

## Remarks on Palatalization

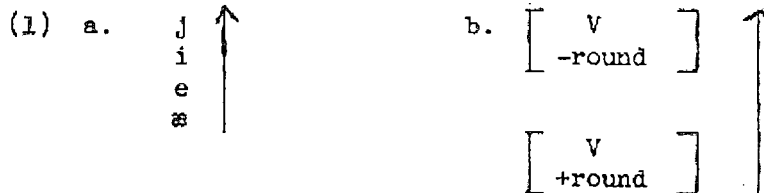
Ronald L. Neeld

### 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]<sub>-back</sub>. 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.<sup>1</sup> In other words there is no language with a rule

(2) C → 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)<sup>2</sup> 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 [rezim] arises from a Latin stem /reg/, so that *g* has shifted to *z*. But this has not happened in the word régularité [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.<sup>3</sup> 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 [çar] '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 → tç, tç', ç / \_\_ high front V

Another rule creating palatals is:

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

c, c', s → tç, tç', ç / \_\_ 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 [tç] when the final begins with a high front vowel, as [mi] → [mei-tçi]. (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.<sup>4</sup> In any event it is clear in this example that palatalization operates before the front rounded vowel y.<sup>5</sup>

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:

$$(9) \quad c \rightarrow c' / \_ \left\{ \begin{array}{l} i \\ e \end{array} \right\}$$

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  $\text{ɛ}$  and  $\text{ɔ}$  are neutralized to a, and only where there is an underlying  $\text{ɛ}$  do palatalized consonants appear before a. The rule is:

$$(10) \quad c \rightarrow c' / \_ \left\{ \begin{array}{l} i \\ e \\ a \end{array} \right\}$$

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  $c, \check{j}, \check{s}, \check{z}$  appear only at certain speech tempos. There is a rule, which I will call Palatal Formation, in which  $\{z, j\} \rightarrow \check{z}, \{s, r\} \rightarrow \check{s}, \{d, g\} \rightarrow \check{j}, \{t, k\} \rightarrow \check{c}$ .<sup>6</sup> The question here is the conditioning environment. Wescott says that  $\check{z}$  results from prevocalic  $zi$  and  $ji$ .<sup>7</sup> 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)	<u>rate 1</u>	<u>rate 4</u>	<u>rate 7</u>	<u>gloss</u>
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:  $i, u \rightarrow \check{j}, w$  before vowels  
 7. Slurred:  $c, \check{j}, \check{s}, \check{z}$  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:<sup>8</sup>

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

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 derivation<sup>9</sup>

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 <sup>s</sup> út <sup>s</sup> ki	'woodpecker'
asita	→	asta	'tomorrow'
kasuka	→	kaska	'faint'
utikatu	→	u <sup>h</sup> kat <sup>s</sup>	'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', [čēnutōa] '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 Rohlf's (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.<sup>10</sup> (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.<sup>11</sup> 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.<sup>12</sup> There is a historical change in Slavic whereby the segments k, g, and x become č, ž and š respectively, with the environment being  $\_ [-\text{cons}]_{-\text{back}}$ . 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.

- \*nožj-u > noẓ̌-u > noži
- \*nožj-omu > noẓ̌-omu > nožemu
- \*nožj-ā > noẓ̌-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)  $k, g, x \rightarrow \check{c}, \check{z}, \check{s} / \_ \left[ \begin{array}{l} -\text{cons} \\ -\text{back} \end{array} \right]$

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-~~ǣ~~- > stoja-

mēguk-~~ǣ~~jisiji > mēguc~~ǣ~~jsiji > mēgucājsiji

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 <sup>+voc</sup><sub>-cons</sub>

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

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.

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

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. ə changed into e after a palatal consonant:

<u>Common Rumanian</u>	<u>Latin</u>
*pál'ə > pál'e	palea
*kún'ə > kún'e	cunea

This also happened when ə was preceded by  $\check{s}$ '; CRum. \*kəmés'ə > \*kəmés'e. In many Rumanian dialects  $\check{s}$ ' lost its sharpness. When  $\check{s}$ ' became  $\check{s}$ , e, i > ə,  $\check{s}$  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.<sup>14</sup> 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

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

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,  $rh = r$ ,  $z = \check{z}$ ,  $s = \check{s}$ ,  $\check{j} = d\check{z}$ ,  $\check{c} = t\check{j}$ .

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, [lɪθuɛjɲiɛn] - [lɪθwɛjɲɲɪn] 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  $\lambda$  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.
- Rohlfss, 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.
- Vasilin, 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.