (34) and is not an ad hoc device. Cohen says 'Furthermore, the choice of feature is arbitrary. The feature [+back] would do as well' (307). But this is a nonargument. Note that

$$\left[\begin{array}{l} +\text{cons} \\ -\text{voc} \\ +\text{cor} \\ -\text{ant} \end{array} \right]$$

specifies all and only those segments which are

$$\left[\begin{array}{l} -\text{voc} \\ +\text{cons} \\ +\text{high} \\ -\text{back} \end{array} \right]$$

The segment /č̣/ can be specified either

$$\left[\begin{array}{l} +\text{cor} \\ -\text{ant} \\ -\text{contin} \\ -\text{voice} \end{array} \right]$$

or

$$\left[\begin{array}{l} +\text{str} \\ -\text{contin} \\ -\text{voice} \end{array} \right]$$

.5

This arbitrary feature effect is not a defect of Chomsky and Halle's analysis, but of the nature of the feature framework (if, indeed, it is a defect).

As Cohen says of his second argument, the feature reversal argument, 'this argument is a direct consequence of the ad hoc and arbitrary use of [-str] in the SD of rule (34)' (307). But since his first argument against Chomsky and Halle doesn't go through, neither does his second.

Cohen's real arguments are as follows.

(1) both palatalizations can optionally occur across /v/:
 nom. sg. vlūxvu 'magician', nom. pl. vlūsvi, voc. sg. vlūšve.
 We would then need an optional /v/ in the environment of two separate rules.

(2) There is no independent motivation for the rule of diphthong reduction.

(3) We can predict where the 2nd Velar Palatalization occurs syntactically (i.e. by morphological category).

The only reason for the diphthong reduction rule is to keep certain velars out of the environment for the first palatalization, so that they later undergo the second palatalization. If we assume that diphthongs have been restructured as underlying front vowels, we can collapse rules (26) and (34). The second Velar Palatalization occurs when the velar precedes /e/, or certain [-back] vowel affixes, i.e. any noun affix in any case but the vocative, or a verb affix in the imperative. Otherwise, the first Velar Palatalization applies. The rule is then:

$$(1) [-ant] \rightarrow \begin{bmatrix} -back \\ <+ant> \end{bmatrix} / _ (v) \left[\begin{array}{l} -cons \\ -back \\ +voc \\ \left\{ \begin{array}{l} [+low] \\ \left\{ \begin{array}{l} +Noun \\ -vocative \end{array} \right\} \\ + \\ [+imperative] \end{array} \right\} \end{array} \right]$$

This discussion brings up a point in regard to the naturalness of phonological rules. There is no other justification for the rule of diphthong reduction, so it seems implausible that Russian children should learn it. But given the lack of diphthong reduction, rules (26) and (34) can be collapsed into a single rule, and the extreme similarity in environments and effects indicate that they are in fact a unified process. The difficulty of Chomsky and Halle's analysis is the methodological one of assuming that diachronic order of rules gives evidence as to their synchronic order. Halle has stated (1962),

It has been proposed here that the primary mechanism of phonological change is the addition of rules to the grammar. ...If now we assume that rules are added always singly and always at a given spot in the grammar, then *it follows that the synchronic order of rules will reflect the relative chronology of their appearance in the language.*

Using this principle, many people have taken the historical phonology of a language and proposed this as a synchronic analysis. What is ignored here is the crucial matter of reformulation of phonological systems. Suppose rule B is added after rule A such that A precedes B and this is a non-feeding order. Then the rules are reordered to come into feeding order, so that B precedes A. Rules could also be reordered (after one of them had been added) to change from non-bleeding order into unmarked bleeding order to minimize rule opacity. We then cannot propose diachronic order as a basis for synchronic order.

Likewise, at some point underlying forms must be reformulated (or else the underlying forms of modern English would be the same as the underlying forms for Old English). Specifically, I agree with Cohen that the old diphthongs in Slavic have become underlying front vowels. The Chomsky-Halle analysis is then highly unnatural in terms of the type of rule order and underlying forms that are posited for the speaker of Russian.

The idea that segments which were formerly derived might become restructured as underlying segments is broached in Darden (1971). In discussing the phenomenon of palatalization, he takes issue with Lightner's claim that there are no underlying palatalized segments in Russian (Lightner MS). Many words end in palatalized consonants in Russian. Lightner posits a short front vowel following such segments which conditions palatalization and is then deleted. The rules are:

$$(2) [+cons] \rightarrow \begin{bmatrix} +high \\ -back \end{bmatrix} / _ \begin{bmatrix} +voc \\ -cons \\ -back \end{bmatrix}$$

$$(3) \begin{bmatrix} +voc \\ -cons \\ +high \\ -tense \end{bmatrix} \rightarrow [-high] / _ C_1 \begin{bmatrix} +voc \\ -cons \\ +high \\ -tense \end{bmatrix}$$

$$(4) \begin{bmatrix} +voc \\ -cons \\ +high \\ -tense \end{bmatrix} \rightarrow \emptyset$$

Historically, the short jers *b* and *ḅ* were lowered to /e/ and /o/ respectively in certain positions and deleted in others. We have another case where the synchronic description mirrors the historical development.

Lightner's derivation of *tat'* 'thief' would be as follows.

	nom.sg.	gen.sg.
U.R.	tat + b	tat + i
palatalization	tat' b	tat' i
jer deletion	tat'	tat' i

Darden claims that since a final /t/ always appears phonetically as /t'/ in the *i*-declension, it has become an underlying /t'/, i.e. the stem is *tat'*- in all forms. I agree with Darden for two reasons:

- (1) The rule of jer deletion which is needed to condition surface palatalization is a case of absolute neutralization; we should thus seek another explanation where possible.
- (2) Lightner's theory assumes the validity of the free-ride principle. There is an independent rule of palatalization. Therefore,

Lightner argues, consonants before a front jer can catch a 'free ride' on this rule. We can then eliminate palatals from the underlying inventory. The notion of simplicity metric is at issue here. It is not immediately obvious whether elimination of underlying segments can be purchased at the price of writing unnatural and unmotivated rules. In this case, our 'free ride' has a hidden cost attached. Caveat emptor.

I would like to discuss Darden's putative historical justification for his position. He notes that irregular masculine i-stems (which had front vowel endings) changed to regular o-stems. In this case the underlying back vowels of the endings were fronted (by a rule fronting vowels after palatal consonants, see Darden (1970)). This means that the stem ended in a palatalized consonant. When the back vowels of the o-declension were added, we find /tat'/ conditioning fronting of the vowel, not /tat/ followed by a back vowel. Darden says:

One example cannot be expected to prove a theory. It may, however, disprove a theory. If a theory predicts that something is impossible, and we find that it occurs, then the theory must be wrong. The single example provided by this paper can be taken as proof that the theory that underlies Lightner's analysis of Russian is incorrect. (330)

However, his example does not disconfirm Lightner's analysis, because:

- (1) There is no reason to suppose that shift of paradigms should not be conditioned by surface forms rather than underlying forms, and there is a surface palatalized consonant in tat'.
- (2) We can order fronting of vowels after palatalization (indeed, we have to if there is no underlying palatalization). The derivation includes a new rule (5) and proceeds as follows:

$$(5) V \rightarrow \emptyset / _ + V$$

U.R.	tat + a
palatalization	tat' + a
V truncation	tat' + a
V fronting	tat' + e

It should also be pointed out that Darden's historical evidence is dubious. The attested form is $\tau a \tau a$. However, the symbol Λ stood for /-ja/ as well as /e/ at the time of the records that Darden cites.

In short, I agree with Darden's conclusion, that we need to set up underlying forms different from surface forms only when the phonology of the language gives evidence that the child would learn that underlying form. His putative historical argument is not, however, convincing. In other words, it does not disprove Lightner's analysis. Both approaches can handle the data. The issue is that in order to eliminate underlying palatals Lightner and Chomsky and Halle have to add rules which one would not suppose to exist unless one already knew

the history of the language. The situation with palatalization is the same as with palatal shift. While one might look at the history of the language in order to find clues for an analysis, this is a method to be used with extreme care. There are at least two rules in this paper, diphthong reduction and jer deletion, which are at best highly dubious candidates for contemporary rules. If these fall, then the absence of underlying palatal and palatalized consonants is highly problematic. This is a reflection of the fact that at some point, the underlying forms and rules will cease to reflect their diachronic order.

Footnotes

1. I shall use 'palatal shift' to refer to a shift of a segment to a palatal point of articulation. 'Palatalization' will refer to adding the secondary feature of palatalization to a segment.

2. For South Slavic there is a minor adjustment of rule (42). For West Slavic, dental palatalization and the second Velar Palatalization have slightly different forms. In addition, the dental palatalization precedes the second Velar Palatalization.

3. We would also have an interesting case of a global condition on a phonological rule, since we would have to distinguish derived from nonderived segments.

4. Where /c/ is an affricate /ts/, -enie is a nominal ending, -iṣ is 2 sg. verb ending. Forms in slashes are near-surface or phonetic.

5. I am indebted to various students in Linguistics 601, Autumn Quarter 1971, Ohio State University, for pointing this out to me.

6. The rule must in fact be

$$\begin{bmatrix} -\text{ant} \\ -\text{str} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{back} \\ +\text{ant} \end{bmatrix} / \dots$$

for reasons given in my discussion of the feature of stridency. /obruč/ 'hoop', nom. pl. /obruč + i/, although Cohen's rule predicts */obruči/.

7. There is justification for rule (5). See Lightner MS.

References

- Chomsky, Noam, and Morris Halle. 1968. *The Sound Pattern of English*. New York: Harper and Row.
- Cohen, David. 1969. Why the Slavic 'second palatalization' comes first. *Papers from the Fifth Regional Meeting of the Chicago Linguistic Society*, 459-470.

Cohen, David. 1971. Diachronic evidence for phonemics. Papers from the Seventh Regional Meeting of the Chicago Linguistic Society, 323-331.

Halle, Morris. 1962. Phonology in generative grammar. Word 18. 514-72.

Lightner, Theodore. MS. Russian phonology.

References

Cohen, David. 1971. Diachronic evidence for phonemics. Papers from the Seventh Regional Meeting of the Chicago Linguistic Society, 323-331.

Halle, Morris. 1962. Phonology in generative grammar. Word 18. 514-72.

Lightner, Theodore. MS. Russian phonology.

References

Cohen, David. 1971. Diachronic evidence for phonemics. Papers from the Seventh Regional Meeting of the Chicago Linguistic Society, 323-331.

Halle, Morris. 1962. Phonology in generative grammar. Word 18. 514-72.

Lightner, Theodore. MS. Russian phonology.

Notes on Complete Consonantal Assimilations

James W. Hutcheson

0. Introduction

This paper is one of a number of studies within the conceptual framework of natural phonology (Stampe 1972b), according to which phonological processes are of two kinds, context-free and context-sensitive. Studies have shown that context-free changes in simple vowels and diphthongs are to be explained by the character of the sounds themselves (Miller 1972, Stampe 1972a). Recent studies in context-sensitive processes--syncope (Zwicky 1972b), nasal assimilation (Zuckerman 1972), palatalization (Neeld 1972), and vowel nasalization (Schourup 1972a, 1972b)--have demonstrated that they are also to be explained largely by the function of the processes themselves and by the character of the sounds which are affected by them. Much of this work has been concerned with the notion of hierarchy of application. The purpose of this paper (and the larger work from which it is excerpted) is to investigate the operation of complete consonantal assimilations within the same theoretical framework as the studies mentioned above.

1. Complete assimilation: a definition

The designation complete assimilation has been used in a variety of ways. I use the term to mean that the process of assimilation results in the complete identity of the two sounds involved, i.e. $C_1C_2 \rightarrow C_1C_1$ (complete progressive assimilation), $C_1C_2 \rightarrow C_2C_2$ (complete regressive assimilation), or $C_1C_2 \rightarrow C_3C_3$ (complete coalescence). Some writers use complete assimilation to describe the assimilation of one feature, such as complete assimilation of position. For such single-feature processes I use locutions like complete or total assimilation of manner or position. The simple term complete assimilation will mean total assimilation of all features.

2. Sources of data

The data on which this paper is based come from several sources: casual speech (optional sandhi phenomena triggered by a casual speech style);¹ regular, non-optional external sandhi; internal assimilations resulting from inflectional and derivational processes; and historical developments.

3. English casual speech assimilations

In two notes C-J. Bailey (1969, 1970) has offered evidence that consonant clusters of apicals followed by nonapicals appear to be marked sequences and for this reason are unstable, showing a tendency to become unmarked. Such marked clusters can be eliminated in a variety of ways. Bailey cites unmarking by metathesis in the case of ancient Greek and by assimilation in contemporary English. It is the latter case that is of interest here, because the assimilations which do occur--and, perhaps more important, those which do not--offer important insights into the nature of complete consonantal assimilations.

Bailey (1970) cites the occurrence of the following assimilations in rapid casual speech: rihph poor, goob-bye, goob boy, leab balloon, rihk corner, bag guess.for right poor, good-bye, lead balloon, right corner, bad guess, respectively.² However, such forms as keet track (for keep track) and bat track (for back track) do not occur. These forms are sufficient for Bailey to make his point about the marked nature of the apical plus nonapical cluster. More information of theoretical interest and importance can be obtained from this tendency toward assimilation in rapid speech: note that all the forms cited by Bailey involve clusters in which the two segments share all features except the position feature apical. Thus t + p, d + b, t + k, and d + g assimilate completely to pp, bb, kk, and gg respectively. If, however, clusters of apicals plus nonapicals which are not identical in all other respects are considered, no such complete assimilation occurs. Thus, right bill, bad police, right goal, and bad kid become rihph bill, bab police, rihk goal and bag kid. These facts have been noted by Gimson (1960, 1972).

An apical sibilant will assimilate to the position of a following palatal but not to labials or velars (Bailey and Gimson). It is important to note that any change in the position of the sibilants beyond the change of apical to palatal would require changing more than just the position of articulation; the distinctive sibilance could not be maintained.

The assimilation of an apical n to the position of a following nonapical segment is an instance of a much more pervasive tendency of a nasal to assimilate to the position of a following segment. Moreover, of all nasals, the apical nasal n is the most unstable with respect to position, a fact which seems to support Bailey's claim about markedness.³

The apical lateral does not assimilate at all in casual speech. This is not surprising in view of the examples cited above. The assimilatory process under discussion is one which affects the feature makeup of a segment only minimally. In order for a lateral to change position (other than by a light-dark alternation), it must undergo a change not only in position, but in manner features as well.

These observations about one kind of putative complete assimilation are offered as supporting evidence for a more general principle which claims that complete assimilations normally occur only when the segments

involved are already very similar (indeed the casual speech assimilation I have been discussing is really a total assimilation of position affecting apical segments and is an example of a complete assimilation in the more general sense only accidentally in the small set of instances where the segments involved are already nearly identical). Support for this principle can be found in a number of other languages.

4. Sandhi phenomena in Arabic and Yakut

These two unrelated languages show assimilatory phenomena that lend support to the claims made in the preceding paragraph and also offer a further insight into the operation of phonological processes. The dialects of Arabic spoken in Syria (Cowell 1964), Morocco (Harrell 1972), Iraq (Erwin 1963) and the Saʿi:di dialect of Egypt (Khalafalla 1969) show complete assimilation of the l of the definite article ʾil- when that article is prefixed to a noun which has an initial dental, alveolar, or palatal consonant. Elsewhere the l remains unassimilated. For example, from Iraqi (Erwin, 214-5):⁴

a. Unassimilated

ʾakil	'food'	l-ʾakil	'the food'
beet	'house'	l-beet	'the house'
fikra	'idea'	l-fikra	'the idea'
qisim	'part'	l-qisim	'the part'
kaatib	'clerk'	l-kaatib	'the clerk'

(Similarly words with initial ʁ, ʕ, ʙ, ʔ, m, h, w, y, p, ʒ.)

b. Assimilated

timman	'rice'	t-timman	'the rice'
ʒoob	'shirt'	ʒ-ʒoob	'the shirt'
junta	'suitcase'	j-junta	'the suitcase'
diinaar	'dinar'	d-dinar	'the dinar'
ʒibbaan	'flies'	ʒ-ʒibbaan	'the flies'
rukkaab	'passengers'	r-rukkaab	'the passengers'
zibid	'brother'	z-zibid	'the brother'
ʒana	'year'	ʒ-ʒana	'the year'
sahar	'month'	s-sahar	'the month'
ʒuura	'picture'	ʒ-ʒuura	'the picture'
ʒaabuʔ	'officer'	ʒ-ʒaabuʔ	'the officer'
ʔooba	'ball'	ʔ-ʔooba	'the ball'
leela	'night'	l-leele	'the night'
naar	'fire'	n-naar	'the fire'
caakuuʕ	'hammer'	c-caakuuʕ	'the hammer'

In the colloquial Arabic spoken in Cairo the assimilation extends optionally to initial k and ʒ (Mitchell, 47n; Abdoul-Petouh 1969).

The assimilations in all dialects are complete. Of particular importance, however, is the fact that in each dialect, including Cairo Arabic, the assimilations take place between similar sounds and extend in the case of Cairo Arabic hierarchically. Thus we would not expect ?il-k to assimilate to ?ik-k unless ?il-t assimilated to ?it-t also. It is of further interest that the extension of the assimilatory process to include velar stops is optional, showing the customary tendency of a process to operate optionally at first as it extends its domain.

In Yakut, a Turkic language of Siberia, nouns form plurals by a process of suffixation (Krueger 1963, 74-5). The plural suffix is -lAr (where A represents a vowel subject to regular harmonic alternations which are of no significance to the point in question). The initial segment of this plural ending remains l only when suffixed to a stem ending in a vowel, a diphthong, or l itself. When suffixed to other stems the l of the plural regularly assimilates in the following way:

- a. $l \rightarrow t/C_ _$ where C is a voiceless obstruent; there are no stem-final voiced obstruents

at	'horse'	attar	'horses'
balik	'fish'	baliktar	'fishes'
tuox	'what thing'	tuoxtar	'what things'
iskaap	'cabinet'	iskaaptar	'cabinets'
muos	'horn'	muostas	'horns'

- b. $l \rightarrow d/C_ _$ where C is r or y

ubay	'elder brother'	ubaydar	'elder brothers'
atiir	'stallion'	atiirdar	'stallions'

- c. $l \rightarrow n/C_ _$ where C is a nasal

suoryan	'blanket'	suoryannar	'blankets'
xatiq	'birch'	xatiqnar	'birches'
olom	'ford'	olomnor	'fords'

Notice that the l assimilates with respect to a single feature in each case. In no instance is the alveolar point of articulation lost. As was the case in the English examples the only complete assimilations are in those cases where the neighboring segment was already minimally different. Elsewhere the assimilation is partial.

Both the Arabic and the Yakut examples show one feature that is of further interest, in that they offer evidence that not all assimilations are determined by purely phonological conditions. In both cases the segment which is assimilated is a part of a grammatical affix. The weakness of the l which allows it to be assimilated is determined in both languages by facts having to do with grammar. This is particularly easy to see in the case of Arabic, where there are many

clusters exactly like those treated above but which do not assimilate. These facts are of course not surprising, as nonphonological conditions have been seen to constrain many sorts of phonological processes (see Zwicky 1970, 1972a).

However, once the assimilation process has been triggered by (whatever) grammatical factors, it obeys constraints that are purely phonological, e.g. the constraints involving minimal difference and the hierarchical extensions of the process. Such evidence as that just cited should serve, however, as a warning to use extreme caution when attempting to define notions of weakness and strength on purely phonological grounds, as is done, for example, by Grammont.

5. Latin assimilations in derivations

I now consider briefly the phonological behavior of the Latin prefixes ad-, con-, and ab- (Väänänen 1963, 62-8 for Vulgar Latin; Buck and Hale 1966, 24-5 for the classical language). Con- shows regular assimilation of the n to the position of a following segment. Before l and r, the n tends to assimilate completely, as in cor-rumpō, cor-ripiō, and col-ligō. However, there are a number of combinations of con + liquid, especially con + l, where the assimilation does not take place. Note that in the assimilation of con + l, r to coll and corr, the assimilation is to the manner of a more sonorous segment articulated at the same point.

The d of the prefix ad- shows a tendency to assimilate to nearly every following consonant; the tendency seems strongest when the following consonant is similar in position or manner. Thus, particularly in Vulgar Latin, examples of ad + t, r, n, l, s, k, g becoming att-, arr-, ann-, all-, ass-, akk-, and agg- are common, while the assimilation of ad-m to amm- is less regular (ad + p + app seems quite regular).⁵

The Latin prefix ab- shows no such ready assimilability. Indeed where clusters would arise that might be difficult, the prefix takes the form abs or ā.

There are many details of the assimilations (or lack of them) that await a further, much more detailed analysis of the data from Vulgar Latin and the development of the Romance dialects, especially Italian; I expect corroborative evidence for the hierarchical nature of constraints on complete assimilations.

6. Finnish consonant gradation

A well-known aspect of Finnish phonology is the alternation of weak and strong stems known as gradation, which affects syllable-initial stops in closed syllables. Of particular interest are cases where gradation involves a complete assimilation of stops with preceding nasals or liquids; assimilation is complete only when certain phonological conditions are met (see Harms 1964, Karttunen 1970).

Finnish has underlying consonant clusters of the following kind: mp, nt, nk, rp, rt, rk, lp, lt, lk. One regular (and obligatory) process in the language is the assimilation of n to the position of a following velar, giving a derived cluster ŋk. When the clusters meet

the conditions for gradation (e.g. in nouns in the genitive singular) the following assimilations result:

mp → mm
 nt → nn
 ŋk → ŋŋ (spelled ng).

lt → ll
 rt → rr

But:

lp → lv
 lk → l
 rp → rv
 rk → r

These Finnish examples strikingly illustrate the phenomenon I have been discussing. The assimilations involving nasals are complete in all features. Note that all examples of clusters with nasals involve a nasal and a homorganic stop, a fact assured by the operation of the nasal assimilation rule. When the cluster involves a liquid (r or l) plus a stop, only the homorganic clusters assimilate.

7. Conclusion

I have tried here to make the following points:

- a. Complete assimilations normally affect sounds that are already very similar.
- b. If relatively different sounds assimilate completely, so will less different sounds--that is to say, assimilations operate hierarchially.
- c. Nonphonological conditions can play a role in the triggering of assimilatory processes.

These claims, though not implausible, do not appear to have been made in the literature; it is of value to make them explicit if only as a prelude to the really important task of specifying the conditions and constraints on assimilatory processes, in particular the hierarchies of application.

Footnotes

1. For a discussion of casual and fast speech phenomena and the theoretical significance of these notions see Zwicky (1972a) and Dressler (1972).
2. I use Bailey's nonce spellings.
3. For a thorough discussion of nasal assimilations and the hierarchical nature of application of such processes see Zuckerman (1972).
4. Note that the Iraqi definite article is *l* rather than the longer form cited above, which is from the classical language.
5. I have been purposely vague about the hierarchies of these assimilations. The evidence is not clear and is often contradictory (Väänänen 1963, 63). Despite this the point concerning the differences between con- and ad- on the one hand and ab- on the other is still valid.

References

- Abdoul-Fetouh, Hilmi M. 1969. A morphological study of Egyptian Colloquial Arabic. Mouton, The Hague.
- Bailey, C-J. 1969. A possible explanation for an assimilation curiosity. Working Papers in Linguistics 5, University of Hawaii.
- _____. 1970. Toward specifying constraints on phonological metathesis. Linguistic Inquiry 1.3.348-50.
- Buck, C. D., and W. G. Hale. 1966. A Latin grammar. University of Alabama Press [reissue of 1903 ed.].
- Cowell, Mark. 1964. A reference grammar of Syrian Arabic. Georgetown University Press.
- Dressler, Wolfgang. 1972. *Allegroregeln rechtfertigen Lentoregeln: Secondäre Phoneme des Bretonischen*. Innsbrucker Beiträge zur Sprachwissenschaft, Band 9.
- Erwin, Wallace M. 1963. A short reference grammar of Iraqi Arabic. Georgetown University Press.
- Gimson, A. C. 1960. The instability of alveolar articulations. *Le Maître Phonétique* 113.7-10.
- _____. 1972. An introduction to the pronunciation of English. London, Edward Arnold.
- Grammont, Maurice. 1965. *Traité de phonétique*. Librairie Delagrave, Paris [8th ed.].
- Harms, Robert. 1964. Finnish structural sketch. Indiana University Press.
- Harrell, Richard S. 1962. A short reference grammar of Moroccan Arabic. Georgetown University Press.
- Karttunen, Frances. 1972. Problems of Finnish phonology. Ph.D. dissertation, Indiana University.
- Khalafallah, Abdelghany A. 1969. A descriptive grammar of *Sa'idi* Egyptian Colloquial Arabic. Mouton, The Hague.
- Krueger, John R. 1962. Yakut manual. Indiana University Press.

- Miller, Patricia. 1972. Some context-free processes affecting vowels. Ohio State University Working Papers in Linguistics 11.
- Mitchell, T. F. 1962. Teach yourself Colloquial Arabic. English Universities Press, London.
- Neeld, Ronald. 1973. Remarks on palatalization. This volume.
- Schourup, Lawrence. 1972a. Characteristics of vowel nasalization. This volume.
- _____. 1972b. Where binarity fails. This volume.
- Stampe, David. 1972a. The natural history of diphthongs. Papers from the Eighth Regional Meeting, Chicago Linguistic Society, 578-90.
- _____. 1972b. Dissertation on natural phonology. Ph.D. dissertation, University of Chicago.
- Väänänen, Verikko. 1963. Introduction au Latin Vulgaire. Klincksieck, Paris.
- Zuckerman, Suzanne. 1972. The migratory habits of nasals. M.A. thesis, Ohio State University.
- Zwicky, Arnold M. 1970. Auxiliary reduction in English. Linguistic Inquiry 1.3.323-36.
- _____. 1972a. On casual speech. Papers from the Eighth Regional Meeting, Chicago Linguistic Society, 607-15.
- _____. 1972b. Note on a phonological hierarchy in English. In Linguistic change and generative theory, ed. R. Stockwell and R. Macaulay, Indiana University Press, 275-301.

Glide Metatheses

Holly Semiloff-Zelasko

0. Introduction.

The purpose of this paper is to determine whether the sounds η , h, y, w function as a natural class by investigating languages that have a metathesis rule affecting these sounds. A natural class is a group of sounds that share articulatory and/or acoustic features and function similarly with respect to phonological rules. Good evidence for a natural class would come from an implicational hierarchy of sounds that undergo a certain rule. In addition there is the question of why glides are especially prone to metathesis. I will propose several hypotheses concerning the phonetic and phonological motivations for such a process.

The paper is divided into four sections. First I briefly describe the rules in the nine languages chosen for study. Section II explores the possibility of an implicational hierarchy of glides. Section III consists of some hypotheses about the motivation for metathesis, and Section IV is a list of six additional languages which, because of insufficient data, are not included in the main arguments of the paper.

1. Rules.

The following nine languages metathesize glides with consonants. They are briefly described with examples. (\rightarrow indicates a synchronic process and $>$ a diachronic one.)

(1) Yagua (Powlison 1962), a South American language. The glide is y, and it metathesizes with any consonant: $yC \rightarrow Cy$. For example, ráY '1 sg', + haá 'water' \rightarrow ráhyaá 'my water'. ráY + tááryoY 'buy' + rúúY 'desiderative' + ra 'inanimate object' \rightarrow ratyééryoryúúrya 'I want to buy it'.

(2) Zoque (Wonderly 1951) a Mexican language. There are two metathesis rules, one with y (Zoque₁) and one with η (Zoque₂). The Zoque₁ rule is:

y [-voc]

1 2 \rightarrow 2 1

conditions: (a) $2 \neq h$; (b) when an e precedes $1, 2 = \eta$.

y metathesizes with a following consonant or glide, except h; and when y is preceded by e, it metathesizes with the glottal stop only. For example, y pronominal prefix + pata 'mat' → pyata 'his mat', kuy 'seven' + maɣ suffix → kumyɣ 'a week hence', Ny prefix + wiht 'to walk' → nwyihtu 'you walked', re.y 'king' + ?aŋa suffix → re.ʔyaŋa 'to the king', but tey 'there' + ma suffix → teyma 'there'. There is some indication that the rule is becoming more general: condition (b) is generalizing such that eyt → eytʔ, as in tey + tih suffix → teytʔih 'right there'. Here y has palatalized the following t although it still precedes it.

The Zoque₂ rule is

nasal
{liquid}

1 2 → 2 1

For example, kom 'post' + ?aŋa suffix → koʔmaŋa 'to the post', lugar 'place' + ?oyh suffix → lugaʔroyh 'at the place', perol 'copper kettle' + ?is suffix → peroʔlis 'of the copper kettle'.

(3) Classical Greek (Kiparsky 1967). The glides y and h metathesize with a preceding resonant.

V resonant {^y
{h}

1 2 3 > 1 3 2

- conditions: (a) when 2 = w, 1 = any vowel;
(b) when 2 = l, r, m, n, 1 = a, o;
(c) 2 ≠ h, y

For example, *morya > moira 'lot', *phanyō > phaínō 'share', *ekrinha > *ekrihna (> ékriŋa) 'judged'.

(4) Mandaic (Malone 1971), a Semitic language. h and ʔ metathesize with a preceding consonant.

V C {^ʔ
{h}

1 2 3 → 1 3 2

condition: 3 = 3rd radical of the root.

For example, yarhá > yahrá 'month', mišhá > mišhá (> miššá) 'oil', tirʔá > tiʔrá (> tirá) 'door', but eḥám̄bal 'was spoiled' where h is the first root consonant.¹ Malone also suggests that there was a y-metathesis at an earlier stage of Mandaic. But the environment, if correct, is highly constrained, namely ǎ N y > ǎ y N. There are only a few examples, plus a number of non-metathetic forms of the same morphological structure.

(5) Akkadian (Malone 1971). Malone believes the Mandaic rule also applied in Akkadian, except that segment 3 includes the class of all glides--w, y, h, ?. According to Reiner (1966), Akkadian w, y fell together with ? at some period, and it is not known whether this historically preceded or followed operation of the metathesis rule.

(6) Hanunóo (Gleason 1955), an Austronesian language. A ? metathesizes with a following consonant: ?C → C?. In the following examples, ka- is a prefix. *?sa: kas?a 'once' but ?usa 'one', *?pat: kap?at '4 times' but ?upat 'four', *?num: kan?um '6 times' but ?unum 'six'.

(7) Tübatulabal (Voegelin 1934), an Amerindian language. h metathesizes with a following resonant in final position.

h	resonant	#			
1	2	3	→	2	1 3

The h then assimilates to the resonant if it is a liquid or a nasal. For example, pōnihwīŋ 'of the skunk': pōniwh 'the skunk', ha?ayahli 'the trout (obj.)': ha?ayall 'the trout (subj.)', tsō·hni?iŋ 'my gray fish': tsō·nŋ 'his gray fish'.

(8) Twana (Drachman 1969). There are two² glottal attraction rules, whereby ? and h are moved toward the stress. For example, dəqhas → dəhqas 'one' and w?d-wədaW → wd?-wədaW 'horns'. There is also an optional y-metathesis:

y	[C]		
		-voi			
1	2	→	2	1	

as in ys?-yəsad ~ šy?-yəsad 'feet'.

(9) Hungarian (Hall 1944, Harms 1968). There is an h-metathesis, such that

resonant	h	{	#	}	
		C			
1	2	3	→	2	1 3

h cannot appear in syllable-final position. For example, *terh + -ek 'plural' → terhek 'burdens', but tehər 'burden' (with epenthetic ə), *kel'h + -et 'accusative' → kel'het 'cup (acc.)', but *kel'h + -ben 'in' → kehl'ben 'in the cup', *kejh + -ek → kejhək 'chalices', but kehəj 'chalice'.

2. The Hierarchy.

It has been assumed here and argued by others (Chomsky and Halle 1968, Zwicky 1969, 1972, and elsewhere) that the glottals (or laryngeals) $ʔ$ and h should be treated as glides, and that they form a natural class with the semivowels w and y . There is both phonological and phonetic evidence to support this classification, for instance the facts that nasalization spreads through both glottals and semivowels and that neither group has a vocal tract constriction that impedes spontaneous voicing (glottals have no tract constriction at all).

The next question to ask is whether these segments function as a natural class in metathesis specifically. There are two possibilities for an implicational hierarchy in each group:

$$(1) \begin{array}{c} ʔ \\ h \end{array} \uparrow \quad (2) \begin{array}{c} h \\ ʔ \end{array} \uparrow \quad (3) \begin{array}{c} y \\ w \end{array} \uparrow \quad (4) \begin{array}{c} w \\ y \end{array} \uparrow$$

What the notation in (1) means is that if the language metathesizes h and if $ʔ$ occurs in the same environment, the language will metathesize $ʔ$ too, but not the reverse. Likewise for (2)-(4). Obviously (1) and (2) cannot both be true, nor can both (3) and (4). In fact, (1) and (3) are correct. Of the six languages that metathesize h , either (a) the language does not have phonemic $ʔ$ (Hungarian, Greek), (b) $ʔ$ does not occur in the right environment for the metathesis (Tübatulabal), or (c) the language does metathesize both $ʔ$ and h (Twana, Mandaic, Akkadian). (2) cannot be correct because Hanunóo and Zoque₂ metathesize only $ʔ$. Regarding hierarchy (3), the only language that metathesizes w is Akkadian, and it also affects y . But Greek, Yagua, and Zoque₁ all metathesize only y . Thus (4) cannot be correct.

Having established (1) and (3) as implicational hierarchies, we would like to determine if there is one hierarchy for all the glides. The possibilities are:

$$(5) \begin{array}{c} ʔ \\ h \\ y \\ w \end{array} \uparrow \quad (6) \begin{array}{c} y \\ w \\ ʔ \\ h \end{array} \uparrow$$

Taking (6) first, which I will show is not correct, it would have to be shown that every language that metathesizes $ʔ$ (or $ʔ$ and h) also metathesizes w and y , if they occur in the right environment. This condition does not hold in Tübatulabal, Twana, Mandaic, or Greek. On the other hand, to show that (5) is true, it would have to be shown that any language that metathesizes y (or w and y) also metathesizes h and $ʔ$, if they occur in the right environment. There are four languages that metathesize y (not counting the optional rule in Twana or the presumed y -metathesis in Mandaic, neither of which are counterexamples). The languages are Greek, Yagua, Akkadian, and Zoque₁. Hierarchy (5) holds for Greek, which takes h (and doesn't have $ʔ$); Akkadian, which takes all the glides; and Yagua,

where h doesn't occur in the right environment and ? doesn't occur at all. Zoque₁ is the one counterexample. Both ? and h occur in the same environment as y, but neither undergoes the metathesis rule.

Recall that Zoque has two rules:

$$(1) \quad y \quad C \qquad (2) \quad \begin{matrix} \{N\} \\ \{L\} \end{matrix} \quad ?$$

$$1 \quad 2 \rightarrow 2 \quad 1 \qquad 1 \quad 2 \rightarrow 2 \quad 1$$

If rule (1) were generalized to metathesize the class of all glides with any consonant, then ? (a glide) would metathesize with liquids and nasals (members of the class of all consonants); the effect would be to undo rule (2). That is, part of one rule would be the exact reverse of the other rule, and the effect of rule (2) would never be visible on the surface. For a language to admit such a pair of processes would be extraordinary. I claim that Zoque is an explicable counterexample to hierarchy (5); to avoid mirror-image processes the Zoque₁ rule is constrained to take y alone, instead of y, h, and ?.

In general then, I conclude (tentatively, because of the paucity of the data) that the class of glides, ?, h, w, y, does function as a natural class in metathesis.

3. Motivations.

In searching for a phonetic motivation for glide metathesis, at least two factors have to be taken into account--the language-specific phonological constraints on where glides can occur in syllables and clusters, and the class of segments with which the glides metathesize. The following is a list of the surface phonological constraints on the occurrence of glides in some of the languages in the preceding section.

<u>Language</u>	<u>Surface Constraint</u>
1. Yagua	yC is prohibited.
2. Zoque ₁	yC is prohibited (with some conditions).
3. Zoque ₂	? cannot occur as the last member of a cluster; must be preceded by a vowel.
4. Hanunóo	? cannot occur as the first member of a cluster; must be followed by a vowel.
5. Tübatulabal	h can be syllable onset or offset only.
6. Hungarian	h occurs only as a syllable onset.

Not included are Greek, Mandaic, Akkadian, and Twana, whose metathesis rules do not reflect a specific constraint on the occurrence of certain glides.

Simply to list the surface constraints against certain clusters and syllable structures does not explain why a language 'chooses' metathesis as a way of resolving the disfavored sequence. One thing we must look at is the class of segments with which the glides metathesize. In no language in this sample does a glide metathesize with only one member of a class, e.g., no language exchanges h with r but not with l, or switches y with k but not with all stops. In fact, environments for glide metathesis fall into two sets: the class of all consonants and the class of all resonants.

In searching for a phonetic basis for metathesis, the first thing to look at is directionality. The following list shows the direction in which the glide moves in each rule.

Yagua	→
Zoque ₁	→
Zoque ₂	←
Greek	←
Mandaic	←
Akkadian	←
Hanunóo	→
Tibatulabal	→
Twana	↔
Hungarian	←

There seems to be no preferred direction; in fact the sample is split practically in half. But if we look more closely at the type of glide that moves and the environment in each language, some generalizations appear.

Yagua and Zoque₁ are the only languages that metathesize y from left to right and with any consonant. (Greek and Akkadian take y to the left over resonants and consonants, respectively.) It is also true that Yagua and Zoque have extensive palatalization. The claim I would like to make is that in both languages, the metathesis rule is really a subpart of a general tendency in the language to palatalize consonants. This hypothesis would further explain the fact that the Zoque₁ rule is the only counterexample to hierarchy (3) in the preceding section. If the rule that moves y to the right of a consonant is really a reflection of Zoque's tendency towards palatalized consonants, then we would hardly expect h, ? to undergo the same rule, since they have no place in the palatalization process.

Discounting Twana, whose rules go in both directions, there are five languages that metathesize glides from right to left: Zoque₂, Greek, Mandaic, Akkadian, and Hungarian. As a possible phonetic motivation for this similarity, I suggest that metathesis serves 'glide attraction' toward the vowel nucleus. By this I mean that glides tend to act as offglides to the vowel nucleus instead of onsets to the following syllable; I am claiming that the preferred syllable position for glides as a class is immediately following the

vowel, other things being equal. Leftward glide metathesis then accords with what David Stampe (personal communication) calls the 'hierarchy of relative sonority', whereby the vowel, being the most sonorous element, constitutes the syllable peak, while toward the margins the order is glide, liquid, nasal, obstruent.

On this basis, the sequences (a) VCGV and (b) VGCV both satisfy the hierarchy if the syllable boundary in (a) follows C, and may follow either G or C in (b). But in fact the hierarchy is somewhat restricted due to the tendency for all syllables to start with a consonant (that is, an obstruent, nasal, or liquid). Thus, I am claiming that (a) will reorder C and G so that the second syllable will start with a consonant, and that the syllable boundary in (b) will follow G. Glide attraction then, is a universal phonological process which is realized (for some languages) as a leftward metathesis.³

It should be kept in mind that both of my functional explanations--metathesis serving palatalization and metathesis yielding a preferred syllable shape--are based on the quite small number of languages with glide metathesis and do require much further investigation.

Three of these five languages (Hungarian, Greek, and Zoque₂) limit the environment to resonants. This is significant because the resonants as a class are prone to a number of phonetic changes which indicate that they are more 'weakly' articulated than obstruents. For example, liquids and nasals become syllabic, nasalization spreads through them, liquids metathesize with vowels, and they frequently dissimilate. So it is not surprising that they are also subject to glide metathesis.

Treating glide metathesis as reflecting two processes--palatalization for the forward movement of y, and glide attraction for the backward movement of glides in general--leaves three languages in this study unaccounted for: Twana, Hanunóo and Tübatulabal. Recall that Twana moves ? and h over one or two segments toward the stress, Hanunóo moves ? to the right of any consonant, and Tübatulabal moves h to the right of a resonant in word-final position. Notice that in the last two languages the input to the metathesis rule is exactly the ideal syllable structure that I have argued is the output of backward (left) metathesis. In Hanunóo and Tübatulabal the output is (a) instead of (b).

(a) C {_R^C} G

(b) V G {_R^C}

We might view these exceptions as indicating the relative 'strength' of phonological processes. In Twana, for example, we might say that the attraction of glottals toward the stressed segment of the stem is a stronger rule than the universal tendency to put glides to the right of vowels.

In Hanunóo on the surface a ' must be followed by a vowel. But in order to account for certain morphophonemic alternations (see examples in Section 1), an abstract underlying form with the sequence ?C must be postulated. To account for alternations like ?usa 'one' and kas?a 'once', I claim that there are two metathesis processes here,

which serve two requirements of the language: no syllable starts with a vowel, and ? must be followed by a vowel. Regarding the first, Conklin (1953) says that all borrowed words of the form #VC- become #?VC- in Hanunóo. The following treatment has been suggested by Drachman (personal communication): for the above words, the underlying form is *?sa, the u is an infix in ?usa, and when ka- is prefixed, the cluster ?s metathesizes. But I would suggest that u is a prefix, just like ka-, and because 'one' would then begin with a vowel (*u?sa) the sequence u? is metathesized to ?u. Thus, the metathesis goes in either direction, depending on which constraint is being violated. It goes to the left to prevent the syllable from beginning with a vowel, and to the right to ensure that a vowel follows ?. The point of this argumentation is to illustrate that a natural state of affairs, like a favored syllable structure, can be overruled by a surface phonological constraint, which therefore must be said to have greater strength.

The third exception is Tübatulabal, where final hR becomes Rh. The constraint is that h can be either a syllable onset or offset, but never the first member of a cluster that closes a syllable (which will always be word-final position). If h precedes an obstruent, it becomes x, but before a resonant, the metathesis rule applies. Again, the surface constraint is stronger than the process making glides into vowel offsets.

Before we take the explanations for these three languages entirely seriously, two questions must be raised. (1) Does the notion 'relative strength' of a phonological process actually reflect a reason why it, rather than some other process, applies? (2) Do surface constraints express phonological conspiracies that ensure an appropriate phonetic output, or are they simply statements of what appears on the surface? Based on the limited data in this study, I have no elucidating answer to either question. Independent evidence is needed to show that in (1) 'relative strength' is a reality, and in (2) the constraints that prevent the universally favored syllables from occurring reflect some other universal tendency, or at least that there are other manifestations of a conspiracy in the language.

In summary, glide metathesis, as a phonological process, serves one of several purposes in natural language. (1) It reorders consonants and glides such that glides are vowel offsets. I consider this output the natural state of affairs in universal syllable structure. (2) It is one of the ways in which languages with extensive palatalization realize palatalized consonants. (3) It is a means of preventing certain concatenations of elements on the surface, that is, inadmissible clusters for that language. We would expect then, that in the absence of requirements like (2) or (3), (1) would apply. Needless to say, a larger sample of languages that evidence glide metathesis is necessary to test these hypotheses.

4. Additional languages.

This section contains a brief annotated list of six additional languages that employ a glide metathesis rule. In these cases I was

unable to obtain enough information concerning the frequency of and constraints on the rules to include them in my main arguments. They are mentioned here as starting points for future research and testing of the hypotheses discussed in Sections 2 and 3.

- (1) Aymara Quechua (Mary Haas, class notes).

$$\left\{ \begin{array}{c} l \\ n \end{array} \right\} w$$

$$1 \quad 2 \quad + \quad 2 \quad 1$$

Supposedly *w* does not metathesize with any other consonants, making Aymara a potential counterexample to the semivowel hierarchy--if *y* occurs in the proper environments. The rule is also optional. čalʷwa ~ čawlʷa 'fish', k'anwa ~ k'awna 'egg', č'ilwi ~ č'iwli 'chick'.

(2) Southern Estonian (Kiparsky 1967, 623n). *Rh* > *hR*. I have three examples borrowed from Finnish. Fin. jáuhan > Est. jahvan 'I grind', Fin. káruhu > Est. kahr 'bear', Fin. vánha > Est. vahn 'old'. The leftward movement over a resonant supports the glide attraction hypothesis in Section 3, but I don't know what the constraints are on the occurrence of h.

(3) Harari (Leslau 1963, 9). *hr* + *rh* and *fh* + *hf*. Metathesis is said to be very frequent in Harari, but I am unable to determine if it is systematic. agábäri gēhri + agábäri gērhi 'shepherd', fuddi fōhri + fuddi fōrhi 'worms of small children', buhfān + buhfān 'bladder'.

(4) Kota (Emeneau 1967, 400-2). *VC* + *y* + *VyC*. *y* is the past tense marker for one class of verbs. This rule applies in over thirty words, but for every form where it applies, there are structurally identical forms where it does not. kūp + *y* + kūyp 'blow with breath', āk + *y* + āyk 'construct', ūt + *y* + ūyt 'fix into ground by pressure', taļ + *y* + tayļ 'push', but āt + *y* + āty 'climb', toļ + *y* + toļy 'disparage the good qualities of'.

(5) Pāli, New Persian (Gray 1899, 241). *Ry* > *yR*. There are only a few examples, and I am unable to determine if the rule is systematic. If it is, it does follow the glide attraction hypothesis in Section 3. Pāli -ariya > -ayira, Skt. āccarya > Pāli *acchayra- 'miraculous', New P. any > ain, Avestan airyaman > New P. īrmān 'quest'.

- (6) Old Spanish (Menéndez Pidal 1958, 48, 147, 185).

$$c \left\{ \begin{array}{c} v \\ w \end{array} \right\}$$

$$1 \quad 2 \quad + \quad 2 \quad 1$$

It is not at all clear whether semivowels are distinguished from vowels. The same rule is said to be needed for a synchronic study of Spanish morphology (Foley 1965). Vidua > viuda 'widow', caldariu > caldairo, sapiat > saipa, basiu > baiso. This rule may also be evidence for the glide attraction hypothesis.

Footnotes

1. According to Macuch (1965) Mandaic lost all ?s very early and they do not figure in the metathesis rule. This does not matter significantly, as I will explain in Section 3.
2. Ordering prevents them from being combined.
3. In Mandaic, Greek, and Akkadian, glide attraction is an intermediate process: VGC > VC or VCC. (See Malone, 409, 412n and Kiparsky, 620 for details of this development.) Macuch (1965, 84f.) has another explanation for the h-metathesis in Mandaic, namely to preserve the h from being lost as all the other pharyngeals and ? were. But h was optionally lost anyway, and I view the metathesis as a sort of 'h-retraction', the first step towards the subsequent loss.

References

- Chomsky, N., and M. Halle. 1968. Sound pattern of English. Harper and Row, New York.
- Conklin, H. 1953. Hanunóo-English Vocabulary. U. of California Publications in Linguistics 9.
- Drachman, G. 1969. Twana Phonology. Ph.D. dissertation, University of Chicago.
- Emeneau, M. B. 1967. The South Dravidian languages. JAOS 87.365-412.
- Foley, J. 1965. Spanish Morphology. Ph.D. dissertation, M.I.T.
- Gleason, H. 1955. Workbook in descriptive linguistics. Holt, Rinehart and Winston, New York.
- Gray, L. 1899. Certain developments in Pāli and New Persian phonology. JAOS 20.229-43.
- Hall, R. 1944. Hungarian grammar. Language Monograph No. 21.
- Harms, R. 1968. Introduction to phonological theory. Prentice-Hall, New Jersey.
- Kiparsky, P. 1967. Sonorant clusters in Greek. Lg. 43.619-35.
- Leslau, W. 1963. Etymological dictionary of Harari. U. of California Publications in Near Eastern Studies 1.
- Macuch, R. 1965. Handbook of Classical and Modern Mandaic. Walter de Gruyter, Berlin.
- Malone, J. 1971. Systematic metathesis in Mandaic. Lg. 47.394-415.
- Menéndez, Pidal, R. 1958. Manual de gramática histórica Española. Espasa-calpe, Madrid.
- Powlison, P. 1962. Palatalization portmanteaus in Yagua (Peba-Yaguan). Word 18.280-99.
- Reiner, E. 1966. A Linguistic Analysis of Akkadian. Mouton, The Hague.

- Voegelin, C. 1934. Tübatulabal grammar. Univ. of California
Publication in American Archaeology and Ethnology 34.
- Wonderly, W. 1951. Zoque II: Phonemes and morphophonemes. IJAL
17.105-23.
- Zwicky, A. 1970. Auxiliary reduction in English. Linguistic
Inquiry 1.323-36.
- _____. 1972. Note on a phonological hierarchy in English.
Linguistic change and generative theory, ed. R. Stockwell
and R. Macaulay. Indiana University Press.

Metathesis of Obstruent Clusters

Clare M. Silva

Obstruent metathesis is an infrequently observed metathetical process, and it is accounted for less frequently than it is observed. In this paper I will summarize the few descriptions of obstruent metathesis which have come to my attention, give examples illustrating the process, discuss experimental work on the perception of the clusters, and conclude with observations of my own regarding the process.

The concern of this paper is limited to metathesis of contiguous sibilants and stops.

1. Accountings of the process

1.1. There are three publications which deal at length with obstruent metathesis. Malone (1971) presents eleven cases of morphophonemic metathesis of $tS > St$ (where S is $s, ʃ, ʂ, ʐ,$ or z) in the history of Mandaic. He notes that the metathetical process occurs twice, on the two occasions when t and S are pushed together by other processes. The first time is when the reflexive prefix $t-$ is adjoined to $S-$ initial stems, and the second time is when stress shift and syncope have brought the $t-$ prefix and a second radical S together. Malone's article suggests that the phonological structure of a particular language will determine whether or not a particular metathesis will apply in it. He shows that the cluster tS was generally disfavored in the Semitic languages.

1.2. Grammont (1965) includes obstruent reordering in a category he refers to as interversion. He suggests that the stop-sibilant reordering is that of changing from a difficult to 'comfortable' order in terms of ease of articulation. Grammont cites fifty-five examples of obstruent metathesis, taken from fourteen languages. All of the sets of examples except two (comprising five examples) illustrate a change from stop-sibilant to sibilant-stop. No distinction is made regarding ease of articulation for initial, medial, or final position, except when it is noted that one of the languages (Old English) with a sibilant-stop metathesis has a different syllable division from the other languages considered.

1.3. Ultan (1971) observes that there is a general preference for sibilant-stop clusters over their stop-sibilant counterparts. He brings nine examples of stop-sibilant metathesis and five of sibilant-stop. He found no examples of clusters of sibilant plus dental or alveolar stop which reordered, and offered the following

statement as a tentative universal:

clusters with the order dental (or alveolar) stop + sibilant (i.e. spirant) may metathesize but those with the inverse order do not. The more interesting generalization to the effect that dental + sibilant implies the presence of sibilant + dental may prove to be valid for phonological (as opposed to phonetic) clusters if dental, alveolar and palatal affricates are viewed as unit phonemes. (15)

Ulan concludes that metathesis is (1) a segment-or feature-preserving process, (2) subject to the interference of more dominant processes (i.e., reduction, assimilation, dissimilation, and epenthesis or anaptyxis), (3) more likely to affect a relatively sonorant segment than a less sonorant one. He finds the causes of metathesis to be as follows:

- (1) The threatened or imminent reduction of a segment or feature (by apocope, syncope, or apheresis) due to accentual shift or other ultimate causes.
- (2) The actual reduction of a segment or feature, also due to accentual shift, grammatical process..., lenition ...or other causes.
- (3) A change from a mixed to a predominantly open syllable canon produced by several processes, one of which is metathesis. The ultimate cause of such a change would seem to stem from unusually weak articulation of syllable-final consonants.
- (4) The necessity for maintaining a specific syllable or word quantity.
- (5) Phonological constraints of a morphophonemic nature violated by accidents of morphological juxtaposition, introduction of noncanonical sequences in loan words, etc.
- (6) Analogical processes reflecting existing models of dissimilation, palatalization, glottalization, diphthongization, favored sequences, and the like.
- (7) Attraction and repulsion of phonetically similar and dissimilar, respectively, segments or features.
- (8) Anticipation of disfavored sequences. (36-7)

1.4. In addition to the three works referred to above, there are two recent publications which attempt to account for obstruent metathesis in terms of articulation. Bailey (1970) suggests that the preference for an st cluster over a ts may be due to physiological reasons. He presents a case for the consideration of nonapicals plus apicals and dorsals plus nondorsals as unmarked clusters, and proposes that 'In line with the tendency of languages to move from marked to unmarked situations, we can legitimately explain metatheses which place the apical or the nondorsal last on the basis of universal linguistics facts' (349).

1.5. Hjelmslev (1970) claims that metathesis 'always takes place in such a way that elements not appearing in the order of expiration are transposed so that they do. (Order of expiration is the order of movements of speech organs from the interior to the exterior--from throat to lips.)' (50). Since there are cases of ks > sk, this is not true.

2. The data

The following examples have been culled from grammars and dictionaries; in most cases other examples can be found on the pages cited. The collection is intended to be a sampling of the types of obstruent metatheses this paper is concerned with, rather than an exhaustive presentation.

2.1. ps > sp

2.1.1. Cl. Greek ψάλιον > Attic σπάλιον 'part of the bridle'

Dialectal variant. Liddell and Scott (1894, 1751).

Note: Grammont says that this is a diachronic process, from Old Attic to Vulgar Attic (240). Buck (1955, 74), however, suggests that the sp- variant may be of a colloquial and transitory nature.

2.1.2. Old Irish *acsnam (ad-cosnam) > asnam verbal noun 'strives after'

Diachronic development. Thurneysen (1966, 113).

2.1.3. Old English cops > cosp 'fetter, bond'

Possibly a dialectal variant. Wright (1925, 161).

2.2. ts > st

2.2.1. pre-Hebrew *hitsabbila > Heb. histabbél 'he dragged himself'

Diachronic development. Malone (1970, 397).

- 2.2.2. pre-Mandaic *ʔeθār > Mand. esθār 'he was bound'
 Diachronic development. Malone (1970, 405).
- 2.2.3. English kitchen > Irish cistin 'kitchen'
 Borrowed form. Meyer (1906, 376; also 134 and 169).
- 2.2.4. Finnish peitseä ~ peistä 'spear'
 Forms in free variation. Tauli (1966, 211).
- 2.3. st > ts
- 2.3.1. Luiseño wa-ni[-tal ~ wa-ni-t|al 'river (loc.)'
 Forms in free variation. Malécot (1963a, 93).
 Note: See also Malécot (1963b, 203).
- 2.4. ks > sk
- 2.4.1. Slavic *xvoja > Lit. skujà, Lett. skuja 'pine needle'
 Diachronic development. Stang (1966, 95).
- 2.4.2. Uralic *kč > kš ~ šk in Erza Mordvin mokšana, Mokša mokšonda,
 Cheremis moskōndō, muskōndō 'fist'
 Diachronic development. Collinder (1960, 90).
- 2.4.3. Old English dox > Middle English dosc, dusk 'dusk'
 Diachronic development. American Heritage Dictionary.
- 2.4.4. French luxé > Colloquial French lusgue 'luxury'
 Dialectal variant. Guiraud (1969, 103).
- 2.4.5. Skt. pakṣa > Māgādhī paśka 'wing, side'
 Diachronic development. Pischel (1965, 226)
- 2.5. sk > ks
- 2.5.1. Old English asce > late West Saxon axe 'ashes'
 Diachronic development. Wright (1925, 165).
- 2.5.2. Uralic šk (as in Lappish boaske 'the small of the leg') >
 (?) Mordvin pukso 'the thick flesh; thigh, buttock'

Diachronic development. Collinder (1960, 105).
 Note: Collinder refers to *sk > ks in Ostyak, Southern Samoyed, and perhaps in Mordvin, but gives examples only of the questionable Mordvin cases. He also notes (101) PU *sk > ks in Ob-Ugric, but again there are no examples.

2.6. I have not found any examples of sp to ps, and only the Luiseño examples for st to ts. Sk to ks, however, is found at least in English and some of the Uralic languages. Ultan cites a morphophonemic process in Lithuanian (15), where there appears to be a metathesis of IE *-sko to Lit. ks. I have not used this Lithuanian case, since there is the possibility that an epenthetic k before medial sC clusters could be involved. (See Stang, 108-13, regarding this epenthesis.)

3. Perception of consonant clusters

3.1. The psycholinguist observes that consonant clusters are perceived somewhat differently from a CV sequence. The experiments carried out by Bond (1971) for perception of the clusters ps, sp, ts, st, ks, and sk showed that (1) the most common error of perception is the reversal of the cluster, and (2) the stop-fricative cluster is perceived correctly more often than the corresponding fricative-stop cluster.

The clusters were tested for correct identification in a series of three tests, with differing levels of signal degradation. Since the testing was carried out in English, all of the clusters were syllable-final or across syllable boundaries. In the series of tests with the greatest signal degradation, the clusters involving bilabial and velar stops show approximately the same amount of confusion, no matter in which order the cluster is given; sp was correctly perceived 29.9% of the time, ps 36.4%, sk 37.3%, and ks 38.4% of the time. For the st/ts clusters, however, the difference was greater. St was heard correctly 32.2% of the time, and ts 57.2% of the time.

3.2. Bond observes that the greater degree of accuracy in identifying stop-fricative clusters may be due to the higher frequency of stop-fricative clusters in English. An examination of the distribution of word-final clusters (excluding inflectional endings) in Wood's Complete Rhyming Dictionary shows the following frequencies of occurrence.

<u>cluster</u>	<u>no. of forms</u>	<u>cluster</u>	<u>no. of forms</u>
sp	12	ps	10
st	102	ts	26
sk	33	ks	35

There is a marked difference between the frequencies of occurrence

for the st and ts syllable-final clusters. It should be noted, furthermore, that the ts clusters accounted for in this data are subject to dialect variation, i.e., false, waltz, quartz, prince, once, bounce, science, etc., are pronounced with a final s and no preceding stop by many speakers.

The frequency distribution of st and ts clusters would be considerably different, with a preponderance of ts clusters, if the frequency of inflected forms ending with ts was taken into account. This would be in accord with Bond's observation regarding the possible cause for greater perception of ts clusters. If inflected forms were considered, however, then ps and ks should show considerably more frequent distribution than sp and sk. It is not the case, however, that bilabial and velar stop-sibilant clusters are more readily perceived than their sibilant counterparts, so it does not appear likely that a greater degree of accuracy in identifying stop-sibilant clusters can be attributed to a higher frequency of these clusters.

3.3. Bond finds her data compatible with a theory proposed by Wickelgren (1969a and 1969b), which suggests that a consonant cluster is coded in terms of an element resembling an allophone of an unordered cluster. The explanation of this kind of coding is as follows:

When a listener is presented with a consonant cluster, e.g. sk, he knows that it is composed of two elements, but he does not encode these elements in order; rather, the cluster is coded as an unordered sequence, with each element identified for what precedes and follows it. Schematically, the coding would be something like the following: s^k# #^sk. These elements can be assembled in the correct order, and the listener can arrive at the intended sequence. (48)

Bond concludes that

If a consonant cluster is coded in terms of allophones, then the allophone of s before p will be slightly different acoustically, from the allophone of s after p. This difference, however, will be the most subtle part of the signal; particularly, it will be smaller than the acoustic information differentiating consonants from each other. These small acoustic differences will be the first to disappear when the signal is degraded by noise; consequently reversal errors will be the most common in a degraded signal. (75)

4. Conclusion

4.1. The examples of obstruent metathesis that have been observed indicate that the reordering of a stop-sibilant cluster occurs in

a greater number of languages and with more frequency than the reordering of a sibilant-stop cluster. The languages that are observed to have the sibilant-stop reordering are English, Ostyak, Southern Samoyed, Vogul, Mordvin (perhaps), Luiseño, and possibly Lithuanian.

4.2. The evidence for the English speaker's greater readiness to identify the stop-sibilant cluster *ts*, and the similarity of the *ts* cluster to the voiceless palatal affricate *č*, prompted an inquiry into the phonological inventories of the metathesizing languages. It would seem natural for speakers of a language with a *č* to have access to a sibilant-stop reordering, since they should find the stop-sibilant order phonetically and phonologically admissible. And it is the case that all of the languages which have so far been shown to have a metathesis of sibilant-stop clusters do have *č*, except for one of the Ob-Ugric languages, Vogul, which has a palatalized affricate *č̣*. Whether the presence of *č* in the sound system of the language preceded or followed the sibilant stop metathesis is difficult to ascertain in the case of English, since opinions conflict as to when it came into the language. Wright says:

Some scholars assume that palatal *c* and *nc* became *tʃ* (= *ch* in NE. *chin*), *ntʃ* in Mercian, WS. and Ken. in the earliest period of the language, but this is an assumption which cannot be proved.... All that can be said for certain is that the change had already taken place by the beginning of the Middle English period. (162-3).

The Uralic affricates can be traced to both Common Uralic and Common Finno-Ugric. The Luiseño process is synchronic, and co-occurs with a *č*. Modern Lithuanian also has a *č*, which dates back at least to the earliest Lithuanian documents available, those of the 16th century; this fact is likely relevant to the appearance of *k* before *sC* clusters medially, whether this is due to metathesis or epenthesis.

For the languages in section 2 that do not show a sibilant-stop reordering, there is little or no trace of an affricate at the time of the reordering to a sibilant-stop cluster. The trace, as far as the languages considered in this paper are concerned, appears in Finnish; it has a *ts* or *s* in medial position as a remnant of **č*, and a *t* or *h* as a remnant of **č̣*.

4.3. We have evidence that the occurrence of a sibilant-stop reordering implies the presence of (or, in the case of Old English, at least the strong potential for) an alveolar or palatal affricate within the sound system of a language. The inverse of this is not true, however, since there are many languages with *č* that have no recorded sibilant-stop reordering; both Spanish and Lake Miwok, for example, have *č*, but neither exhibits a sibilant-stop reordering.

References

- Bailey, C-J. N. 1970. Towards specifying constraints on phonological metathesis. *Linguistic Inquiry* 1.347-349.
- Bond, Zinny S. 1971. Units in speech perception. Working Papers in Linguistics No. 9, Ohio State University.
- Buck, Carl Darling. 1955 (rev. ed.). *The Greek dialects*. Chicago.
- Collinder, Björn. 1960. *Comparative grammar of the Uralic languages*. Uppsala.
- Grammont, Maurice. 1965 (8th ed.). *Traité de phonétique*. Paris.
- Guiraud, Pierre. 1969. *Le français populaire*. Collection "Que Sais-je?". Paris: Presses Universitaires de France.
- Hjelmslev, Louis, 1970. (trans. Francis J. Whitfield). *Language*. The University of Wisconsin Press.
- Liddell, Henry George, and Robert Scott, comp. 1894. *A greek-English lexicon*. New York.
- Malécot, André. 1963a. Luiseño, A structural analysis I: Phonology. *IJAL* 29.2.89-95.
- Malécot, André. 1963b. Luiseño, A structural analysis II: Morphology, morphophonemics, syntax. *IJAL* 29.3.196-210.
- Malone, Joseph L. 1971. Systematic metathesis in Mandaic. *Language* 47.394-415.
- Meyer, Kuno. 1906. *Contributions to Irish lexicography*. Vol. I. London.
- Morris, William (ed.). 1969. *The American Heritage dictionary of the English language*. Boston/New York/Atlanta/Geneva, Illinois/Dallas/Palo Alto.
- Pischel, R. 1965 (2nd ed., trans. Subhadra Ihā). *Comparative grammar of the Prākṛit languages*. Delhi/Varanasi/Patna.
- Stang, Chr. S. 1966. *Vergleichende Grammatik der Baltischen Sprachen*. Oslo/Bergen/Tromsø.
- Tauli, Valter. 1966. *Structural tendencies in Uralic languages*. Indiana University Publications, Uralic and Altaic Series Vol. 17.
- Thurneysen, Rudolf. 1966 (rev. ed.). *A grammar of Old Irish*. Dublin.
- Ultan, Russell. 1971. A typological view of metathesis. Stanford University Working Papers on Language Universals No. 7.
- Wickelgren, W. A. 1969a. Context-sensitive coding, associative memory, and serial order in (speech) behavior. *Psychological Review* 76.1-15.
- Wickelgren, W. A. 1969b. Context-sensitive coding in speech recognition, articulation, and development. In *Information Processing in the Nervous System*, K. N. Leibovic, ed., New York.
- Wood, Clement (ed.). 1936. *The complete rhyming dictionary*. Garden City, New York.
- Wright, Joseph and Elizabeth Mary Wright. 1925 (3rd ed.). *Old English grammar*. Oxford University Press.

The Strategy of Generative Phonology*

Arnold M. Zwicky

1. Introduction.

The purpose of this paper is to examine some principles of argumentation and verification used by generative phonologists, so as to show areas of agreement and to highlight areas of controversy.¹ By 'generative phonology' I refer not necessarily to the analyses in The Sound Pattern of English, but rather to a wider body of practice, of which the Chomsky-Halle approach represents one rather extreme position out of a large class of possible positions.

I begin by attempting to clarify the central notion of methodological principle, which is meant to be opposed to theoretical, or substantive, principle. Briefly, substantive principles are theoretical requirements, methodological principles are theoretical biases.² For example, the sequential application of processes within derivations is a theoretical principle of generative phonology; to question this principle is clearly to advocate a new, though related, theory of phonology, in the sense that the two systems allow distinct sorts of phenomena as potential human languages. On the other hand, the greater worth of phonological variants as opposed to distributional restrictions (Principle (E) below) is a principle of good practice. To question this principle is to question its value within a given theoretical structure--but reversing the bias would not create a new theory (since all languages consistent with one theory would be consistent with the other).

I do not wish to give the impression that there is a clear or a priori distinction between the two sorts of principles. Obviously there is not. The same assumption may figure now as a substantive principle, now as a methodological one; consider in this light the assumptions that two segments that distinguish morphemes are underlyingly distinct, *ceteris paribus* (Principle (L) below) and that two segments that never distinguish morphemes are not underlyingly distinct, *ceteris paribus* (Principle (M) below). In some classic treatments of phonemics, these are theoretical principles defining the phoneme, whereas in generative phonology they are background assumptions, utilized when there is no contradictory evidence. That is, a generative phonologist is entitled to say that English t and d are distinct segments because of minimal pairs like tip and dip; in so saying he supplies the tacit assurance that he knows of no reason to suppose that the t in tip versus the d in dip ought to be predicted from considerations he hasn't mentioned.

Similarly, what most generative phonologists would take as methodological issues--the relative unacceptability of special underlying

representations for non-alternating segments, like the ? in button (Principle (T) below) and the relative unacceptability of absolute neutralization (Principle (U) below)--Paul Kiparsky (ms. 1968) has promoted to theoretical issues, by hypothesizing that no languages violate strong forms of Principles (T) and (U).

Methodological principles are cited, or appealed to implicitly, in response to the question 'Why did you choose analysis X instead of analysis Y or Z?' and as guiding procedures in analyzing a language. So, for example, Principles (L) and (M) move the analyst to survey minimal pairs and look for elements in non-contrastive distribution.

Neither the structure of the evidence nor the rationale of on-going analysis is exposed by presentations that lay out the result as a *fait accompli*, an extensive formal description with illustrative examples. Unfortunately, some of the generative phonological literature is of this sort, and some consists of exegeses of Chomsky's theoretical positions, with no regard for evidential or procedural issues. This reluctance on the part of us generative grammarians to take our colleagues into the kitchen has made many of them feel the cooking is done not with ordinary materials and by ordinary utensils but instead with soma and by divine inspiration. Fortunately, the literature now contains the reminiscences of some reputable, if not infallible, chefs. I refer to such works as Kuroda (1967) on Yawelmani, Schane (1968a) on French, Harris (1969) on Spanish, McCawley (1968) on Japanese, parts of Wurzel (1970) on German, and here and there sections of Chomsky and Halle (1968) on English. Especially valuable in this regard are the squabbles over controversial issues in the analysis of specific languages. For instance, there is the many-faceted discussion surrounding the underlying form of the English inflectional endings: Does the underlying shape of the noun plural suffix contain a vowel, or is it simply z?³ The vowel analysis was first defended by Bloomfield (1933:212), who cited 'an exact parallel in English syntax', namely the forms of the verbal auxiliary *is*, as supporting evidence; Nida (1948:sec. 3.03) gives the argument in detail. Hockett (1958:282), on the other hand, argues for a vowelless analysis, on the grounds that z is the only plural allomorph whose selection is not automatic. Both positions are represented in the generative literature--the vowel analysis is maintained by Luelsdorff (1969) and Zwicky (1970a:333f.), who give Bloomfield's argument; the association of auxiliary contraction and the noun plural alternation is attacked by Lightner (1970a) in an otherwise inconclusive article; the vowelless solution, assumed without argument in Labov (1969), is defended by Sloat and Hoard (1970), Shibatani (1971), and Delack (1971); more recently, Guile (1972:468) and Miner (1972) have adduced new evidence in favor of the vowel analysis. This sequence of articles is especially interesting, in that not only are new data from English cited in connection with the English inflectional endings, as in Sloat and Hoard, Shibatani, and Miner, but also quite a variety of other lines of argument are offered--theoretical considerations proper, as when Shibatani considers the role of surface phonetic constraints and Miner the effect of eliminating extrinsic ordering statements; cross-linguistic generalizations, as when Guile cites a putative condition on syncope and epenthesis; non-standard dialects, used by Shibatani; and patterns of acquisition, mentioned by Delack.⁴

Some additional insight into the characteristic approaches of generative phonologists can be obtained from restatements, such as the reworking of the Southern Paiute material in Sapir (1946) by Harms (1966), Rogers (1967), Chomsky and Halle (1968:345-9), Nessly (1971), Lightner (1972:340-2) and Cairns (forthcoming); the recasting of Swadesh and Voegelin (1939) by McCawley (1969) and Lightner (1970b); and the discussion of Robins (primarily 1957) on nasalization in Sundanese by Langendoen (1968:100f.), Howard (ms. 1971), and Anderson (1972).

Also valuable are sequences of argument on theoretical points illustrated by language-particular data, for instance on the representation of vowel length (Kenstowicz 1970; Pyle 1970; Fidelholtz 1971), on binary features for vowel heights (Kiparsky 1968:sec. 5; Wang 1968; Contreras 1969; Harris 1970b; Naro 1971), on the assignment of phonological features to word boundaries (Zwicky 1965; Lass 1971; Halle 1971; Lightner 1972:331-5), and on rule insertion (King ms. 1970; Watkins 1970; Dressler 1971).⁵

In the sections of the paper that follow, I try to bring out many of the methodological principles that figure in these and similar works.

2. Data.

The first principles I mention are of a rather special sort; they declare what are acceptable sources of data.

- (A) The data to be comprehended by a phonological analysis consists of
- (1) variant shapes of morphemes and
 - (2) distributional restrictions on phonological elements.

This, the orthodox list, contains the data treated by structuralist morphophonemics and phonemics taken together, and no more. However, numerous other means have been suggested for the validation of feature systems, phonological representations, and phonological processes. These are listed in (B) together with a few works in which they are cited.

- (B) Additional data can be obtained by considering
- (1) speech errors (Fromkin 1971),
 - (2) misperceptions (Bond 1971:ch. 3),
 - (3) language replacement (Dressler 1972b),
 - (4) aphasia (references in Whitaker 1971:208-14),
 - (5) borrowing (Hyman 1970a, b; Ohso 1972),
 - (6) cross-linguistic surveys of inventories (Miller 1972),
 - (7) cross-linguistic surveys of processes (Foley ms. 1970; Lightner 1970c; Schourup 1972; Stampe 1972b; and many articles in Working Papers in Linguistic Universals, Stanford University),
 - (8) linguistic games (Sherzer 1970),
 - (9) productivity of processes (Hsieh 1970; discussion in Dingwall 1971a; Skousen 1972),
 - (10) poetic requirements (Kiparsky 1968b, 1971a),

- (11) historical change (Kiparsky 1968a, 1971b; and the phonological papers in Stockwell and Macaulay 1972),
- (12) acquisition (Edwards 1970; many articles in Papers and Reports on Child Language Development, Stanford Univ.; Drachman 1971 and elsewhere),
- (13) stylistic variation (Zwicky 1972a, b; Dressler 1972a),
- (14) patterns of dialect and idiolect variation, and
- (15) statistics of variation (both treated in many studies by Labov and his students and by Bailey, e.g. Labov 1971 and Bailey to appear),
- (16) orthography (Chomsky and Halle 1968:49; Aronson 1969),
- (17) articulatory phonetics, and
- (18) acoustic phonetics (each separately or both together cited to support feature systems and formulations of processes in numerous works),
- (19) patterns of exceptions (Zwicky 1970c),
- (20) informant judgments on novel forms, and
- (21) psycholinguistic investigations of other types (for example Read 1971 and Gudschinsky, Popovich, and Popovich 1970: 86f.--two relatively unusual examples from a considerable body of material, much of it not explicitly generative),
- (22) distorted speech (Kazazis 1968, 1969).

Attitudes towards the types of data in (B) differ widely, from those who appear to believe that the types of evidence in (B) can never be used alone to justify an analysis, to those who hold that the two groups are of equal value, or even that some types of data in (B) are weightier than those in (A). Reliance on (A) alone, combined with a relatively 'abstract' stand on the nature of underlying representations and no special emphasis on regular or productive variants, or on variants as opposed to distributional restrictions, characterizes the Sound Pattern approach, whereas the phonological theory of Stampe (1972a) insists upon the psychological reality expressed by the considerations in (B).

For an illustration of the differences that can arise, consider how to analyze a language that appears to have the rule

$$s \rightarrow r / V _ V$$

The most direct approach, and the one most in accord with (A), is to say that the rule shifts s to r. A less obvious approach would claim that two rules applying in sequence give the effect of $s \rightarrow r$: roughly,

$$\begin{array}{l} s \rightarrow z / V _ V \\ z \rightarrow r / V _ V \end{array}$$

The phonologist alive to the sorts of data in (B) would consider, for example, the occurrence of rhotacism rules across languages. One reasonable hypothesis (though data are hard to come by) is that if a language has intervocalic s and z in underlying representations, and shifts s to r in this position, then it shifts z to r in this position also. Accordingly, the direct shift of s to r is not a possible

natural rule; the shift must proceed through an intermediate stage, even if that stage is not evidenced by synchronic alternations, or else the shift must be a morphologized remnant of several distinct phonological changes.

Beyond (A) and (B), other principles assign relative weights to different sorts of evidence: First, the disputed principle

(C) Data from (A) has greater value than data from (B).

then the widely accepted principles

(D) A variant has greater value according as it is

- (1) more regular, and
- (2) more productive.

(E) Evidence from variants has greater value than evidence from distributional restrictions (cf. Vennemann 1970).

Finally, the principle of 'independent evidence':

(F) Insofar as possible, the choice of a particular remote representation should be motivated by several independent lines of evidence.

Thus, Kiparsky (1971b:585), responding to Kisseberth (1969), admits that one might have to 'assume that wholly abstract segments are to be allowed when more than one rule refers to them crucially', despite the strictures of Kiparsky (ms. 1968).

3. Realism and Working Back.

I turn now to methodological principles proper, beginning with two related injunctions that distinguish generative phonology from earlier morphophonemics; these are aspects of Postal's (1968:ch. 4) Naturalness Condition:

(G) Insofar as possible, the content of segments in remote representations is phonological rather than abstract.

Thus, morphophonemes are not distinguished by diacritics but by appropriate phonetically-based distinctive features, wherever possible.

(H) Insofar as possible, phonological rules are conditioned phonologically rather than arbitrarily.

That is, phonetically-based features are preferred to lexical markings.

Next, three principles bearing directly on the choice of remote representations, beginning with a third aspect of the Naturalness Condition:

(I) Whenever possible, a remote representation for an occurrence of a surface segment is chosen from its set of variants.

That is, the analyst normally assumes that the underlying representation of a morpheme is one of its 'forms'.⁶

- (J) Otherwise, the content of segments in remote representations is assembled piece by piece, using information from variants and distributional restrictions ('homing in', as in Zwicky ms. 1972).

For example, we find the Sound Pattern (191f.) analysis of [ɔj] as underlying $\bar{\epsilon}$ defended by a series of steps in which it is argued that on the basis of English rules previously motivated, a remote representation for [ɔj] must be first a tense vowel, which next must be nonback, then also low and round.

- (K) As far as possible, each set of surface variants has a single corresponding underlying representation.

Thus, insofar as possible (excluding, e.g., suppletion), each morpheme has a unique underlying form; the listing of alternants is to be minimized.

Principles (G), (I) and (K), taken together, require the analyst to assume that phonological representation is identical to phonetic representation, unless he has evidence to the contrary. Consequently, analysis proceeds by 'working back from the surface'. At each stage it is argued that some representations are underlain by different representations (for which I have been using Postal's felicitous term 'remote representations', so as to make no claims about when the most remote, or underlying, representations are reached). The make-up of remote representations is guided by two further rules of thumb,

- (L) *Ceteris paribus*, two segments that distinguish morphemes are underlyingly distinct.
- (M) *Ceteris paribus*, two segments that never distinguish morphemes are not underlyingly distinct.

At each stage in the process of working, or arguing, back from the surface, rules are formulated as notations of the processes relating more remote representations to less remote ones. These rules and remote representations themselves are subject to various conditions that have been proposed in the literature, among them:

- (N) Of the available alternatives, choose the remote representation with the most complex or least determined context, so as to obtain the simplest rules deriving the surface form.
- (O) Choose a representation from which the surface forms can be derived by rules that are natural, in the sense that they recur in many languages and have a phonetic basis.
- (P) Choose the least marked representation available (Schane 1968b, opposed by Malone 1970 and Vennemann ms. 1971a).

- (Q) Choose the representation that results in the longest derivations (take a 'free ride', in the sense of Zwicky 1970b).
- (R) Choose representations and rules so as to minimize extrinsic ordering statements (Anderson 1969; Kisseberth ms. 1972; Norman 1972).
- (S) Choose underlying systems that are unmarked, in the sense that they recur in many languages and are symmetrical (Chomsky and Halle 1968:ch. 9).

Of these principles, only (N) is regularly used without comment. Principle (O) is widely applied, but presents difficulties when the most natural analysis (in the sense of this principle) is not the simplest one, or when facts make the most natural analysis unlikely (Davison 1971). The remaining principles are all controversial. Probably, none of them is a good guide to analytic or verificatory practice. Certainly they are contradictory as a set and contradictory to other principles,⁷ so that at the very least different principles must be assigned different weights; some must undoubtedly be discarded.

Further constraints on the choice of remote representations have been advocated by Kiparsky (ms. 1968; 1971b). Expressed in terms of methodological principles, Kiparsky's constraint on abstract analyses splits into two conditions, the first a special case of (I):

- (T) Other things being equal, an occurrence of a segment not involved in alternations should be represented underlyingly in its surface form.
- (U) Wherever possible, avoid rules that neutralize completely some underlying distinction.

A condition that is similar in spirit to (T), but logically independent of it, is one that McCawley (1967a:79; 1967b:107) observes in the descriptions of William Dwight Whitney and Edward Sapir:

- (V) Every underlying segment should also occur as a surface segment.

Generative descriptions do not hold to this principle absolutely, but analysts customarily feel obliged to defend violations of Principle (V), and (T) as well.

Even in analyses in which the underlying segments constitute a subset of the surface segments, there is considerable room for non-patent steps. For example, underlying forms can be chosen by a sort of 'musical chairs' principle, so that surface x realizes underlying y, surface y realizes underlying z, and surface z realizes underlying x; the result violates Principle (T) and requires special justification. The Sound Pattern treatment of English vowels is very close to this paradigm. Also, intermediate steps in derivations may introduce elements that do not occur on the surface, even when the underlying inventory is impeccable; these 'false steps' (Zwicky 1972c) are constraints by a generalization of Principle (V):

(W) Every segment in a derivation should occur as a surface segment.

Again, deviations from Principle (W) are reasonably common; they do need defense, however.

If principles (T) and (U) are promoted to theoretical principles prohibiting special underlying forms for non-alternating forms and prohibiting rules of absolute neutralization, then this position in combination with a strong form of principle (I) yields a particularly 'realistic' or 'non-abstract' view of underlying representations, one not held by anyone, to my knowledge. This extreme position would be opposed to a highly 'formalistic' or 'abstract' approach, which would seek the simplest lexicon and system of rules consistent with the data to be explained, regardless of other considerations. An extreme version of the formalistic position is again one not actually advocated by anyone, although as Vennemann (ms. 1971b) points out, there is a noticeable tendency in the literature towards a 'once a systematic phoneme, always a systematic phoneme' principle:

(X) If some occurrences of a segment *x* are derived from a remote representation distinct from *x*, then all occurrences should be derived from remote representations distinct from it.

That is, the existence of one or more sources for *x* allows us to eliminate it entirely from the underlying inventory. This principle is applied several times in Sound Pattern, as when the existence of a Vowel Shift rule deriving *aj* from *i* permits even non-alternating occurrences of *aj*, as in light, to be so derived. This principle has not been defended, except insofar as it promotes simple underlying systems, and it contradicts reasonably well-established principles like (I), hence it cannot be considered established.

4. Simplicity and Significant Generalizations.

I provide here no discussion of formal simplicity and the evaluation metric, because I believe that these considerations have played virtually no role (beyond that in Principle (N)) in what generative phonologists have done in arriving at and arguing for particular analyses. Consequently, although I find Botha's recent (1971) book on methodology in generative phonology stimulating at many points, I have not built on it in this paper, because its almost exclusive concern with the evaluation metric removes it from the domain of the working phonologist.

Simplicity in its informal sense is, of course, appealed to often in the generative literature, by implicit use of principles like

(Y) Write as few rules as possible.

and in the explicit attempts to capture (in Chomsky and Halle's phrasing) 'significant linguistic generalizations', an undertaking governed by the maxim

(Z) Whenever possible, apparently disparate facts which belong together should be described by identical means.

Here we have passed well beyond methodological assumptions peculiar to linguistics, into attitudes towards scientific inquiry in general. Principle (Z), which is appropriately the last of the set, amounts to an injunction to search out the hidden unities of nature.

5. Concluding Remarks.

Methodological principles are established by success; they are valuable insofar as they lead us to choose those accounts of phonological phenomena we have independent reason to suppose are (relatively) correct. As a result, if there is a poverty of sustaining evidence for us to refer to, there is a high degree of indeterminacy in our descriptions. This indeterminacy--the existence of alternative descriptions all of which are possible theoretically--has manifested itself so often that there has been a continuing effort to go beyond linguistic facts in the narrowest sense (those in (A) above) and to pursue other evidence (the lines of inquiry in (B), for instance). Consequently, the central methodological issues depend for their solution upon a decision as to the sorts of data germane to phonological analysis.

The title of this paper echoes 'The Strategy of Phonemics', an article of Morris Halle's setting out some of the methodological principles of phonemics at a time when he was wrestling with the foundations of the theory. I have tried to do something similar for generative phonology at a time when most of its practitioners⁸ are sceptical of some of the fundamental tenets of that theory. I close with an apposite quotation from Halle's earlier work (1954:199): 'To us the major criterion for the applicability of a certain category to linguistic description is whether or not this category yields simple statements not only on the particular level for which it was introduced, but on all levels which are pertinent to descriptions of a language. It must always satisfy a multiplicity of criteria'.

Footnotes

*This version of the paper was prepared after the Phonologie-Tagung and shows my responses to some of the suggestions made to me at the conference. In particular, I have included a fair amount of bibliography. The references cited are by no means exhaustive, however, and exhibit my personal biases. In some cases I cite an item to illustrate a point even if I disagree with the approach or find the argumentation faulty; this paper is intended to be primarily descriptive rather than prescriptive.

1. My aim here is similar to that of Trubetzkoy's rules (1935), Bloch's postulates (1948), and the structuralist manuals of Pike (1947) and Nida (1949).

2. See the discussion in Zwicky (1971a). A wider discussion would include also those substantive and methodological principles that are embodied in experimental methods and design.

3. For the purposes of this discussion, the additional possibilities s and vowel plus s are excluded (though this exclusion

must be defended, as in Lightner 1970a), as is the possibility that different inflectional endings are to be analyzed in different ways (a solution advocated by Sloat and Hoard 1970). Also I take no stand on which lax vowel would occur in the suffix; there are at least four alternatives--i, e, ɪ, and ə--that are not obviously wrong.

4. Other *casus belli* include umlaut in German (Zwicky 1967; Bach and King 1970; Vennemann 1968; Wurzel 1970:Teil 2), word stress in English (Chomsky and Halle 1968:ch. 3; Ross ms. 1969; Lee 1969; Langendoen 1969; Sloat and Hoard 1972), sentence stress in English (Chomsky and Halle 1968:sec. 2.1; Bresnan 1971; Lakoff 1972; Berman and Szamosi 1972; Bresnan 1972; Bolinger 1972), Spanish plural formation (Foley 1967; Saltarelli 1970; Harris 1970a), metathesis in Greenlandic (Pyle 1970; Underhill 1971; Sadock 1972), vowel harmony in Nez Perce (Aoki 1966; Chomsky and Halle 1968:377f.; Jacobsen 1968; Kiparsky ms. 1968; Rigsby and Silverstein 1969; Zwicky 1971b), stem vowels in Finnish nouns (Harms 1964:ch. 1; McCawley 1963; Austerlitz 1967; Anttila 1967:569f.), and Grassmann's and Bartholomae's Laws in Sanskrit (Zwicky 1965:ch. 5; Kiparsky 1965; Anderson 1970; Butler ms. 1972). Indeed, it can be fairly said that each language that has received more than cursory study from generative phonologists has its own puzzle areas--nasalization in French, retroflexion of s in Sanskrit, palatalization in Russian, vowel harmony in Turkish, the glottal fricative in Welsh, the coronal consonants in Japanese, the vowel shift in English, to add a few examples to those given already. In many cases, generativists' interest in these puzzles continues earlier structuralist discussion, of course.

5. A full list of such topics would include at least: the alpha notation, the predictability of ordering relationships, cyclical application of rules, phonological conspiracies and targets, the representation of complex segments (e.g. affricates and diphthongs), strata of the vocabulary, variable rules, phonemic representation, rule repetition, syntactic constraints on phonological rules, and phonological constraints on syntactic rules.

6. A strong, or substantive, form of this principle, requiring the underlying representation to be one of its forms, is attributed by McCawley (1967a:80) to William Dwight Whitney. As is well known, structuralist phonologists expressed doubts about 'fictitious' base forms; but the need for some cases of such representations is a commonplace of generative phonology.

7. The opposition of Sound Pattern naturalness, expressed by (S), and Postalian naturalness, expressed by earlier principles, is remarked upon in Zwicky (1971b).

8. See, for example, the discussion in Lightner (1971).

Bibliography

- Anderson, Stephen. 1969. West Scandinavian vowel systems and the ordering of phonological rules. Ph.D. dissertation, M.I.T.
- _____. 1970. On Grassmann's Law in Sanskrit. *Linguistic Inquiry* 1.387-96.
- _____. 1972. On nasalization in Sundanese. *Linguistic Inquiry* 3.253-68.
- Anttila, Raimo. 1967. Review of Harms, Finnish structural sketch. *Language* 43.2.566-73.
- Aoki, Haruo. 1966. Nez Perce vowel harmony and Proto-Sahaptian vowels. *Language* 42.4.759-67.
- Aronson, Ruth. 1969. The predictability of vowel patterns in the Hebrew verb. *Glossa* 3.127-45.
- Austerlitz, Robert. 1967. The distributional identification of Finnish morphophonemes. *Language* 43.1.20-33.
- Bach, Emmon and Robert T. Harms, eds. 1968. *Universals in linguistic theory*. New York: Holt, Rinehart and Winston.
- _____, and Robert D. King. 1970. Umlaut in Modern German. *Glossa* 4.3-21.
- Bailey, Charles-James. To appear. The patterning of language variation. *Varieties of present day American English*, ed. by R. W. Bailey and J. L. Robinson.
- Berman, Arlene and Michael Szamosi. 1972. Observations on sentential stress. *Language* 48.304-25.
- Bloch, Bernard. 1948. A set of postulates for phonemic analysis. *Language* 24.3-46.
- Bloomfield, Leonard. 1933. *Language*. Chicago: Holt.
- Bolinger, Dwight. 1972. Accent is predictable (if you're a mind-reader). *Language* 48.633-44.
- Bond, Zinny S. 1971. Units in speech perception. Ph.D. dissertation, O.S.U. Published in *Working Papers in Linguistics* 9.viii-112.
- Botha, Rudolf. 1971. Methodological aspects of transformational generative phonology. The Hague: Mouton.
- Bresnan, Joan. 1971. Sentence stress and syntactic transformations. *Language* 47.257-81.
- _____. 1972. Stress and syntax: a reply. *Language* 48.326-42.
- Butler, Jonathan. ms. 1972. A murmured proposal regarding Grassmann's Law.
- Cairns, Charles. Forthcoming. Universal rules and vocalic devoicing in Southern Paiute.
- Chomsky, Noam, and Morris Halle. 1968. *The sound pattern of English*. New York: Harper & Row.
- CLS x = Papers from the xth regional meeting, Chicago Linguistic Society.
- Contreras, Heles. 1969. Simplicity, descriptive adequacy, and binary features. *Language* 45.1-8.
- Davison, Alice. 1971. A problem concerning the relative naturalness of phonological rules and phonological representation. *CLS* 7.332-9.
- Delack, John B. 1971. English morphology and linguistic universals. *Glossa* 5.202-21.
- Dingwall, William O. 1971a. Linguistics as psychology: a definition and some initial tasks. *Dingwall* 1971b:758-802.
- _____. 1971b. A survey of linguistic science. Linguistics Program, University of Maryland.

- Drachman, Gaberell. 1971. Some strategies in the acquisition of phonology. Paper presented to the Urbana Conference on Phonology.
- Dressler, Wolfgang. 1971. An alleged case of nonchronological rule insertion: flörälis. *Linguistic Inquiry* 2.597-9.
- _____. 1972a. Allegroregeln rechtfertigen Lentoregeln: Sekundäre Phoneme des Bretonischen. *Innsbrucker Beiträge zur Sprachwissenschaft*.
- _____. 1972b. On the phonology of language death. *CLS* 8.448-57.
- Edwards, Mary Louise. 1970. The acquisition of liquids. M.A. thesis, O.S.U. To appear in *Working Papers in Linguistics*.
- Fidelholtz, James L. 1971. On the indeterminacy of the representation of vowel length. *Papers in Linguistics* 4.577-94.
- Foley, James. 1967. Spanish plural formation. *Language* 43.486-93.
- _____. ms. 1970. Systematic morphophonology.
- Fromkin, Victoria A. 1971. The non-anomalous nature of anomalous utterances. *Language* 47.27-52.
- Gudschinsky, Sarah C., Harold and Frances Popovich. 1970. Native reaction and phonetic similarity in Maxakalí phonology. *Language* 46.77-88.
- Guile, Timothy. 1972. A generalization about epenthesis and syncope. *CLS* 8.463-9.
- Halle, Morris. 1954. The strategy of phonemics. *Word* 10.197-209.
- _____. 1971. Word boundaries as environments in rules. *Linguistic Inquiry* 2.540f.
- Harms, Robert T. 1964. Finnish structural sketch. *Indiana Univ. and Mouton, Bloomington and The Hague*.
- _____. 1966. Stress, voice and length in Southern Paiute. *IJAL* 32.3.288-35.
- Harris, James W. 1969. *Spanish phonology*. Cambridge, Mass.: M.I.T. Press.
- _____. 1970a. A note on Spanish plural formation. *Language* 46.4.928-30.
- _____. 1970b. Sequences of vowels in Spanish. *Linguistic Inquiry* 1.1.129-34.
- Howard, Irwin. ms. 1971. On some problems of formalization in generative phonology.
- Hsieh, Hsin-I. 1970. The psychological reality of tone sandhi in Taiwanese. *CLS* 6.489-503.
- Hyman, Larry M. 1970a. How concrete is phonology? *Language* 46.58-76.
- _____. 1970b. The role of borrowing in the justification of phonological grammars. *Studies in African linguistics* 1.1-48.
- Jacobsen, William H. 1968. On the prehistory of Nez Perce vowel harmony. *Language* 44.4.819-29.
- Kazazis, Kostas. 1968. Sunday Greek. *CLS* 4.130-140.
- _____. 1969. Distorted Modern Greek phonology for foreigners. *Glossa* 3.198-209.
- Kenstowicz, Michael J. 1970. On the notation of vowel length in Lithuanian. *Papers in Linguistics* 3.1.73-114.
- King, Robert D. ms. 1970. Can rules be added in the middle of grammar?
- Kiparsky, Paul. 1965. *Phonological change*. Ph.D. dissertation, M.I.T.

- Kiparsky, Paul. 1968a. Linguistic universals and linguistic change. *Bach and Harms* 1968:170-202.
- _____. 1968b. Metrics and morphophonemics in the Kalevala. *Studies presented to Professor Roman Jakobson by his students*, ed. by Charles Gribble, Slavica, Cambridge, Mass. 137-48.
- _____. ms. 1968. How abstract is phonology?
- _____. 1971a. 'Elsewhere' in phonology. Paper presented to Dec. LSA meeting, St. Louis, Missouri.
- _____. 1971b. Historical linguistics. *Dingwall* 1971b:576-642.
- Kisseberth, Charles W. 1969. On the abstractness of phonology: the evidence from Yawelmani. *Papers in Linguistics* 1.2.248-82.
- _____. ms. 1972. Is rule ordering necessary in phonology? To appear in *Papers in linguistics in honor of Henry and Renée Kahane*, Univ. of Illinois Press.
- Kuroda, Sige-Yuki. 1967. *Yawelmani phonology*. Cambridge, Mass.: M.I.T. Press.
- Labov, William. 1969. Contraction, deletion, and inherent variability of the English copula. *Language* 45.4.715-62.
- _____. 1971. Methodology. *Dingwall* 1971b:412-91.
- Lakoff, George. 1972. The global nature of the nuclear stress rule. *Language* 48.285-303.
- Langendoen, D. Terence. 1968. *The London school of linguistics*. Cambridge, Mass.: M.I.T. Press.
- _____. 1969. Some problems in the description of English accentuation. *O.S.U. Working Papers in Linguistics* 3.122-42.
- Lass, Roger. 1971. Boundaries as obstruents: Old English voicing assimilation and universal strength hierarchies. *Journal of Linguistics* 7.1.15-30.
- Lee, Gregory. 1969. English word-stress. *CLS* 5.389-405.
- Lightner, Theodore M. 1970a. On regular inflectional endings in English. *Papers in Linguistics* 3.3.503-19.
- _____. 1970b. On Swadesh and Voegelin's 'A problem in phonological alternations'. *Papers in Linguistics* 3.2.201-20.
- _____. 1970c. Why and how does vowel nasalization take place? *Papers in Linguistics* 2.2.179-226.
- _____. 1971. Generative phonology. *Dingwall* 1971b:498-564.
- _____. 1972. Problems in the theory of phonology. Volume 1: Russian phonology and Turkish phonology. Edmonton and Champaign: Linguistic Research.
- Luelsdorff, Philip. 1969. On the phonology of English inflection. *Glossa* 3.1.39-48.
- Malone, Joseph L. 1970. In defense of non-uniqueness of phonological representations. *Language* 46.328-35.
- McCawley, James D. 1963. Finnish noun morphology. *Quarterly Progress Report*, M.I.T. Research Laboratory of Electronics, 68.180-6.
- _____. 1968. The phonological component of a grammar of Japanese. The Hague: Mouton.
- _____. 1967a. The phonological theory behind Whitney's Sanskrit Grammar. *Languages and Areas: Studies presented to George V. Bobrinskoy*. Division of Humanities: University of Chicago, 77-85.
- _____. 1967b. Sapir's phonologic representation. *IJAL* 33.106-11.
- _____. 1969. Length and voicing in Tübatulabal. *CLS* 5.407-15.

- Miller, Patricia Donegan. 1972. Some context-free processes affecting vowels. M.A. thesis, O.S.U. In Working Papers in Linguistics 11.136-66.
- Miner, Kenneth. 1972. English inflectional endings and unordered rules. Paper presented to the LSA July Meeting, Chapel Hill, N.C.
- Naro, Anthony. 1971. Resolution of vocalic hiatus in Portuguese: diachronic evidence for binary features. *Language* 47.2.381-93.
- Nessly, Larry. 1971. Simplicity and explanatory adequacy in Southern Paiute. Paper presented to the LSA Dec. Meeting, St. Louis, Missouri.
- Nida, Eugene A. 1948. The identification of morphemes. *Language* 24. 414-41.
- _____. 1949. *Morphology: the descriptive analysis of words*. Ann Arbor: University of Michigan Press, 2nd ed.
- Norman, Linda. 1972. The insufficiency of local ordering. *CLS* 8. 490-503.
- Ohso, Mieko. 1971. A phonological study of some English loan words in Japanese. M.A. thesis, O.S.U.
- Pike, Kenneth. 1947. *Phonemics: a technique for reducing language to writing*. Ann Arbor: University of Michigan Press.
- Postal, Paul M. 1968. *Aspects of phonological theory*. New York: Harper & Row.
- Pyle, Charles. 1970. West Greenlandic Eskimo and the representation of vowel length. *Papers in Linguistics* 3.1.115-46.
- Read, Charles. 1971. Pre-school children's knowledge of English phonology. *Harvard Educational Review* 41.1-34.
- Rigsby, Bruce and Michael Silverstein. 1969. Nez Perce vowels and Proto-Sahaptian vowel harmony. *Language* 45.1.45-59.
- Robins, R. H. 1957. *Vowel nasality in Sundanese: a phonological and grammatical study*. Studies in Linguistic Analysis. Basil Blackwell, Oxford.
- Rogers, Jean H. 1967. Some implications of two solutions to a phonological problem. *IJAL* 33.3.198-205.
- Ross, J. R. ms. 1969. A reanalysis of English word stress.
- Sadock, Jerrold M. 1972. In defense of metathesis in Greenlandic. *Papers in Linguistics* 5.1-9.
- Saltarelli, Mario. 1970. Spanish plural formation: apocope or epenthesis? *Language* 46.1.89-96.
- Sapir, Edward. 1946. The psychological reality of phonemes. Selected writings of Edward Sapir, ed. David Mandelbaum. Berkeley: Univ. of California Press. 46-60.
- Schane, Sanford. 1968a. *French phonology and morphology*. Cambridge, Mass.: M.I.T. Press.
- _____. 1968b. On the non-uniqueness of phonological representations. *Language* 44.4.709-16.
- Schourup, Lawrence. 1972. A cross-language study of vowel nasalization. M.A. thesis, O.S.U. To appear in Working Papers in Linguistics.
- Sherzer, Joel. 1970. Talking backwards in Cuna: the sociological reality of phonological descriptions. *Southwestern Journal of Anthropology* 26.343-53.
- Shibatani, Masayoshi. 1971. The phonological representations of English inflectional endings. Paper presented to the LSA December Meeting, St. Louis, Missouri.

- Skousen, Royal. 1972. On capturing regularities. CLS 8.567-77.
- Sloat, Clarence and James E. Hoard. 1971. The inflectional morphology of English. *Glossa* 5.47-56.
- _____, _____. 1972. English stress. Paper presented to the LSA July Meeting, Chapel Hill, N.C.
- Stampe, David L. 1972a. Dissertation on natural phonology. Ph.D. dissertation. University of Chicago.
- _____. 1972b. On the natural history of diphthongs. CLS 8.578-90.
- Stockwell, Robert P. and Ronald K. S. Macaulay. 1972. *Linguistic change and generative theory*. Bloomington: Indiana University Press.
- Swadesh, Morris and Charles F. Voegelin. 1939. A problem in phonological alternation. *Language* 15.1-10.
- Trubetzkoy, Nikolai Sergeevic. 1935. *Anleitung zu phonologischen Beschreibungen*. Brno.
- Underhill, Robert. 1971. Metathesis vs. gemination in Greenlandic. *Papers in Linguistics* 4.299-311.
- Vennemann, Theo. 1968. German phonology. Ph.D. dissertation. UCLA.
- _____. 1970. The German velar nasal: a case for abstract phonology. *Phonetica* 22.65-81.
- _____. 1971a. Phonological uniqueness in natural generative grammar.
- _____. ms. 1971b. Vowel alternations in English, German, and Gothic: remarks on realism in phonology.
- Whitaker, Harry A. 1971. *Neuro-linguistics*. Dingwall 1971b:136-251.
- Wurzel, Wolfgang Ullrich. 1970. *Studien zur deutschen Lautstruktur*. *Studia Grammatica* 8. Akademie-Verlag, Berlin.
- Wang, William S-Y. 1968. Vowel features, paired variables, and the English vowel shift. *Language* 44.4.695-708.
- Watkins, Calvert. 1970. A case of non-chronological rule insertion. *Linguistic Inquiry* 1.525-7.
- Zwicky, Arnold M. 1967. Umlaut and noun plurals in German. *Studia Grammatica* 6.35-45.
- _____. 1970a. Auxiliary reduction in English. *Linguistic Inquiry* 1.3.323-36.
- _____. 1970a. The free-ride principle and two rules of complete assimilation in English. CLS 6.579-88.
- _____. 1970c. Greek-letter variables and the Sanskrit ruki class. *Linguistic Inquiry* 1.4.549-55.
- _____. 1971a. Linguistics as chemistry: the substance theory of semantic primes. *OSU Working Papers in Linguistics* 8.111-35.
- _____. 1971b. More on Nez Perce: on alternative analyses. *IJAL* 37.2.122-6.
- _____. 1972a. Note on a phonological hierarchy in English. Stockwell and Macaulay 1972: 275-301.
- _____. 1972b. On casual speech. CLS 8.607-15.
- _____. 1972c. Taking a false step. Paper presented to the July LSA meeting, Chapel Hill, N.C.
- _____. ms. 1972. Homing in.

Taking a False Step*

Arnold M. Zwicky

1. Background

The question of abstractness considered by Postal (1968, 53-77) under the name of naturalness concerns the character of underlying representations: can elements of underlying representations be of a different nature from the elements of surface representation? A predominantly negative, or concrete, answer to the question says that a language can't be analyzed as having the underlying front rounded vowel *y* unless it has surface *y*--unless, in fact, it has some surface *y*'s derived from underlying *y*. A predominantly positive, or abstract, answer to the question says that the language can be analyzed as having underlying *y* anyway, certainly if there is multiple justification for it (cf. Kisseberth 1969).

There is another question about sequences of elements in underlying representations: can sequences of elements (phonological segments within a morpheme, for example) be of a different nature from the sequences found in surface representation? Can a language, for instance, be analyzed as having morphemes with the underlying sequence *l* plus dental in them even if the language doesn't have that sequence superficially?¹

I am concerned here with some cases related to these. In each case, underlying representations are well-formed, in the sense that they contain only segments and sequences of segments that occur superficially, but some derivations go off the rails. This situation occurs in many published linguistic descriptions, both in phonology and in syntax. The Sound Pattern of English (Chomsky and Halle 1968) supplies many phonological examples, and any attempt at a comprehensive syntactic description is full of them.

Thus, we have in Sound Pattern (204) the treatment of words like push, pully, bullock, and full, which are said to have underlying lax *u*, to undergo an unrounding rule to *ɪ*, and then to be subject to a rule rounding *ɪ* back to *u*, which is the surface form. At the same time, other words assumed to have an underlying lax *u*, like pun, undergo an extension of Vowel Shift, which yields lax *o*, which is then adjusted to *ʌ*. The intermediate stages *ɪ* (for push) and *o* (for pun) are neither of them well-formed on the surface (in the dialect Chomsky and Halle are describing). Special rules are required to generate the actual forms.

In syntax, consider Langacker's (1965) treatment of French interrogatives, which posits a rule of Reduplication that takes an essentially² well-formed structure like the one associated with

- (1) Il pleut.
It's raining.

and converts it into the uninterpretable

- (2) *Il peut il.

which is then rescued by an Ellipsis rule, yielding the well-formed question

- (3) Pleut il?
Is it raining?

Let me try to formulate what is common to these, and similar, cases. First, at some stage A in derivations, all representations are essentially acceptable surface forms in the language; that is, there are neither unacceptable elements nor unacceptable combinations of elements.

Second, a rule R_1 applies to the representations at stage A and maps some of them into surface-unacceptable representations at stage B. Call R_1 the background rule and B a false step.

Finally, a later rule R_2 eliminates the unacceptable aspects of stage B, perhaps while performing other operations as well. Call R_2 the rescue rule. Speaking loosely, the background rule turns some good forms into bad ones, and the rescue rule fixes this up.

2. Criticism of the examples

The cases already given are very suspicious ones; it is instructive to see why this is so. First, the case of push. Here there is a special rule, Unrounding, taking underlying lax u to \ddot{u} . This background rule has no motivation beyond the forms in question; it is designed to remove them from the domain of Vowel Shift so that there can be surface instances of u. The rescue rule, Rounding, has one motivation beyond the forms in question: it is used to rescue another false step, namely tense \ddot{u} derived from underlying lax u in open syllables (194-5), which is diphthongized to $\ddot{u}w$, extended to $j\ddot{u}w$, and finally rescued by Rounding, giving $j\ddot{u}w$. Summarizing, the background rule for push has no independent motivation, and the rescue rule is motivated entirely by two false steps.

The case of pun interlocks with this one, for in the Sound Pattern analysis, every lax u undergoes either Unrounding or Vowel Shift. The background rule for pun is Vowel Shift, some form of which undoubtedly figures in English phonology. What can be doubted is its applicability to one lax vowel in addition to the tense vowels. Vowel Shift must be 'generalized' in a peculiar way to accommodate the pun analysis.

Langacker's analysis of French interrogatives involves a background rule that must play some rôle in a grammar of French: Reduplication is responsible for the occurrence of the pronoun elle in

- (4) Cette femme est-elle folle?
Is this woman mad?

What Langacker does is make this rule absolutely general in questions, so that it has to be rescued by the combined effect of two rules, Pronominalization and Ellipsis:

- (5) Q cette femme est folle
→ by Reduplication
Q cette femme est cette femme folle
→ by Pronominalization
Q cette femme est elle folle [= (4)]
- (6) Q il pleut
→ by Reduplication
Q il pleut il
[not altered by Pronominalization]
→ by Ellipsis
Q pleut il [= (3)]

The weakest point in this analysis is the special pronominalization rule required for (5). It generates simple, rather than reflexive, pronouns, even though it applies within a simple S, and in order to generate alternative forms for wh-questions, as in

- (7) Quel tableau Henri préfère-t-il?
(8) Quel tableau préfère Henri?
[both] What picture does Henry prefer?

it has to be made optional in exactly these environments (which looks like an ad hoc complication of the rule and which goes against our expectations that pronominalization within a simple S will be obligatory rather than optional). Moreover, the Ellipsis rule in (6) lacks independent motivation.

3. Contra false steps

On the basis of examples like these, it would be natural to try to restrict linguistic theory by ruling out false steps entirely--by saying that any description involving a false step is ill-formed. Scattered throughout the literature there are criticisms of false step analyses, so that there is some implicit support for outlawing them.

Thus, Zimmer (1967) expresses some unhappiness with Lightner's (1965) analysis of Classical Mongolian vowel harmony, in which the back-harmonic vowel generated from *i* is \ddot{i} , which does not occur in the language and has to be merged with *i* by a rescue rule. Similarly, many people experience twinges when they consider the English rule of Whiz-Deletion, which yields a man sick with envy from a man who is sick with envy. For one-word adjectival phrases the result of

Whiz-Deletion is unacceptable--*a man sick from a man who is sick--and has to be rescued by an Adjective Preposing rule. Some critics have felt that the 'unreal' intermediate stage should be avoided by restricting the application of Whiz-Deletion and by deriving prenominal adjectives directly from relative clauses with predicate adjectives, or by deriving prenominal adjectives from some other source altogether, as suggested by Winter (1965). Indeed, there is surprisingly little hard evidence for Adjective Preposing.

Even if false steps are not explicitly ruled out, we find in syntactic discussions a preference for derivations all of whose steps are 'grammatical', as it is often put.³ The UCLA grammarians, for instance, criticize Rosenbaum's (1967) treatment of sentences like

(9) Bill is said to work hard.

for its (in their words) 'excessively ingenious' derivation (Stockwell, Schachter, and Partee 1972, 531):

- (10) *One says it [for Bill to work hard].
 → *It [for Bill to work hard] is said.
 → *It is said [for Bill to work hard].
 → *Bill is said for to work hard.
 → Bill is said to work hard.

a derivation that is bad right up to the last minute. The UCLA grammarians support a substitute analysis by saying (533) that 'with all but one small set of verbs of this class, all steps in the derivation are grammatical' (and for the three exceptional verbs, among them say, only one step is ungrammatical).

Quite often it is argued that an analysis is good because apparently unmotivated intermediate steps actually have surface realizations. This line of argument is an indirect indication of a prejudice against false steps. A lovely example is Langacker's (1968) treatment of French possessives like ma maison 'my house', which he assumes to be derived through the stages

- (11) la maison [la maison est à moi]
 → la maison qui est à moi
 → *la maison à moi
 → *la maison moi
 +MOD
 → *la moi maison
 +MOD
 → moi maison [= ma maison]
 +MOD

Of this approach Langacker says

Not only is it very economical to derive possessive adjectives in this way; there are compelling reasons why they must be so derived. A number of other possessive constructions

result quite naturally as reflexes of the postulated intermediate stages of the derivation; these appear to be wholly idiosyncratic if considered in isolation from the analysis of possessive adjectives we propose. (56)

The other possessive constructions referred to include

- (12) C'est une maison à moi
It's a house of mine.

for the third line of the derivation,

- (13) Cette maison est la mienne.
That house is mine.

for the fourth, and Old French and Italian constructions for the fifth.

4. Pro false steps

Despite the widespread prejudice against them, I claim it would be wrong to outlaw false steps. Some are bad, some not. In general, it depends on the extent to which the background rule and/or the rescue rule are justified.

4.1. Clear cases

Consider first a large class of cases in which no one has ever criticized false steps. Each of these involves a phonological rule of great generality and regularity which feeds a rescue rule that acts to create sequences pronounceable in the language. The English rules of Auxiliary Reduction and Progressive Voicing Assimilation interact in this way. There is no question about the existence of the background rule, Auxiliary Reduction (which gives contracted forms of is, has, would, had, am, are, and will). In certain cases it creates word-final sequences of voiceless obstruent plus voiced obstruent, which are unpronounceable in English (perhaps universally)--*[kætz] from [kæt Iz] cat is, for example. Progressive Voicing Assimilation (which applies also to noun plurals like cats and verb presents like hits) then automatically shifts the false step tz to the correct ts. When the rescue rule shifts not only derived sequences, but also the same sequences across morpheme boundaries in underlying forms, the case is especially strong. If the underlying shape of the English noun plural and verb present morphemes is z (instead of vowel plus z), the Auxiliary Reduction example is of this type. But clear cases abound. In Karok, 'basic v and y are lost when, through morphological processes [i.e., through affixation-AMZ], they come to stand between two short vowels; vowel contraction...then occurs' (Bright 1957, 33). Vowel contraction takes place for original sequences of vowels across morpheme boundaries as well as those derived by the deletion of v and y; and there are no vowel sequences within words on the surface.⁴

Analogous examples in syntax would be reorderings to fit some required surface order. Perhaps the English Whiz-Deletion case is of this sort.

4.2. Syntactic support

One area of syntax in which the possibility of a false step analysis has been much discussed is that of chopping rules (Ross 1967). A chopping rule, which moves a constituent without leaving a trace in its former position, is to be contrasted with a copying rule, which leaves something behind. Although the end products of a chopping rule and of a copying rule followed by deletion would be identical, Ross claimed that only chopping rules were subject to his constraints. It would then be possible to tell, by checking the behavior of a rule with respect to the constraints, which class it belonged to. Note that the application of a chopping rule will not (*ceteris paribus*) lead to a false step, while a copying rule might, if there was a succeeding deletion rule that was obligatory in some of the structures generated by the copying rule. There are no such cases in Ross (1967).

Since 1967 there has been a lively debate⁵ surrounding the possibility that chopping rules might all be eliminated in favor of copying plus deletion, beginning with Sanders and Tai (1972), who argue from data in Mandarin Chinese, English, and Lebanese Arabic. A response by Neubauer (1970) pointed out that some deletion rules were not subject to Ross constraints. Since then Drachman (1970) has attempted to reanalyze Modern Greek reordering transformations as copying followed by deletion, and Perlmutter (1972) has argued in great detail for a copying analysis of French relatives. Perlmutter supports the claim that a relative clause like the one in

- (14) les hommes à qui Marie parle
the men to whom Mary is speaking

has a remote representation like

- (15) *les hommes à qui Marie parle à eux
*the men who whom Mary is speaking to them

which is a false step, since (14) could be derived directly from its underlying structure (as relative clauses were in all early transformational descriptions).

4.3. Fell swoops versus chains

Situations in which unacceptable phonological segments are in question are on the whole less clear than those in which sequences are at issue. The problem here is whether the background rule should be restricted or complicated, or whether it should apply generally and call a rescue rule into play. Consider, for instance, a language

with vowel harmony or umlaut, and with the very common asymmetrical superficial vowel system

$$(16) \quad \begin{array}{cc} i & u \\ e & o \\ & a \end{array}$$

In such a language, front harmony or palatal umlaut necessarily involves neutralization; if *o* and *a* are fronted, they will both be realized as *e*. Disregarding the rounding feature, should the shift be described as a complication of

$$(17) \quad V \rightarrow [-\text{back}]$$

that is, as

$$(18) \quad V \rightarrow \begin{bmatrix} -\text{back} \\ -\text{low} \end{bmatrix}$$

or should the shift rule retain its generality and feed a neutralization rule

$$(19) \quad \begin{bmatrix} V \\ -\text{back} \end{bmatrix} \rightarrow [-\text{low}] \quad ?$$

For a nonhypothetical example, consider the four French nasalized vowels, $\tilde{\epsilon}$ $\tilde{ɔ}$ $\tilde{œ}$ $\tilde{ɑ}$; there are no surface vowels \tilde{i} \tilde{u} \tilde{y} $\tilde{ø}$ etc. In the analysis given by Schane (1968, sec. 2.2), the nasalized vowels are derived from oral vowels, so that (as in the previous hypothetical example) some neutralization must occur. Schane assumes a general nasalization rule,

$$(20) \quad V \rightarrow [+nas] / _ \begin{bmatrix} +\text{cons} \\ +\text{nas} \end{bmatrix} \left\{ \begin{array}{c} \# \\ [+cons] \end{array} \right\}$$

and then reduces the resulting ten-vowel system to the actually occurring four-vowel system by two neutralization rules--

$$(21) \quad \begin{bmatrix} V \\ +\text{nas} \end{bmatrix} \rightarrow [+low]$$

which realizes both \tilde{y} and $\tilde{ø}$ as $\tilde{œ}$, and both \tilde{i} and $\tilde{ɛ}$ as $\tilde{\epsilon}$; and

$$(22) \quad \begin{bmatrix} V \\ +\text{nas} \\ +\text{low} \\ +\text{tns} \end{bmatrix} \rightarrow [+back]$$

which realizes $\tilde{ɑ}$ and some $\tilde{\epsilon}$ as $\tilde{ɑ}$. But it would also be possible to complicate the nasalization rule itself and derive the correct outputs (including the correct associations of alternants) in one fell swoop:

$$(23) \left[\begin{array}{c} v \\ \langle +low \rangle \\ +tns \end{array} \right] \rightarrow \left[\begin{array}{c} +nas \\ +low \\ \langle +back \rangle \end{array} \right] / - \left[\begin{array}{c} +cons \\ +nas \end{array} \right] \left\{ \begin{array}{c} \# \\ [+cons] \end{array} \right\}$$

To my knowledge, no one has suggested this fell swoop treatment, probably because the result is so obviously several rules crammed into one, the sort of rule one would not expect to find in real languages; whereas all of Schane's rules are plausible. But I know of no evidence from within French that would argue for the three-rule solution over the single-rule analysis--no evidence that Schane's rules cannot be ordered together, that they are subject to grossly different conditions on application, that they have disparate sets of exceptions, or the like.

There is at least one phonological problem, Finnish vowel harmony, for which both the fell-swoop and the rule-chain solutions have been suggested in the literature, although the writers do not in fact attempt to justify either treatment. Finnish has three front-harmonic vowels, ä ö ü, three back-harmonic vowels, a o u, and two neutral vowels, i e, which occur with both of the other sets. Suffixes agree in backness with roots. Kiparsky (ms. 1968), attacking an earlier suggestion by Lightner (1965) that backness be a property of roots as a whole (with individual vowels unmarked for backness), points out that roots with only neutral vowels take front harmony, a fact that cannot be explained in Lightner's system. He proposes that vowels in roots all be marked for backness and that suffix vowels not be marked in underlying forms; they harmonize to the last nonneutral root vowel by the rule

$$(24) V \rightarrow [\alpha \text{ back}] / [\alpha \text{ back}] X _$$

(leaving out details not essential to this discussion). (24) generates the back unrounded vowels ī and ē as well as the front unrounded vowels i and e. The false step must be rescued by a neutralization⁶ rule

$$(25) \left[\begin{array}{c} v \\ -low \\ -round \end{array} \right] \rightarrow [-back]$$

Rardin (1969) has since pointed out a class of suffixes that have back vowels after neutral roots. He proposes that the suffix vowels as well as the root vowels be lexically marked for backness and formulates the harmony rule as

$$(26) \left[\begin{array}{c} v \\ \gamma \text{round} \\ -\gamma \text{low} \end{array} \right] \rightarrow [\alpha \text{ back}] / \left[\begin{array}{c} \alpha \text{back} \\ \beta \text{round} \\ -\beta \text{low} \end{array} \right] X _$$

(again ignoring inessential complications), so that no neutralization rule is needed. As it happens, both the Rardin, or fell-swoop, solution and the Kiparsky, or chain, solution is consistent with the facts

discussed. Rardin's preference for the single-rule solution may arise from the fact that his analysis compels him to specify that only nonneutral vowels condition harmony; once the class is mentioned in one part of the rule, it is natural to refer to it in another; in addition, Rardin remarks (230) on the way that *i* and *e* seem to function as a natural class in Finnish.

Fell-swoop solutions will always be at least marginally simpler, in terms of the number of features mentioned, than rule-chain solutions. But the difference between the two formulations will almost surely be less than the 'slack' in present descriptive systems (the indeterminacy in feature-counting due to inadequacies in feature systems and notational conventions and to uncertainty about how to weight different conventions). However, the real issue is the adequacy of the rules, not simplicity simpliciter.

4.4. The Welsh soft mutation.

A ban against false-step analyses would decide the questions in the previous section; but I believe the decision would be wrong in a great many cases. Here I will consider one such case, one similar to those just described. This is the soft mutation in Welsh, a rule that shifts stops in certain environments as follows:²

$$(27) \quad \begin{array}{ll} p \rightarrow b & b \rightarrow v \\ t \rightarrow d & d \rightarrow \delta \\ k \rightarrow g & g \rightarrow \emptyset \end{array}$$

That is, except for *g*,

$$(28) \quad \left[\begin{array}{l} \text{obst} \\ -\text{cont} \\ \langle +\text{vcd} \rangle \end{array} \right] \rightarrow \left[\begin{array}{l} \text{vcd} \\ \langle +\text{cont} \rangle \end{array} \right] \quad \text{in some contexts}$$

If we are not permitted to let (28) take a false step, we must either use nested angle brackets and the feature [*±segment*], as in

$$(29) \quad \left[\begin{array}{l} +\text{obst} \\ -\text{cont} \\ \left\langle \begin{array}{l} +\text{vcd} \\ \langle -\text{ant} \rangle \end{array} \right\rangle \end{array} \right]_1 \rightarrow \left[\begin{array}{l} +\text{vcd} \\ \left\langle \begin{array}{l} +\text{cont} \\ \langle -\text{seg} \rangle \end{array} \right\rangle \end{array} \right]_1 \quad \text{in some contexts}$$

or else state the shift as two rules,

$$(30) \quad g \rightarrow \emptyset \quad \text{in some contexts}$$

plus (28). The fell-swoop treatment in (29) seems to me to be utterly hopeless; probably both of the notational tricks used to achieve this solution ought to be disallowed. I take seriously only the second alternative, (30) followed by (28).

A false-step analysis uses the shift in (28) as a background rule, allowing an intermediate stage γ to be derived from g , and rescues with the context-free rule

$$(31) \gamma \rightarrow \emptyset$$

Now what would make us choose this somewhat abstract analysis over the relatively more concrete solution?

First, there is evidence internal to Welsh, which concerns the intrinsic connection between g -deletion and lenition of the remaining stops. To begin with, an argumentum ex silentio: there is no reason to suppose that the two rules are not ordered together. More important, they apply in exactly the same environments. This fact would in itself carry little weight if it were not that the environments for the rules are a marvel of morphological conditioning. (30) and (28) would have to apply to the initial segment of: a feminine singular noun after the definite article (but not a masculine noun, or any plural), a noun after any one of a list of prepositions, a noun in an expression of time or space, the object of an inflected (but not periphrastic) verb, an adjective after the predicative particle yn, an adjective in the comparative (that is, after the particle cyn or mor), a verb after the negative, interrogative, future, and relative particles (or initially in a clause from which one of these particles has been deleted), and so on.⁸ Consequently, it would be preposterous to treat the two processes as independent.

Second, there is a modicum of cross-linguistic evidence in favor of the false-step analysis. The argument is based on the following hypothesis:

- (32) If a language has a rule of lenition by which underlying g is deleted, then any instances of underlying γ are also deleted.

Solid support for (32) is hard to come by, since verification hangs on finding languages with (a) underlying g , (b) a lenition rule affecting g , and (c) underlying γ . In what follows I rely on the plausibility of (32) and hope that appropriate language data will be forthcoming.

There are two ways in which the postulated linguistic universal (32) could come about:

Most favored segment. There is a type of lenition by deletion. γ is the most favored segment, so that if a language has γ and deletes any segments at all, γ will be affected. The process may be generalized to delete other consonants (e.g., γ , or in the case at hand, g).

Compounding of processes. Universally, there are two distinct types of processes--a lenition of g to γ , and a lenition by deletion of γ . The first process shifts

some or all voiced stops to continuants (perhaps affecting some voiceless stops as well), the second deletes some or all voiced continuants.

The proposals have somewhat different implications, in that compounding of processes predicts the occurrence of languages with only the shifting lenition, besides languages with only the deletion lenition. The most-favored-segment proposal predicts only lenition by deletion, for *g* at least. But the lenition of *g* to γ seems to be even more common than deletion; this is a well-known historical change in English, Greek, and Spanish, among other languages, and there are synchronic gradations of this type in Gilyak and Loma, cited by Ultan (1970). I conclude, tentatively, that $g \rightarrow \emptyset$ always proceeds in two stages, $g \rightarrow \gamma$ and $\gamma \rightarrow \emptyset$. If so, the false-step analysis of the Welsh soft mutation must be the correct one.

Footnotes

*A shorter version of this paper was given at the 1972 summer meeting of the Linguistic Society of America, Chapel Hill, North Carolina; the expanded paper was read at the Ohio State University on November 13, 1972. Both audiences gave me useful comments and suggestions. I am indebted to the John Simon Guggenheim Memorial Foundation for its support of this work.

1. On rather weak evidence, I once suggested just such an abstract analysis for certain occurrences of the Sanskrit retroflex consonants (Zwicky 1965, sec. 3.3).

2. The hedge 'essentially' here and in what follows is intended to separate the operation of some rule in question from the effects of other rules not relevant to the issue at hand. Thus, the structure associated with (1) at the point in derivations where Reduplication applies might very well not be 'readable' as (1) because some obligatory rules not mentioned in the text (say, affix placement and number agreement) haven't yet applied. We then ask whether the structure associated with (1) is otherwise well-formed. Compare note 3.

3. Grammaticality of intermediate stages is, of course, not quite the issue here. Rather it is whether an intermediate stage in a derivation would lead to a grammatical output if operated upon only by (independently motivated) obligatory rules other than those in question.

4. My thanks to Lawrence Schourup for pointing out this reference.

5. I am indebted to Ronald Neeld for reminding me of the significance of this literature for the false step question.

6. Kiparsky's article argues against absolute neutralizations of underlying distinctions. Therefore, since *i* and \bar{i} , *e* and \bar{e} are not claimed to be distinct in underlying forms, this neutralization rule is no violation of Kiparsky's principle.

7. The rule also shifts *m* to *v*, but since this alternation doesn't affect the argument, I prefer to ignore it here rather than complicate the exposition.

8. Bowen and Rhys Jones (1960, 166-7) provide a convenient list.

References

- Bowen, John T. and T. J. Rhys Jones. 1960. Teach yourself Welsh. English Universities Press, London.
- Bright, William. 1957. The Karok language. University of California Publications in Linguistics 13. Univ. of California Press, Berkeley and Los Angeles.
- Chomsky, Noam and Morris Halle. 1968. The sound pattern of English. Harper and Row, New York.
- Drachman, Gaberell. 1970. Copying, and order-changing transformations in Modern Greek. Working Papers in Linguistics No. 4, Ohio State University, 1-29.
- Kiparsky, Paul. ms. 1968. How abstract is phonology?
- Kisseberth, Charles W. 1969. On the abstractness of phonology: the evidence from Yawelmani. Papers in Linguistics 1.2.248-82.
- Langacker, Ronald W. 1965. French interrogatives: a transformational description. Lg. 41.4.587-600.
- Langacker, Ronald W. 1968. Observations on French possessives. Lg. 44.1.51-75.
- Lightner, Theodore M. 1965. On the description of vowel and consonant harmony. Word 21.244-50.
- Neubauer, Paul. 1970. On the notion 'chopping rule'. Papers from the 6th Regional Meeting, Chicago Linguistic Society, 400-7.
- Perlmutter, David M. 1972. Evidence for shadow pronouns in French relativization. In Paul M. Peranteau, Judith N. Levi, and Gloria C. Phares. The Chicago which hunt: papers from the relative clause festival. Chicago Linguistic Society, 73-105.
- Postal, Paul M. 1968. Aspects of phonological theory. Harper and Row, New York.
- Rardin, R. B. II. 1969. On Finnish vowel harmony. Quarterly Progress Report of the Research Laboratory of Electronics, M.I.T. No. 94, 226-31.
- Rosenbaum, Peter S. 1967. The grammar of English predicate complement constructions. M.I.T. Press, Cambridge, Mass.
- Ross, John Robert. 1967. Constraints on variables in syntax. Ph.D. dissertation, M.I.T. [Reproduced by Indiana Univ. Linguistics Club, 1968.]
- Sanders, Gerald A. and James H.-Y. Tai. 1972. Immediate dominance and identity deletion. Foundations of Language 8.2.161-98.
- Schane, Sanford. 1968. French phonology and morphology. M.I.T. Press, Cambridge, Mass.
- Stockwell, Robert P., Paul Schachter, and Barbara Hall Partee. 1972. The major syntactic structures of English. Holt, Rinehart and Winston, New York.

- Ultan, Russell. 1970. Some sources of consonant gradation. Working Papers on Language Universals No. 2, Stanford University, C1-30.
- Winter, Werner. 1965. Transforms without kernels? Lg. 41.1. 484-9.
- Zimmer, Karl E. 1967. A note on vowel harmony. IJAL 33.2.166-71.
- Zwicky, Arnold M. 1965. Topics in Sanskrit phonology. Ph.D. dissertation, M.I.T.

Homing In: On Arguing for Remote Representations*

Arnold M. Zwicky

Eliminate all other factors, and the one which remains must be the truth.

How often have I said to you that when you have eliminated the impossible, whatever remains, however improbable, must be the truth.

--Sherlock Holmes to Watson in The Sign of the Four

0. Introduction

Linguistic analysis possesses both an 'arbitrary' and a 'natural' component--on the one hand, methodological principles and various means of organizing and handling data; on the other, empirical studies aimed at exposing linguistic universals through the detailed analysis of specific languages, cross-linguistic comparison, phonetic studies, psycholinguistic experiments, observation of language acquisition, and other sources of pertinent data. In practice, the arbitrary and natural components are intertwined, and each makes use of methods and results from outside linguistics in a narrow sense: the arbitrary component contains many principles and methods which are not peculiar to linguistics at all, but are rather the common property of scientific investigation, while the natural component refers ultimately to aspects of mental and social organization and physical properties of the vocal tract, many of which are independent of specifically linguistic behaviors and abilities.

My concern here is with an aspect of the arbitrary component, one shared with other enterprises in which methods of problem solving are brought to bear on empirical data. What is characteristic about homing in is that facts are viewed as a kind of puzzle, obscuring the real elements and relationships; the function of the analyst is to determine what these remote entities are by eliminating possibilities so as to fix upon, or 'home in on', the right answer. Typically, this process involves assembling facts in such a way that one can solve for the answer. In sciences of quantity, the answer is obtained by using a bag of tricks to set up an equation, which is then solved. In linguistics, the analyst makes a list of conditions, and the answer is taken to be the simplest entity satisfying them.

The method is familiar from contrived logical puzzles of the 'A, B, and C are a bank clerk, tightrope walker, and drug smuggler, though not necessarily respectively' variety, which Wylie (1957: intro.) takes to 'epitomize the entire scientific process' and in which 'the answer is ultimately wrested from the seemingly incoherent information initially provided'.

In what follows I examine some argumentation using homing in from The Sound Pattern of English¹ (section 1), which I take to be impeccable in structure, even though it results in an indefensible analysis. This I contrast with a structurally similar case from Sanskrit (section 2), in which the method of homing in is supported at each stage by empirical evidence. I close with some discussion of homing in in syntax (section 3) and a brief assessment of the value of the method (section 4).

1. The SPE treatment of ɔj

SPE treats many choice problems, in which the analysis selects as underlying a segment that is actually in alternation; a typical case is the argument that /k/ underlies the alternation [k] in electric ~ [s] in electricity ~ [s] in electrician (SPE, 168, 219, 224-327). More complex are alternations for which it is argued that the underlying representation is distinct from all of its surface realizations, as when Chomsky and Halle claim that the second vowel in divine and divinity is underlyingly neither a j nor I, but rather /ɪ/ (SPE, 178-86) and that the second consonant in right and righteous is underlyingly neither simple t nor the affricate c, but rather the cluster /xt/ (SPE, 223-4). These are homing in arguments.

Consider now the surface diphthong [ɔj]. The SPE discussion (191-2) of this phonological element proceeds through nine steps:

- (a) It is observed that one consequence of the analyses up to this point in SPE is that VG sequences have been eliminated from the lexicon (in favor of tense vowels affected by Vowel Shift and Diphthongization);
- (b) We then see if we can remove this exception by taking it to be some underlying X which is converted to the surface diphthong [ɔj]; if possible, this conversion should be effected by independently motivated rules, to as not to add rules for this special case.
- (c) Note that the existing Diphthongization rule inserts a glide after a tense vowel; j is inserted after a nonback vowel. To take advantage of this rule, we assume that X is a tense nonback vowel.
- (d) ɔj is low and round. Apparently, if X were nonlow or nonround, we would need special rules to generate the right features. Consequently, take X to be low and round.
- (e) Putting these observations together, we see that X has been specified for all the relevant features: it is a tense, nonback, low, round vowel--that is $\bar{\alpha}$.
- (f) As a result, we need a $\bar{\alpha} \rightarrow \bar{\alpha}$ rule. But there is already a Backness Adjustment taking $\bar{\alpha} \rightarrow \bar{\alpha}$ / ___ j. This rule can now be made more general.

(g) Consider next the effect of adding / $\bar{\epsilon}$ / to the inventory of underlying segments. SPE claims that it fills a 'gap' in the set of tense low vowels, which otherwise are / \bar{e} \bar{a} \bar{o} /.

(h) Next we must see how the new segment would be treated by existing rules. First, there is the Vowel Shift, which affects tense vowels. However, to prevent \bar{a} from being shifted, SPE restricts the rule to [_{back}] vowels; consequently $\bar{\epsilon}$ is conveniently exempted as well.

(i) Nevertheless, $\bar{\epsilon}$ must be marked as an exception to at least one rule, Laxing before two following syllables, because surface [ɔj] occurs in words like exploitative. This is the price we must pay for the analysis.

It is striking how little 'empirical input' this argument has. Its original motivation is to simplify underlying morpheme structure (and even this step depends upon how well supported other arguments eliminating underlying diphthongs are); we determine the identity of X by considering how to use existing rules to the fullest and how to avoid positing new rules; a new rule that is required is justified on the ground that it is a generalization of an existing rule; the new segment is justified on the ground that it fills a distributional gap; its failure to undergo Vowel Shift is said to follow from its being a member of a natural class with \bar{a} ; its failure to lax is, reluctantly, admitted to be exceptional (though presumably outweighed by all the other considerations). There are no morphophonemic alternations to be explained here, no facultative variation, no universal constraints on systems, not even slips of the tongue or stages in acquisition. The entire argument is formal.

Even as they stand, the steps of the argument are subject to criticism. Step (a) depends upon previous arguments against underlying diphthongs; these in turn have been widely attacked. Against step (b), we could claim that underlying form is identical to surface form, unless there are cogent reasons for saying otherwise; a somewhat unusual underlying sequence would scarcely count, since there must be borrowings, exceptions, and the like anyway. Steps (c) through (e) home in on X, using existing rules and features; but there is no inherent advantage in taking a free ride on existing rules. The generalization in step (f) may be spurious. The gap in step (g) certainly is, since the occurrence of a low front rounded vowel in a language seems to depend not at all on what other low vowels occur, but rather on what other front rounded vowels occur (briefly, to have a low front unrounded vowel a language must have mid or high front unrounded vowels); the system SPE argues for is quite unnatural. Step (h) treats \bar{a} and $\bar{\epsilon}$ as a natural class, an unlikely claim, it seems to me; certainly I know of no parallels. Even step (i) creates some difficulties, because although ɔj doesn't undergo trisyllabic laxing, there are examples in which it appears to have been affected by the other laxing environment in English, before two consonants: destruction, puncture, and juncture (presumably related to destroy, point, and join, respectively). Here a remote representation \bar{u} is suggested by the alternation with \wedge (compare profound/profundity for which SPE has / \bar{u} /). Other possibilities are

simply /ɔj/, using the principle that underlying forms shouldn't differ from surface forms without reason (Vennemann 1971); /y/, if we try to apply the same arguments as SPE but attend to the generalization that a language has nonhigh front rounded vowels only if it has high front rounded vowels; /ɤ/, suggested by the few actual alternations and by general constraints on phonological systems (Hoard 1973); or even a front rounded vowel that is both low and high, as postulated by Krohn (1972).

In any event, each stage of the SPE analysis rests entirely upon considerations of systematic simplicity. At the same time it illustrates quite nicely a style of argument in which we are to assume that there is some unknown X and that the features of X can be determined, step by step, from the conditions it must satisfy.

2. Sanskrit roots in ks

I now take up the case of the internal sandhi of Classical Sanskrit roots ending in ks.² As in the previous section, I will present arguments that the underlying representation is distinct from any of its surface realizations and will home in on this underlying form. In contrast to the example from SPE, the Sanskrit argument depends upon empirical input at several points. In fact, the argument begins with morphophonemic alternations to be explained, rather than the asymmetrical underlying system that motivated the SPE analysis.

2.1. Roots in ś and ṣ

To show this, I must first present important background facts about Sanskrit morphophonemics, in particular the internal sandhi of root-final ś and ṣ, as summarized in Table 1.³

Table 1.

Internal sandhi of ś and ṣ

	<u>dviṣ-</u> 'hate'	<u>dāś-</u> 'make offering'	ENDING
PRESENT INDICATIVE:			
(a) 1 sg. act.	dvéṣmi	dāśmi	+mi
1 du. act.	dviṣvās	dāśvās	+vas
1 sg. midd.	dviṣé	dāśé	+e
(b) 3 sg. act.	dvéṣṭi	dāśṭi	+ti
2 du. act.	dviṣṭhás	dāśṭhás	+thas
(c) 2 pl. midd.	dviṣḍhvé	dāśḍhvé	+dhve
(d) 2 sg. act.	dvéṣi	dāśi	+si
ROOT NOUN:			
(e) nom. sg.	dvitṣ	dāṣ	(+s)
loc. pl.	dviṣsú	dāśsú	#su
inst. pl.	dviṣbhís	dāśbhís	#bhis

In the (a) forms in the table--that is, before endings beginning with sonorants⁴--we see \dot{s} and $\dot{\bar{s}}$, which I take to be the underlying segments (because position before sonorants is the position where there are the most contrasts, and because there are no obvious explanations for the segments that appear there, so that there is no reason to suppose that the underlying segments are not the same as the surface ones).

The (b) and (c) forms show a retroflex consonant before endings beginning with a stop; this consonant is a spirant before a voiceless ending, a stop before a voiced ending. These examples also illustrate the operation of two general rules of Sanskrit, a (word-internal) Progressive Retroflexion Assimilation in (b) and a Regressive Voicing Assimilation (applicable in both internal and external sandhi) in (c). In (d), before \dot{s} , both spirants appear as k , and a general rule of \dot{s} -Retroflexion applies to the initial \dot{s} of the ending. Finally, the forms of the root noun in (e) show that in word-final position both spirants are realized as retroflex stops; the nominative singular ending \dot{s} is deleted by an early (independently motivated) rule of Cluster Simplification, and the two other endings behave in general as if they occurred with a boundary stronger than + (note, for example, the failure of Progressive Retroflexion Assimilation in the locative plural). I therefore assume that the relevant context for (e) is : before the boundary #.

The analysis exposed thus far is outlined in Table 2. Cluster Simplification, in (a), applies before the Spirant Shifts, in (b). For the moment, I have not formulated the Spirant Shifts as rules; instead, I give the outputs and their environments. List (c) contains other rules that apply in the derivation of the forms in Table 1; all of these are independently motivated.

Table 2.

Rules exemplified in Table 1.

(a) Cluster Simplification

(b) Spirant Shifts

$$\begin{array}{l} \dot{s} / _ \left[\begin{array}{l} +\text{obst} \\ -\text{cont} \\ -\text{vcd} \end{array} \right] \\ \dot{t} / _ \left\{ \left[\begin{array}{l} +\text{obst} \\ -\text{cont} \\ +\text{vcd} \\ \# \end{array} \right] \right\} \\ k / _ \left[\begin{array}{l} +\text{obst} \\ +\text{cont} \end{array} \right] \end{array}$$

(c) Progressive Retroflexion Assimilation
 Regressive Voicing Assimilation
 s-Retroflexion

The problem of formulating the Spirant Shifts does not affect the subsequent discussion in any significant way. For definiteness, we may consider the process as involving three rules. Rule (A) shifts \mathfrak{s} to $\mathfrak{ś}$ before continuants, and $\mathfrak{ś}$ to \mathfrak{s} before stops and #. Rule (B) then takes \mathfrak{s} to \mathfrak{k} before continuants, while (C) takes \mathfrak{s} to $\mathfrak{ṣ}$ before voiced stops and #.⁵ The feature composition of these rules is not relevant here.

2.2. Roots in $\mathfrak{k}\mathfrak{s}$.

Table 3 gives forms for the root caks- 'see' corresponding to the forms in Table 1. The (a) cases again show the root-final element unchanged, and the remaining cases show exactly the same alternants as the roots in \mathfrak{s} and $\mathfrak{ś}$. We now seek an explanation of why the cluster $\mathfrak{k}\mathfrak{s}$ should behave in just the same way as the simple spirants.⁶

One possible account would be to say that there is a k-dropping rule, roughly of the form

$$k \rightarrow \emptyset / \text{---} \left[\begin{array}{l} +\text{obst} \\ +\text{cont} \end{array} \right] \left\{ \begin{array}{l} [+ \text{obst}] \\ \# \end{array} \right\}$$

ordered before the spirant shifts. Such an analysis would cover the facts, but at the cost of an additional rule, one without independent motivation.

Table 3

Internal sandhi of $\mathfrak{k}\mathfrak{s}$.

	<u>caks-</u> 'see'	ENDING
PRESENT INDICATIVE:		
(a) 1 sg. act.	cákṣmi	+mi
1 du. act.	cakṣvās	+vas
1 sg. midd.	cakṣé	+e
(b) 3 sg. act.	cáṣṭi	+ti
2 du. act.	caṣṭhás	+thas
(c) 2 pl. midd.	caḍḍhvé	+dhve
(d) 2 sg. act.	cákṣi	+si
ROOT NOUN:		
(e) nom. sg.	cáṣ	(+s)
loc. pl.	caṣsú	#su
inst. pl.	caḍbhís	#bhís

Moreover, k-dropping would have to precede Cluster Simplification, since otherwise the nominative singular of cakṣ- would come out cak instead of the correct caṣ. This is a somewhat peculiar consequence of the analysis, because Cluster Simplification otherwise appears to apply before all other phonological rules in Sanskrit. In fact, the

k-Dropping solution leads to an ordering paradox, if s-Retroflexion is to be used to explain the fact that there are no Sanskrit roots ending in ks, only in kṣ. That is, if the final ṣ in cakṣ- and similar roots is derived from s by the s-Retroflexion rule, then s-Retroflexion must both precede k-Dropping (so that underlying caks will yield cakṣ and then caṣ, rather than the incorrect cas) and follow it (k-Dropping precedes the Spirant Shifts, and these must precede s-Retroflexion because they create some occurrences of k that trigger retroflexion, as in 2 sg. act. cākṣi).

The ordering paradox is apparently eliminable by reference to general principles of rule application: s-Retroflexion applies before k-Dropping so that both rules will have the opportunity to apply, and then s-Retroflexion applies again when new occurrences of k are created. Perhaps such principles could be appealed to for an explanation of why k-Dropping precedes Cluster Simplification; although the two rules bleed each other and both yield opaque outputs, k-Dropping leads to forms (e.g. caṣ) to which other rules are applicable, whereas Cluster Simplification doesn't feed other rules.

In any event, the k-Dropping solution is not without problems of its own, aside from involving a new rule.

Now just as SPE attempted to find an underlying representation for ɔj so as to avoid VG sequences in the lexicon, we attempt to find an underlying representation for kṣ so as to avoid adding a special rule. First, this X must reduce to ṭ before #. There are only four segments--ṣ, ś, ṭ, and ḍ--that yield ṭ in this position by existing rules of Sanskrit, so that one of these four must be an intermediate stage between underlying X and surface ṭ.

Next, X must become kṣ before sonorants. Again, given the rules presented so far, there are only four possible sources of kṣ in this position: ṣṣ, śś, ṣṣ, and śś. Before # any one of these would give ṣ or ś as an intermediate stage leading to ṭ.

Of the four clusters, the first three contain ṣ in a position where retroflexion is not in general predictable. Consequently, if we try to minimize features in the lexicon, the cluster śś is the best candidate for X. Underlying caśś+mi would give cakṣ+mi by the Spirant Shifts and cakṣ+mi by s-Retroflexion; underlying caśś#su would give caṣ#su by Cluster Simplification and then caṭ#su by the Spirant Shifts.

Thus far, we have homed in on the underlying cluster śś. But just as Chomsky and Halle had apparently to add a $\bar{\alpha} \rightarrow \bar{\alpha}$ rule, given their solution for X, so we appear to have to add a rule, given our solution. The problem arises in the remaining environments for the kṣ roots, namely before obstruents. Here we have medial clusters like śś+t, śś+d, and śś+s, which would yield kṣ+ṭ, kṣ+ḍ, and kṣ+ṣ with our present rules. Since the correct results are the same as those deriving from the medial clusters ś+t, ś+d, and ś+s, it seems that we need a special rule deleting s between ś and an obstruent. SPE argued that the special Backness Adjustment rule was in fact merely a generalization of an existing rule for $\bar{\alpha}$. Similarly (but with greater justification) I claim that s-Deletion isn't new or special at all: it is a well-known rule of Sanskrit, a general deletion of s between two obstruents,

illustrated in Table 4 by the active voice forms of the s-aorist. The entire conjugation of nī-, and the 1 dual and plural forms for chid- and tap-, have the structure

((a + MODIFIED ROOT + s) + ENDING)

but the remaining four examples have no s. It is just roots ending in obstruents, and then only when preceding endings like -tam, -tām, and -ta, which begin with an obstruent, that lack the s; these forms are boxed in Table 4. Since Sanskrit already needs s-Deletion, it is no surprise that medial clusters of śś plus an obstruent are treated the same way as ś plus an obstruent. It is just what we should expect.

Table 4.

Active s-aorist forms.

	<u>nī-</u> 'lead'	<u>chid-</u> 'cut off'	<u>tap-</u> 'heat'	ENDING
(a) 1 du.	anā ⁱ ṣva	acchā ⁱ tsva	atāpsva	-va
1 pl.	anā ⁱ ṣma	acchā ⁱ tsma	atāpsma	-ma
(b) 2 du.	anā ⁱ ṣtam	acchā ⁱ ttam	atāptam	-tam
3 du.	anā ⁱ ṣtām	acchā ⁱ ttām	atāptām	-tām
2 pl.	anā ⁱ ṣta	acchā ⁱ tta	atāpta	-ta

This completes the arguments for śś as a remote representation for root-final kṣ. The observed alternations have been explained without any additional rule apparatus. At this point in their treatment of ɔj Chomsky and Halle consider whether the underlying system they've argued for is plausible or not; they claim--quite incorrectly, I think--that the addition of ɛ̄ to the vowel inventory of English is plausible. Consider now the corresponding problem in the Sanskrit analysis: I have maintained that there are roots ending in the cluster śś. On general grounds, this is an unusual, highly marked cluster (just as ɛ̄ is an unusual, highly marked vowel). And it is peculiar in Sanskrit (just as ɛ̄ is peculiar in English, which lacks other front rounded vowels); there are no other clusters of unlike spirants within Sanskrit morphemes. Unless we can in some way explain away the oddness of morpheme-final śś, we will have saved a rule only at the cost of lexical complexity, and our analysis will be no better than SPE's.

The cluster śś would be unsurprising across morpheme boundaries. Could the final s be a separate formative? As it turns out, there are lexical doublets indicating just this analysis. These are bhā- and bhās-, both 'shine'; śru- and śruṣ-, both 'hear'; and hā- 'leave, go forth' as well as hās- 'go'. The case is clinched by a precious pair of doublets in which an alternation between ś and kṣ corresponds to

the absence or presence of final *s* in the other examples: *as̄-* with *akṣ-*, and *naṣ-* with *nakṣ-*, all meaning 'attain'. That is, there is at least one alternating form to support the treatment of surface *kṣ* as underlying /*s̄* + *s*/.⁷

There has even been some attempt made to characterize the meaning of the morpheme *-s*, which survives in Classical Sanskrit only in a handful of frozen forms. Gonda has examined the connection, made in many standard sources on Vedic, between *bhūṣ-* 'adorn, embellish' and *bhū-* 'be, become, thrive'.⁸ From a careful survey of the textual evidence he concludes that 'in the main, the meaning of *bhūṣati* is: "to make a person or a thing prosper, to add strength to..., to favour etc."' (Gonda 1959, 87), especially by means of adornments or ceremonies with magic value. He maintains (90) that the *s* had causative meaning and cites *bhīṣ-* 'frighten, terrify' alongside of *bhī-* 'fear' as well as possible etymologies for *dviṣ-* 'hate' and *ukṣ-* '(be) sprinkle' treating them as originally morphologically complex.

2.3. The German velar nasal

In the previous section I argued that Sanskrit root-final *kṣ* (alternating with *ṣ*, *ṭ*, *ḍ*, and *k*) should be underlying /*s̄* + *s*/, and I claimed that the process of homing in on this remote representation is supported at each step in a way in which the otherwise quite parallel SPE analysis of *ɔj* as /*ɔ̄*/ is not. The generative phonological literature is full of arguments that home in, but not many of these are laid out in as much detail as the example from SPE, or the one I've supplied as a contrast to it. One excellent illustration of the process is the analysis of the German velar nasal by Vennemann (1970), who summarizes his arguments as follows:

In §8 we...found that because of a phonological rule, [ŋ] must be phonologically bisegmental. In §9-11 the conclusion was forced upon us by phonological and morphological evidence that the first of these two segments is a nasal, the second an obstruent. In §12 we were informed by a phonological rule that furthermore...the obstruent must be voiced. The nasal assimilation condition...tells us that this voiced obstruent must be velar. The only phonological voiced velar obstruent of German is /g/...The conclusion is inevitable that [ŋ] (where it is not flanked by a phonetic velar consonant) derives synchronically from /Ng/. (77-8).

3. Homing in in syntax

The phonological examples of homing in all involve appeals to simplicity (not necessarily, or even usually, in the technical sense). There would be nothing to discuss if we didn't have to worry about keeping down the number of rules, about the wisdom of positing new underlying elements or combination of them, and the like. In this respect, linguistic homing in is like curve fitting, the choice

of continuous curves to fit finite collections of data; there are certain facts to be accounted for, and there are ways of judging some putative solutions as better or simpler than others (in the case of curve fitting, goodness of fit and simplicity of the function graphed by the curve).

In the Sanskrit example I made use of an implicit appeal to explanation as well, when I pointed out that it is no accident that $k\check{s}$ behaves just like \check{s} and \check{s} before obstruents--that given the alternants before sonorants and in final position and given the fact that Sanskrit has an s-Deletion rule, $k\check{s}$ should have the same reflexes in the remaining environments as the simple spirants have there. My analysis, the argument goes, explains the convergence of forms.

Syntactic applications of homing in tend to emphasize the appeals to simplicity and explanation more than the process of constructing a remote representation bit by bit. The following subsections summarize two fairly transparent instances of homing in from the recent syntactic literature.

3.1. Ross' analysis of declaratives

Ross (1970) claims that every declarative sentence has a remote structure in which the content of the surface sentence is dominated by a higher structure with the salient characteristics of the explicitly performative clause

- (1) I declare to you that...

These salient characteristics are at least (a) a first person singular subject, (b) a verb of verbal communication, (c) a second person indirect object, and (d) a direct object with the content of the surface sentence. Ross argues for each of these points individually--proposing to show, for example, that peculiar properties of first person singulars in main declarative sentences reflect peculiar properties of certain embedded noun phrases, namely those dominated by verbs of verbal communication with subjects coreferential to the embedded noun phrases. Thus, the restriction of the reflexive in (2) to the first person singular--compare (3)--reflects a restriction of the embedded reflexive in (4) to pronouns coreferential with the subject of the higher verb; compare (5).

- (2) This is a story about myself.
 (3) *This is a story about himself/themselves.
 (4) He said it was a story about himself.
 (5) *He said it was a story about yourself/themselves.

The factual details of Ross' arguments have been much disputed. For my purposes here, I need only point out that his arguments are arranged to home in on a structure like that of (1), and that they can be seen as making an appeal to explanation and to at least two sorts of judgments of simplicity.

The appeal to explanation comes in the attempt to provide a uniform account for two sets of otherwise disparate data, the peculiar properties of first-person singulars in main declarative clauses and the peculiar properties of pronouns in general in certain types of embedded clauses. The argument runs: it is no accident that there is a parallelism between these sets of properties, for there is a single principle encompassing them both, and for an adequate account of these phenomena the parallelism must be made manifest.

The first simplicity judgment refers to the fact that the structure in (1)--or, at the very least, each of its component parts--is independently required in any description of English syntax. The second appeals to the claim that something very much like (1) is independently required as an account of the semantics of declarative sentences. That is, the Ross analysis does not require the postulation of new sorts of structures. The cost of the Ross analysis, on the other hand, comes in the transformational processes that must be assumed to relate (1) to simple declarative sentences.

3.2. Geis' analysis of conditionals

Another paradigm example of syntactic homing in can be found in Geis' (1973) treatment of unless and only if. Geis argues that the remote structure of unless is essentially that of in any event other than that and that only if is similarly related to in no event other than that. As part of this demonstration he shows that both types of subordinate clauses⁹ have properties like those of clauses headed by event, case, occasion, and the like. He gives evidence as well that unless and only if have properties in common with exclusive constructions, for example those following other than, different from, and except. In addition, he argues that clauses headed by unless behave syntactically like clauses dominated by universal quantifiers (like any), while clauses headed by only if behave syntactically like clauses dominated by negatives.

Again, there is an appeal to explanation--it is no accident that certain constructions share properties with event-clauses, with exclusive constructions, with universal quantifiers, and with negatives. Again also, systematic simplicity can be invoked--the sorts of structures postulated for unless and only if are independently required in an adequate English syntax, or at least their components are, and moreover, something on the order of these structures is needed for an adequate account of the semantics of conditionals.

The central part of Geis' exposition uses the separate instances of shared properties to construct piecemeal a remote representation for the subordinating conjunctions unless and only if. Thereby he homes in on representations like in any event other than that and in no event other than that. Ross uses the same strategy to compose higher sentential structures like I declare to you that. These two articles illustrate nicely the two main lines of inquiry in 'abstract syntax', additional sentential structure (Ross on declaratives) and decomposition of surface lexical units (Geis on conditionals).

3.3. Choice problems

In the Geis and Ross examples the representations built up in the process of homing in are substantially similar to rather superficial representations for other constructions. Sometimes this relationship between two classes of representations presents itself as a problem of choice: here are two (or more) types of constructions which are related to each other (they are near or full paraphrases of each other, and perhaps also they are in complementary distribution or serve as stylistic variants); is there a structural relationship between the constructions, and if so, which is more basic, or are both derived from a structure strikingly different from any of the surface realizations?

Quite a few syntactic problems have been treated in the literature as matters of choice--consider the many discussions on the relationship of passive and active sentences in English and other languages and on the underlying structure of sentences with 'psych' verbs, as in (6) through (11).

- (6) I am surprised that Marcus admires Publius.
- (7) It surprises me that Marcus admires Publius.
- (8) It is surprising to me that Marcus admires Publius.
- (9) Marcus surprises me { by admiring Publius
in that he admires Publius }.
- (10) I am surprised because Marcus admires Publius.
- (11) That Marcus admires Publius causes me to be surprised.

Now it is far from clear that this is the proper way to treat these topics. But even in cases where the simple choice approach has been followed, the analysis proceeds very much as in those of 3.1 and 3.2: it is argued that one of the constructions has a remote structure essentially identical to the surface structure of the other.

More and more, it seems that we need remote representations which incorporate features of each of the surface representations but which are distinct from all of them; or that we need distinct but partially similar representations for the various surface forms. The latter tack is taken, for instance, in recent discussions of the passive by Hasegawa (1968) and Lakoff (1971), who claim that the remote structures associated with active and passive sentences have much in common with each other but are not identical. Such arguments are immensely more complicated than straightforward homing in and therefore lie beyond the scope of this paper.

4. On the method

I hope to have demonstrated in the previous sections that homing in is a valid argument form in both phonology and syntax; but that the correctness of the analysis in a particular case depends upon the extent and value of the data, just as the truth of the conclusion of

a syllogism depends on the truth of its premises as well as on the validity of the form. The utility of homing in will also be limited by theoretical considerations; an analyst committed to concrete solutions will reject the method at the point at which it would lead to analyses unacceptable to him. Moreover, as I indicated in discussing the syntactic examples, homing in will be used in combination with other styles and types of argument. What we aim at is, in the words of Francis Bacon, 'a true and lawful marriage between the empirical and the rational faculty'.

Footnotes

*This is a revision of an inaugural lecture at the Ohio State University, November 29, 1971. Other versions have been presented at the University of Massachusetts, Amherst (February 18, 1972) and the Graduate Center of the City University of New York (February 29, 1972). I am indebted to members of these three audiences for many useful criticisms and suggestions; special thanks are due to Gaberell Drachman, Ilse Lehiste, David Stampe, Frank Heny, James Heringer, and D. Terence Langendoen. My thanks to the John Simon Guggenheim Memorial Foundation for its support of this work.

1. Chomsky and Halle (1968). Hereafter SPE.
2. This section is a much revised and expanded treatment of section 4.1 of Zwicky (1965). The transliterations of Sanskrit forms are essentially standard, but do not show the effects of some late sandhi rules (in particular those affecting final s).
3. A few roots in \bar{s} ($\bar{d}\bar{i}\bar{s}$ - 'point', $\bar{d}\bar{r}\bar{s}$ - 'see', $\bar{s}\bar{p}\bar{r}\bar{s}$ - 'touch', and sometimes $\bar{n}\bar{a}\bar{s}$ - 'attain') show k throughout. See Whitney (1960, 74).
4. The segment customarily transliterated as \bar{y} , whatever its phonetics, functions as a semivowel throughout Sanskrit phonology. See Whitney (1960, 20).
5. (C) might be more general, since there are also cases of $s \rightarrow t$. Moreover, it might be possible to combine (B) and (C) into a single despirantization rule.
6. The argumentation concerns root-final \bar{s} only. It might be possible to support a non-obvious source for the fairly common root-initial cluster $k\bar{s}$, but the material in this paper doesn't bear on the question.
7. A few roots in $k\bar{s}$ require a different treatment. Thus, $\bar{j}\bar{a}k\bar{s}$ - 'eat' is probably to be analyzed as $\bar{j}\bar{a}g\bar{h}\bar{s}$, ultimately as $/\bar{j}\bar{a}+g\bar{h}\bar{s}/$, a reduplicated form of $\bar{g}\bar{h}\bar{a}\bar{s}$ - 'eat'; this treatment is supported by the participle $\bar{j}\bar{a}g\bar{d}\bar{h}\bar{a}$, instead of the expected $\bar{j}\bar{a}\bar{s}\bar{t}\bar{a}$ or $\bar{j}\bar{a}k\bar{s}\bar{t}\bar{a}$. Two other roots, $\bar{m}\bar{r}k\bar{s}$ - 'stroke' and $\bar{b}\bar{h}\bar{a}k\bar{s}$ - 'eat, partake of', have associated forms that suggest underlying $/\bar{j}+s/--$ respectively, $\bar{m}\bar{r}\bar{j}$ - 'wipe' and $\bar{b}\bar{h}\bar{a}\bar{j}$ - 'divide, share'. However, there is no evidence from alternations in inflection, because all the attested forms of $\bar{m}\bar{r}k\bar{s}$ - and $\bar{b}\bar{h}\bar{a}k\bar{s}$ - have a sonorant following the $k\bar{s}$.
8. I am indebted to Calvert Watkins for calling this article to my attention.

9. Also those introduced by if, which is presumably something on the order of in the event that.

References

- Chomsky, Noam and Morris Halle. 1968. The sound pattern of English. Harper and Row, New York.
- Geis, Michael L. 1973. If and unless. In Braj B. Kachru, Robert B. Lees, Yakov Malkiel, Angelina R. Pietrangeli, and Sol Saporta. Papers in linguistics in honor of Henry and Renée Kahane. Univ. of Illinois Press.
- Gonda, Jan. 1959. The meaning of Vedic bhūṣati. Four studies in the language of the Veda. Mouton, The Hague, 71-93.
- Hasegawa, Kinsuke. 1968. The passive construction in English. Lg. 44.2.230-43.
- Hoard, James E. 1973. Naturalness conditions in phonology: with particular reference to English vowels. In Michael K. Brame, Contributions to generative phonology. Univ. of Texas Press, Austin.
- Krohn, Robert. 1972. Underlying vowels in Modern English. Glossa 6.2.203-24.
- Lakoff, Robin. 1971. Passive resistance. Papers from the 7th regional meeting, Chicago Linguistic Society. Dept. of Linguistics, Univ. of Chicago, 149-62.
- Ross, John Robert. 1970. On declarative sentences. In Roderick A. Jacobs and Peter S. Rosenbaum. Readings in English transformational grammar. Ginn, Waltham, Mass.
- Vennemann, Theo. 1970. The German velar nasal: a case for abstract phonology. Phonetica 22.65-81.
- Vennemann, Theo. ms. 1971. Vowel alternations in English, German, and Gothic: remarks on realism in phonology.
- Whitney, William D. 1960. Sanskrit grammar. Harvard Univ. Press, Cambridge, Mass.
- Zwicky, Arnold M. 1965. Topics in Sanskrit phonology. Ph.D. dissertation, M.I.T.