

A CROSS-LANGUAGE STUDY OF VOWEL NASALIZATION

A Thesis

Presented in Partial Fulfillment of the Requirements  
for the Degree Master of Arts

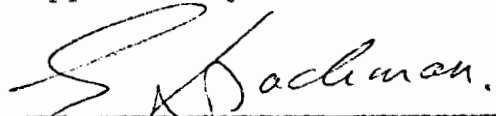
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## TABLE OF CONTENTS

Acknowledgments. . . . .	ii
0. Introduction. . . . .	1
1. The environment for regressive nasalization . .	1
2. Progressive nasalization. . . . .	11
3. A constraint on nasalization. . . . .	13
4. Vowel quality changes. . . . .	19
5. Perceived nasality versus velum-lowering. . .	25
6. Relation between nasalization and nasal loss..	26
6.1 Evidence against compensatory lengthening. .	27
6.2 True compensatory phenomena. . . . .	30
6.3 Evidence for the assimilation solution. . . .	32
6.4 Componential treatment of nasal loss. . . . .	37
7. Summary. . . . .	42

## 0. Introduction

The study of nasalization crucially involves the study of nasal consonants, both because it appears, as Ferguson (59) has claimed, that except for borrowing and analogy<sup>1</sup> contrastively nasalized vowels arise only through loss of a nasal consonant, and because of the structure of the nasal consonant itself of which one striking feature is the independence of oral closure and nasality. This double structure has lead Drachman (1969, 202), Foley (21) and others to view nasals as nasally released stops; but the uniqueness of the nasal consonant rests primarily in the fact that the nasality component can represent the entire segment without accompanying oral closure in the phonetic representation. It is assumed below that several nasalization phenomena can be correctly viewed as the extension, contraction, or migration of the velic opening and oral closure components of nasals. Five aspects of nasalization are examined separately with a view to determining their cross-language characteristics, and in each case an effort is made to account for the tentative universals that emerge from this comparative work by referring to physiological pressures and constraints.

### 1. The environment for regressive nasalization

Below are listed several languages claimed to



- |                                 |                    |
|---------------------------------|--------------------|
| 13.Korean (Jung 13-20)          | __N# (i,u)         |
|                                 | __N (e,o)          |
| 14.Navaho (Sapir and Hoijer 11) | __n,n (.=syllabic) |
| 15.Ayutla Mixtec (Pankratz and  | __N                |
| Pike 289)                       |                    |
| 16.Portuguese (Saciuk 198)      | __N                |
| 17.Old Norse* (Gordon 267)      | __N                |
| 18.Keresan (Spencer 235)        | __N                |

This list provides a basis for the following generalizations:

(1) There are no languages in which non-continuants after nasals permit nasalization when continuants do not also do so. Moreover, there are four languages in which continuants, but not non-continuants, permit nasalization.

(2) Environments which include # are highly favored among these languages. In some--Amoy, Korean (i,u), Hausa--nasalization occurs only word-finally. Of the three languages claimed to nasalize vowels in other environments, but not word-finally, two are known only from written records (Old English and Germanic) and are therefore highly questionable sources for information about a subtle feature like nasality, and the third, French, is not a true exception because, as is well

known, the phrase rather than the word is the relevant unit in French connected discourse. The function of \$ in place of # in the French nasalization rule confirms this treatment; notice also that when French words ending in n are spoken in isolation, they are pronounced with a final nasalized vowel.

In Keresan (Spencer 235) vowels are nasalized before nasals in all positions, but nasalization is more apparent before word-final nasals.

(3) In none of the languages examined are vowels nasalized before prevocalic nasals when they are not also nasalized before all preconsonantal and word-final nasals.

Turning now to the characteristics of the vowel which undergoes nasalization, some generalizations are again possible:

(4) Low vowels are more likely to become regressively nasalized than high ones. Lightner (1970, 214-5) quotes Delattre (unpub. paper) as saying that in French a was nasalized first historically, followed by mid and then high vowels. The same tendency is observed in Korean where nasalization of mid vowels occurs before all nasals, but nasalization of high vowels occurs only before word-final nasals. In Thai (Noss 15) only low vowels are nasalized progressively. In Kashubian (Shevelov) ẽ

is raised in some environments to ĩ and lowered in others to ã; when ẽ is raised to ĩ, nasalization is lost, but it is retained when ẽ is lowered. In none of the languages considered do high vowels become regressively nasalized while low ones do not. Harrington (1946) and Moll (1962) have suggested that low vowels nasalize more readily because the palatoglossus muscles which connect the velum with the tongue musculature tend to draw the velum down when the tongue is lowered for a low vowel.

(5) There also appears to be a tendency for back vowels to nasalize more readily than front ones. In Island Carib (Taylor 231) a, o and u are nasalized word-finally after a nasal, but i and e remain oral. In Ijo (Williamson 17) back vowels are more nasalized than front ones, with i: (c.f. 4 immediately above) least nasalized of all. In Sora and other Munda languages (Stampe, personal communication) only back vowels are progressively nasalized; front and central vowels are unaffected.

(6) Stress and nasalization are strongly corelated. In Irish (O'rahilly 194) only stressed vowels undergo shifts attributable to nasality. In Portuguese (Saciuk 209) a denasalization rule affecting the first member of vowel sequences if it is nasalized affects that vowel only if it is unstressed. In Panama Spanish



(Robe 36) progressive nasalization is claimed to affect only stressed vowels. In the Darmsstadt dialect of German (Keller 166) nasalized vowels have arisen only where stressed oral vowels preceded final nasals. In the Upper Austrian dialect of German (Keller 207) all vowels are nasalized before nasals, but nasalization is often lacking when the vowels in question are in unstressed position in the sentence. In Goajiro (Holmer 1950, 50) "every syllable containing a medial nasalized vowel...has main stress." In Cashibo (Shell 199) only when a contrastively nasalized vowel is stressed does nasalization spread from that vowel to a following one. In early Icelandic (Gordon 267) nasalization was lost first in unaccented syllables. In Island Carib (Taylor 232-3) "nasalization is usually stronger with stressed than with unstressed syllables." And, in the Hopkins dialect of the same language, "in every case where a shift of nasalization occurs, it is accompanied by a parallel shifting of stress." The following forms show the concurrent shift of stress and nasalization:

ida <sup>˘</sup> lia sa	'how is it (that...)?'
má-buga <sup>˘</sup> nía	'didn't I tell thee?'
<sup>˘</sup> io	'hymen'
<sup>˘</sup> tio	'her hymen'

uí-bai	'whistle it!'
uáiriti lía	'great-is-it his-anger'

versus:

ida líā-gi	'how is he?'
aríha niā-dibu	'mind lest I see thee'
gaiōgíru	'she's still a virgin'
maiōharu	'she's no longer a virgin'
tiúira	'she whistle(s,d)'
gáiaha uogóri lèa	'this man got angry'

Consider also:

/gáiu+ẽ/ --- gáie 'eggs'

(See also Taylor 233 for details of a similar alternation.)

Finally, in the same dialect, a "word-final unstressed vowel usually becomes oral when the word takes a suffix."

In none of the languages examined is nasalization of unstressed vowels to the exclusion of stressed vowels attested.

The problem which now arises is what is to be made of these results. If the data are representative, one might be justified in proposing a universal rule of roughly the following form:

$$\left[ \begin{array}{c} \text{v} \\ \text{!stress} \\ \text{!back} \\ \text{!low} \end{array} \right] \rightarrow \left[ \text{+nasal} \right] / \text{---} \text{N} \left[ \begin{array}{c} \# \\ \text{+cont} \\ \text{-cont} \\ \text{+syll} \end{array} \right] \uparrow$$

where exclamation points indicate preferred environments and the vertical arrow indicates a strict implicational hierarchy among the post-nasal conditioning factors; thus, if vowels are nasalized before a nasal followed by any element of the hierarchy, then they are also nasalized before all elements listed in the hierarchy above that element.<sup>2</sup>

The position adopted here, however, is that the formula above is an expression of several constraints on regressive nasalization and is not itself necessarily a universal rule. This reservation seems essential in light of the absence of arguments for the stronger position.<sup>3</sup>

It seems likely that further investigation will provide more detail to the present formulation--for example some specification of which continuants are most likely to permit nasalization before a preceding nasal, and perhaps of which nasals facilitate nasalization and of finer detail in the ease with which different vowels undergo nasalization.

The reluctance of syllabics to permit nasalization before a preceding nasal can be explained by referring to syllabification. Since languages normally exhibit CV syllables, all that needs to be said is that a nasal

which attaches itself to a following syllable (normally the case when a nasal is followed by a vowel) is least likely to nasalize a preceding vowel. Stampe (personal communication) points out that the reluctance of nasalization to spread across syllable boundaries can be seen in the English words

zī.no 'Zeno' (only slight nasalization of ī)  
 1 3

fī̃.o 'Finno(-Ugric)' (heavier nasalization of I)

Drachman and Drachman (1971) have offered a partial explanation for the constituency of the post-nasal hierarchy. They note that in Greek voiceless continuants permit vowel nasalization before a preceding nasal more readily than voiceless stops:

The reason for this seems to be that, since the velum is necessarily raised to satisfy the air-flow (or pressure) condition for the continuant (or stop), it is lowered for the nasal segment prematurely. But if the velum lowering is sufficiently early, the stop component may well be inhibited altogether; the time allotted to the nasal will be added to the preceding vowel, since that time is required in any case for the velum to rise again for the following consonant.

These observations coincide with the view expressed earlier, that nasality is the information-bearing component of the nasal.

This explanation is very appealing; indeed, it is difficult to imagine a better one since the require-

ment which must be met by any theory on this point is that it account for the fact that the vowel is affected by a segment two places to its right. It therefore seems necessary to posit an explanation involving anticipation.

Interestingly, a solution involving pressure and air-flow does not account for the fact that a word boundary is the most likely environment for nasalization. A different principle seems to operate in final position. One possibility emerges if we consider that the range of planning of words is greater than a single segment. In the VNC cases, the velum will act conservatively because it must shut later in the word (a time-consuming operation; see Bjork 1961); that is, it will remain as nearly approximated as it can while still enabling the contrastive function of nasality (of the consonant), but in the case of word-final nasals, the velum need not be prepared for a new ascent and can therefore open early and more completely and remain open longer (c.f. Keresan above).

This speculation is consistent with an experiment by Moll (1962) in which it was shown that the velum is lowered more when oral vowels are spoken in isolation than when they are flanked by consonants. Unfortunately, the validity of this study is questionable because the corpus consisted of nonsense syllables. More clearly relevant is a study by Bjork (1961) in which it is shown that

the velum can be lowered quickly, but must be raised very slowly.

## 2. Progressive nasalization

Progressive nasalization has been all but ignored in studies of nasalization although examples of this phenomenon are not scarce. The degree of nasalization can vary from slight (English, Portuguese<sup>4</sup>) to heavy (Yoruba, Warao, Sundanese, Navaho, Sora). The following list contains several languages claimed to show progressive nasalization, along with the environments in which nasalization occurs and the source of the data:

- |  |     |                        |
|--|-----|------------------------|
| 1. Ayutla Mixtec (Pankratz and Pike 289) | N__ |                        |
| 2. Cora (McMahon 133)                    | N__ |                        |
| 3. Picuris (Trager 32)                   | N__ |                        |
| 4. Sundanese (Robins 91)                 | N__ |                        |
| 5. Yoruba (Ward 13)                      | N__ |                        |
| 6. Central Ewe (Stahlke 51)              | N__ |                        |
| 7. Land Dayak (Scott 432)                | N__ |                        |
| 8. Icelandic (Gordon 267)                | N__ |                        |
| 9. Fanti (Welmers 16)                    | N__ | (freedom of degree)    |
| 10. Ijo (Williamson 17)                  | N__ | ("somewhat nasalized") |
| 11. Navaho (Sapir and Hoijer 11)         | n__ | (heavy)                |

- 12.Sora (Stampe, personal communi- m\_\_ (not n\_\_)  
cation)
- 13.Portuguese (Saciuk 203) N\_\_ (minor rule)
- 14.Warao (Osborn 111-2) N\_\_  
#m\_\_#
- 15.Eskimo (Thalibitzer 153) m,n\_\_# (optional, .  
effects e only)
- 16.Hindi-Urdu (Narang and Becker {#}m{#}  
657) {+}—{+}
- 17.Thai (Noss 15) N,h,#\_\_

Languages with progressive nasalization do not necessarily inhibit regressive nasalization. Both types are attested for Mundari, Ijo, Navaho, Fanti, Portuguese, Icelandic and Thai. It is, of course, impossible to make negative statements about the presence of nasalization without experimental verification; so in the absence of such evidence it would be pointless to speculate about the existence of languages having exclusively one type or the other.

In at least four of the languages with progressive nasalization (Ayutla Mixtec, Yoruba, Navaho, Ijo) the distinction between oral and nasal vowels is neutralized after nasal consonants, but this is not a necessary concomitant of progressive nasalization; in Picuris underlying and surface nasalized vowels contrast on the sur-

face, but there are apparently vowel quality changes which enforce the distinction (Trager 32).

In Sora (Stampe, personal communication) the hierarchy of vowel heights posited above for regressive nasalization (sect 1) is reversed. Back vowels after m are nasalized, but u receives heavy nasalization, o less heavy, and ɔ least of all. Notice that if the velum remains at the same degree of closure, production of a high vowel will shunt proportionally more air through the nasal cavities producing heavier nasalization than for a low vowel. It appears, therefore, that we must recognize two different tendencies for the nasalization of vowels: if the velum remains stationary, higher vowels will be more nasalized than lower ones (so far this has only been observed for progressive nasalization); on the other hand, if the velum bows to anatomical pressures, low vowels will be more nasalized. Since we would expect to find some languages in which both tendencies operate simultaneously, it is not surprising that in Yoruba nasalization (again progressive) is heavy for both high and low vowels, but light for the mid vowels e, ɛ, o, ɔ.

### 3. A constraint on nasalization

In most of the languages considered in this study,



nasalization spreads only to vowels adjacent to the nasal (data is not often available concerning diphthongs). But in several languages nasalization spreads into distant syllables, subject to the following constraints:

(1) In Warao (Osborn 111-2) nasalization initiated by a nasal consonant spreads progressively until it encounters either juncture or a consonant other than the glides w, y, and h.

mõãũ	'give it to him'
nãõ	'come'
inãwãhã	'summer'
mõỹõ	'comorant'
mẽhõkõhi	'shadow'
nãõte	'he will come'
mõãũpu	'give them to him'
mõãũ#ihi	'give it to him, you!'

(2) A strikingly similar phenomenon is observed in Sundanese (Robins 91). Nasality initiated by the production of a nasal consonant is stopped only by supraglottally articulated consonants, but spreads freely through h and glottal stop<sup>5</sup>.

mãro	'to halve'
ɲiãr	'to seek'
ɲãĩã	'to wet'
nĩĩs	'to take a holiday'
mĩasih	'to love'
kumãhã	'how?'
ɲãhõkõn	'to inform'
bɛɣhãr	'to be rich'

(3) The constraint also holds for regressive nasalization. In the Kolokuma dialect of Ijo (Williamson 16) nasalization spreads regressively from nasals and is stopped only by juncture or consonants other than w, r, and y.

(4) In Tereno (Bendor-Samuel 350) nasalization is a suprasegmental morpheme denoting first and second person pronouns. It starts at the beginning of either a verb or noun and spreads as follows: "all the vowels and glides are nasalized up to the first stop or fricative," but nasalization spreads freely through h and glottal stop.

(5) In Ayutla Mixtec (Pankratz and Pike 289) nasalization spreads progressively through an intervocalic glottal stop:

$$\left\{ \begin{array}{c} V \\ VV \\ V?V \end{array} \right\} \rightarrow [+nasal] / N \underline{\quad}$$

but is stopped by other consonants.

(7) In Island Carib nasalization shifts with stress, but "nasalization cannot follow stress when the latter moves across consonant boundaries" (Taylor 233).

sũ	'all, every'
sũhali	'he has finished'

but

ásura	'to finish'
-------	-------------

Similarly:

busuẽ	'in need/want of'
busẽti	'he wants'

but

abúsera	'to want'
---------	-----------

(8) Holmer (1952, 220) remarks that in Seneca "nasalization affects all adjacent vowels and may even extend over a semi-vowel, as in kawenyahsa 'her heart'" = [kãwẽ.].

(9) In Greenlandic Eskimo (Thalbitzer 153) nasalization spreads from a nasal to a preceding r, "often even spreading to the vowel before r."

(10) Stampe (personal communication) reports that in Midwestern dialects nasalization spreads through r, l, w, j, i, u, h, and vowels. It is interesting in connection with what was said in section 1 about the relation between stress and nasalization, that in these

dialects nasalization spreads to a syllable with main stress, but not beyond it; thus

raĩm	'rhyme'
fjũm	'fume'
helən	'Helen'
hālriŋ	'hollering'
klērəts	'Clarence'

but

riwairiŋ	'rewiring'.
----------	-------------

(11) In Land Dayak (Scott 435) "prosodic glottal stop, as a junction feature, does not check [progressive] nasalization...Intervocalic h, j and w do not in all cases check nasality."

nihĩn	'place'
simihĩŋ	'ten'
nāhān	'bear'
pimājĩn	'a game'
pijũm	'kiss'
ŋājũn    nājũn	'swing'
nũwāj	'pour'

(Scott neglects to mention that in each of these examples there is a supporting nasal in the final syllable which would not, alone, be sufficient to provoke nasalization of an adjacent vowel.)

These facts, along with the absence of languages in which nasalization spreads through obstruents, suggest the following constraint on nasalization:

A.0 Nasalization initiated by a nasal segment<sup>6</sup> may never spread through an obstruent.

Gibson (258) claims that in Pame "nasalization is a suprasegmental phoneme...continuing [from a certain vowel] to the end of the word." If the spread of nasalization in Pame is indeed unrestricted, it represents a counterexample to our constraint; but examination of the data given by Gibson in support of his claim fails to turn up a single case of nasalization spreading through an obstruent:

lanhãt	'they will arise'
ŋgolhẽrẽ	'tamale'
nanã	'his tongue'
khãrãt	'they put him in office'
mãikt	'let's go'
snahôl?	'his shirt'
taʔehilʏk	'you sleep (du.)'

Here the only segments which offer no resistance to spreading nasalization are glottal stop and h.<sup>7</sup>

Stampe (personal communication) points out that

in the midwestern dialects discussed above nasalization sometimes spreads through a fricative, as in

hæznt                'hasn't'

which necessitates reformulation of the constraint to allow nasalization to occasionally spread through lax obstruents. But rather than attempt to adjust the constraint as new and slightly different counterexamples turn up (as they are bound to) it seems preferable to formulate the constraint as follows:

A: Nasalization will not spread from an  
initiating segment through a segment  
whose airflow or oral pressure requirements  
are so high that the velum is forced to  
close.

This formulation in physiological terms has three advantages over the earlier form of the constraint:

- (1) It gives a principled explanation of the observed data;
- (2) It is empirically testable;
- (3) It permits variation in the set of segments which may be penetrated by nasalization in particular languages.

#### 4. Vowel quality changes

Often, but by no means always, the quality of a

vowel changes when it becomes nasalized (beyond the change in quality attributable to nasalization itself). Following the data listed below is a composite diagram on which directional tendencies can be clearly seen. Arrows indicate the origin and destination of each change. Dotted lines indicate vowel shifts which occur only in the vicinity of nasal consonants, but where vowel nasalization is not specifically attested. In each case oral vowels (or vowels not adjacent to nasals in the case of the dotted lines) do not shift.

1. Mezquital Otomi (Wallis 215)     $\tilde{a} \text{---} \tilde{ɔ}$
2. French (Schane 48)                 $\tilde{e} \text{---} \tilde{a}$   
     $\tilde{i} \text{---} \tilde{e}$   
     $\tilde{e} \text{---} \tilde{e}$   
     $\tilde{y} \text{---} \tilde{œ}$   
     $\tilde{ø} \text{---} \tilde{œ}$  (nasalization accompanied by nasal loss)
3. Germanic (Moore and Knott)     $\tilde{a} \text{---} \tilde{o}$  (after nasal loss)
4. Hindi (Fairbanks and Misra     $\tilde{e} \text{---} \tilde{e}$   
     xvii)
5. Peki dialect of Ewe (Stahlke     $\tilde{o} \text{---} \tilde{ɔ}$  (historically)  
     51)                                 $e \text{---} \tilde{e}$

6. Irish (O'rahilly 194)      ě---ĩ (stressed vowels  
                                    ō---ũ only)
7. Southern Irish (O'rahilly 195)      ă---ō
8. Scottish Irish (O'rahilly 195)      ǝ---ō  
                                    ǝ---ě
9. Slave (Howard 42-7)      ǝ---ō
10. Slavic (Halle 295)      ě---ǣ  
                                    ō---ũ
11. Hidasta (Halle 296)      ě---ĩ  
                                    ō---ō
12. Yoruba (Ward 7, 12)      ǝ---ō^  
                                    ĩ---ĩ^  
                                    ũ---ũ^
13. Old Norse (Gordon 275)      ǝ---ě (if no N-loss, no  
                                    ũ---ō shift occurred)
14. Portuguese (Saciuk 198)      ă---ă^  
                                    ě---ě  
                                    ǝ---ō
15. Kashubian (Shevelov)      ě---i  
                                    ě---ă / — {#  
  hard dentals



16. Siouan (Wolff 68-71)       $\tilde{a} \rightarrow \tilde{o}$  (historically in  
                                   $\tilde{u} \rightarrow \tilde{o}$  Osage)
17. ~~Siouan~~ (Wolff 68-71)       $\tilde{u} \rightarrow \tilde{a}$  (historically in  
                                  Omaha-Ponca)
17. Burmese (Haas 28-9)       $\tilde{i} \rightarrow \tilde{I}$   
                                   $\tilde{a} \rightarrow \tilde{a}$   
                                   $\tilde{u} \rightarrow \tilde{U}$
18. Pame (Gibson 258)       $\tilde{u} \rightarrow \tilde{o}$
19. Gujarati (Pandit 56)       $\tilde{a} \rightarrow \tilde{u}$  (oral a unchanged)
20. Southern English (Foley 65)       $\varepsilon \rightarrow I$  (/\_\_n)
21. Assiniboine (Levin 14)       $i \rightarrow a$  (when i occurs morphologically /\_\_n)
22. White Tai (Fippinger and Fippinger 93)       $e \rightarrow i$  (historically before  
                                   $o \rightarrow u$  nasals)
23. Russian (Lightner 1963, 295)       $\overset{V}{+grave} \rightarrow \bar{u}$  /\_\_NC  
                                   $\overset{V}{-grave} \rightarrow \bar{o}$  /\_\_NC



From this diagram it is apparent that vowels tend to shift back in the mouth rather than forward. The only language in which a nasalized vowel shifts forward is Omaha-Ponca (perhaps not a counterexample, depending on the exact phonetic quality of a). The explanation for this tendency is not-self evident, but one strong possibility is that backing of vowels equalizes the volume of the oral and nasal pharynges, as in French (Delattre 1968), causing severe reduction of F1 and thereby heavy perceived nasality (see sect 5).

Although it is often claimed (e.g. Lightner 1970) that vowels tend to lower when they becomes nasalized, the diagram shows that this tendency is not very pronounced.

Since vowels in which nasalization is not specifically attested exhibit approximately the same tendencies as those with nasalization, the two groups have not been plotted separately. The question still remains, therefore, whether it is the nasal or the nasalization which causes the shifts. Presumably some nasalization of a prenasal vowel is inevitable, since if the velum began to lower only after the initiation of oral closure for the nasal, we would observe velic plosion at the onset of nasal consonants;

## 5. Perceived nasality versus velum lowering

One issue which must be resolved if nasalization is to be fully understood is the extent to which perceived nasality is attributable to factors other than velum-lowering. Moll (1962) suggests that the nasalization of æ may not be primarily due to velum lowering, but instead to damping caused by jaw lowering. This conclusion is confirmed by House and Stevens who point out that even when æ was synthesized without any nasal coupling, it was still perceived as somewhat nasalized. The acoustic correlate which these experiments identified as the cue for nasality is wider bandwidth of the first formant.

In a remarkable study Delattre (1968) has shown that vowel nasalization is produced differently in French than in, for example, English or Portuguese; that is, not by velum-lowering alone, but by velum-lowering in conjunction with equalization of the volume of the oral and nasal pharynges. The striking acoustic effect of this cineradiographically confirmed articulatory phenomenon is that the first formants of all French nasalized vowels are weak and all at the same frequency. Simple lowering of the velum produces attenuation of F<sub>1</sub>, while the 'double' nasalization

nasalization of French is more marked and characterized not only by attenuation of F1 but also by virtual annihilation of its harmonics.

Finally, notice that Williamson (16) claims that in Ijo nasalization is perceptually heavier after m than n, but she notes that kymography shows the degree of nasal airflow to be identical for both consonants.

It seems likely that these observations will assume considerable importance when more subtle aspects of nasalization are studied.

#### 6. The relation between nasalization and nasal loss<sup>8</sup>

A process which causes sequences VN to be realized as long nasalized vowels occurs frequently in natural languages, both synchronically and diachronically. Lightner (1970) considers three alternative analyses for this phenomenon:

- (1)nasalization of the vowel; loss of the nasal;  
compensatory lengthening of the vowel.
- (2)nasalization of the vowel; lengthening of the  
vowel; loss of the nasal
- (3)nasalization of the vowel; complete assimilation of the nasal to the nasalized vowel.

He argues that the first solution is wrong because

compensatory lengthening is an "ill-conceived notion" and cites four examples to justify this claim. He argues against the second solution indirectly by showing that the third solution is preferable.

I will first argue that the first solution cannot be rejected as easily as Lightner claims, since his arguments against compensatory lengthening are insubstantial. Finally, I will suggest that none of the three solutions listed above is entirely correct because all are constrained by unrealistic notational conventions. I will argue in favor of a solution involving 'migration' of articulatory components (c.f. Drachman 1969, 202).

#### 6.1 Evidence against compensatory lengthening

Lightner cites four examples to show that compensatory lengthening is a mistaken notion and that, therefore, a solution involving compensatory lengthening cannot be correct. In Latin [fagtus] became [fa:xtus] (Lachmann's Law), but [faktus] became [faxtus]. Lightner adopts the reasonable and traditional position that vowels were lengthened before voiced stops, followed by regressive voicing assimilation in clusters. Foley (ms.) has claimed that the process consists rather of weakening of [g] to [x] with corresponding strengthening

(compensatory lengthening) of the vowel. But, as Lightner points out, Foley's position is untenable because no vowel lengthening accompanies the corresponding lenition of [k] to [x] in Latin. This does not, however, constitute evidence against compensatory lengthening as it has ordinarily been conceived; the traditional circumstance in which compensatory lengthening has been recognized involves the complementary reaction of one segment to the disappearance or change in duration of an adjacent one.

In Japanese /i/ and /u/ can be devoiced in certain environments. Lightner maintains that these voiceless vowels can be optionally deleted, and that if they are, the preceding consonant is lengthened. Since, he claims<sup>9</sup>, clusters arise in Japanese only through the loss of voiceless vowels, we can write

$$V \rightarrow \emptyset \quad (1)$$

$$C \rightarrow [+long] / \_\_ C \quad (2)$$

which, however, doesn't directly capture the notion of compensatory lengthening. The rules can capture the appropriate generalization only if their order is reversed and the second assumes global properties; thus:

$$C \rightarrow [+long] / \_\_ V^* \quad (2a) \quad (* = \text{to be deleted})$$

$$V \rightarrow \emptyset \quad (1)$$

But Lightner rejects these solutions because both appear to involve an unconditioned deletion rule, a type of rule whose existence in natural languages is highly questionable; he chooses instead an analysis in which the vowels totally assimilate to the preceding consonant.

If it is indeed true that any voiceless vowel can be lost in Japanese, we might be able to regard the rule that deletes vowels as a stronger form of the amply conditioned devoicing rule (Ohso 22) but this may be unnecessary since Mieko Han (41) claims to have shown experimentally that Japanese voiceless vowels are not deleted at all: "the time dimension of the vowel phoneme is often taken by the preceding consonant, or period of quasi-silence, but it does not disappear." She presents spectrograms which show that traces of the vowel do indeed remain.

Lightner cites monophthongization as a third example of the non-existence of compensatory lengthening. His claim is that the solution involving deletion of one vowel (e.g. ou---ū, eu---ū) followed by compensatory lengthening of the other is counterintuitive and that cases of monophthongization are fundamentally the same, in his view, as the Japanese exam-



ple--that is, they involve only assimilation and not deletion.

Finally, Lightner claims that the development from Latin skriptus to Italian skritto clearly involves complete assimilation rather than deletion of the first stop and compensatory lengthening of the second.

Notice that in the cases of monophthongization and the development of Italian Lightner's claims are based only on intuition. The Japanese example is apparently faulty, and the first Latin example is not relevant at all since it only disqualifies the extension of compensatory lengthening to situations where neither segment loss nor complementary lengthening is involved; thus these examples do not constitute evidence against compensatory lengthening.

## 6.2 True compensatory phenomena

Before continuing, I will give some arguments in favor of the existence of one kind of compensatory lengthening. In Karok (Bright 9, 17-8) distinctively short vowels are normally followed by phonetically long consonants. The rule can be stated as follows:

$$C \text{ --- } [-\alpha\text{long}] / \left[ \begin{smallmatrix} V \\ \alpha\text{long} \end{smallmatrix} \right] \text{ ---}$$

Here it is impossible to interpret compensatory lengthening as assimilation. One segment reacts to the duration of an adjacent one in such a way that the combined length of the two segments remains relatively constant. Probably the process which assigns phonetic length to consonants following vowels in Karok is similar to syllable structure processes in that it creates maximal contrast between adjacent segments; that is, compensatory lengthening here enhances the contrast between long and short vowels. Roughly the same phenomenon is observed in Italian (Agard and Pietro 11) where stressed vowels are short before geminate clusters and long before simple consonants. Allen (1962, 56) remarks that in Classical Sanskrit "gemination was automatic after short vowels." Elert (1964) has shown that in Icelandic, Norwegian, and Swedish there is an inverse relationship between the quantity of a vowel and that of a following consonant.

Strangely, Lightner has failed to include in his list of examples any of the kind which have traditionally been regarded as examples of compensatory lengthening. Thus, for example, in Bloomfield (1933, 379-80) we find only examples in which vowels are lengthened in response to consonant loss.<sup>10</sup>

Old English: niht, nixt ---modern Scotch: ni:t

Pre-Latin: dis-lego ---Latin: di:ligo:

Early Latin: cosmis ---Latin: co:mis

P.I.E. \*nisdos ---Latin: ni:dus

Gothic: bringan versus Gothic bra:hta (loss of nasal).

Of course, since it is precisely this kind of compensatory lengthening that is at issue in the present case, a genuine argument against the compensatory lengthening solution would have to treat examples like those listed immediately above.

### 6.3 Evidence for the assimilation solution

Lightner believes that the development from drink to Old Norse drekka must historically have involved nasalization and lowering of the vowel, followed by assimilation of the nasal to the following stop and denasalization of the vowel; thus

drink--drēnk--drēkk--drekk.

He further claims that the development

drink--drēnk--drē:k--drekk

cannot be seriously considered in the absence of independent evidence for vowel lengthening. Lightner does not say in what sense this example constitutes evidence for the assimilation treatment of the VN--- $\tilde{V}$ : examples.

He cites Gordon's claim (267) that Old Norse had geminate stops in words like drekka, but there is some reason to doubt that Old Norse ever really had double consonants. In modern Icelandic (Einarsson 1949) orthographic geminate stops are phonetically 'preaspirated'; thus drekka is now [drehka] and what has apparently taken place is incomplete assimilation of the nasal to the following stop (loss of nasality, voicing and point of articulation). This is not an implausible development, since a synchronic rule of Menomini (Bloomfield 1939, 113) has precisely the same effect (n-->h/\_C) and a similar rule is found in Kitsai (Bucca and Lesser 18: n-->h/\_t,k, ? ). But even if the phonetic facts in Old Norse were what Lightner claims, they would not constitute clear evidence for assimilation of nasals to vowels in the VN-->V: process. The absence of vowel length is predictable from Lightner's theory (presumably his argument would run that only when the nasal is lost by assimilation to the following consonant does vowel length fail to appear), but the alternative solution to be developed below makes the same prediction.

The most interesting evidence Lightner presents is from Lithuanian. Here is the relevant information:

1. Long and short vowels contrast.
2. Stressed short vowels are characterized by high pitch.
3. Diphthongs may have the structure VV, VL or VN (this is determined only by the way in which such combinations are affected by suprasegmentals; see 5 below).
4. Before j, v, l, r, m, n, s, z (=class Z), VN is realized as V: (Lightner assumes that nasalization has been eliminated by a further rule).
5. Diphthongs and long vowels have either rising or falling pitch. Kenstowicz (1969) has shown that it is possible to account for rising and falling pitch by supposing (1) that long vowels are underlyingly VV and (2) that one member of each underlying diphthong is marked for accent (high pitch). Consider, for example,

/bre<sup>+</sup>t+o/ -- bré<sup>+</sup>nto      /bre<sup>+</sup>ns+ti/ -- bré<sup>+</sup>:sti  
 /bre<sup>+</sup>nd+o/ -- bré<sup>+</sup>ndo      /bre<sup>+</sup>ns+ti/ -- bré<sup>+</sup>:sti

Notice that we apparently cannot write

$$V \rightarrow [+nasal] / \_\_\_ N \left\{ \begin{smallmatrix} \# \\ Z \end{smallmatrix} \right\} \quad (1)$$

$$N \rightarrow \emptyset / \left[ \begin{smallmatrix} V \\ [+nasal] \end{smallmatrix} \right] \_\_\_ \quad (2)$$

because the second rule would cause suprasegmental information to be lost when N is the element marked for stress. A preferable solution appears to be

$$V \rightarrow [+nasal] / \_\_\_ N \left\{ \begin{smallmatrix} \# \\ Z \end{smallmatrix} \right\} \quad (1)$$

$$N \rightarrow V_i / V_i \_\_\_ \quad (2a)$$

The trouble is that, as Lightner himself points out in a totally different connection, there is 'presumably... a general split between segmental and suprasegmental phonology (1970, 187)." He therefore presumes himself that suprasegmentals need not be strictly aligned with segmental phenomena, in which case his own rule (2a) would be ill-founded. Moreover, even if suprasegmentals do respect segmental constituents in this instance, it would be incautious to expand the assimilation solution to other languages on the basis of this evidence alone because it might be that the pressure to retain suprasegmental information in Lithuanian causes speakers to reinterpret nasal loss as an assimilation. On the other hand, we might simply entertain the possibility that suprasegmentals align themselves with underlying rather than surface representations which is equivalent to hypothesizing that a rule deleting a segment leaves its suprasegmental constituents intact in accordance with

the idea that there is a split between segmental and suprasegmental phenomena.

I will also mention other criticisms of Lightner's treatment recently presented by Kenstowicz (1970, 103-8). He first questions Lightner's facilitating assumption that there is a vowel denasalization rule in Lithuanian in view of the fact that there is no vowel nasalization in the surface phonetic representation of Lithuanian words, and because Lightner's assumption is based only on poorly justified intuitions about universals. But, more importantly, he questions the assimilation solution itself as follows:

...the validity of this analysis is far from obvious. Notice that the "assimilation" is complete, i.e. no property or feature of the original segment -the /n/- is retained, except for the accent. But it is reasonable to suppose that assimilation is of a continuous nature in which one segment becomes more and more similar to another to the limiting case of complete identity. Furthermore, it seems that clear cases of complete assimilation arise only when the two contiguous segments are already similar to begin with... Finally, it seems reasonable to assume that a hierarchy is involved in assimilation such that complete assimilation implies partial assimilation, but not vice versa... If these remarks are correct then the assimilation analysis for Lithuanian vowel-nasal sequences becomes rather suspect. Not only are there no properties of the dental nasal left behind, but it is rather difficult to imagine what such traces might be in a case such as this where the distance between /n/ -a consonant- and a vowel is rather great, involving a transition across most of the feature properties-- a fact which by itself casts suspicion on the analysis in the first place,

given the few if any clear cases of direct conversion between consonants and vowels in language.. Note that there is a much more straightforward analysis of the Lithuanian data in which only one rule is involved: elision of the dental nasal /n/ with (compensatory) lengthening of the preceding vowel.

In Polish, nasalization occurs before word-final and precontinuant nasals. Nasals are lost before l. A problem arises here because nasal loss does not affect the preceding vowel. This is a difficulty for both the assimilation solution and one involving nasal loss, since both predict that the vowel will lengthen. But notice that the two solutions handle this problem in different ways. Lightner must claim that there is a process which simplifies the double vowel that results from assimilation; while in the case of the deletion solution, all that needs to be said is that vowel lengthening has been inhibited for some reason.

#### 6.4 The componential treatment of nasal loss

I will now argue in favor of a fourth solution to the problem of nasal loss, one involving the independence of articulatory components (c.f. Drachman 1969, 202-4). Notice that this solution involves compensatory lengthening and, in a sense, deletion and assimilation as well, but that these three observed phenomena will now be



viewed as concomitant effects of the migration of the oral closure component of the nasal toward the end of the word.

First consider three languages in which this notion of component migration seems essential:

(1) In Hausa (Hodge 10-1) final m and n may optionally be realized post-vocally as nasalization of the vowel plus a "lightly pronounced" remnant of the nasal.

(2) In Keresan (Spencer 235) "among some speakers the final nasal consonant may be almost inaudible with a result that a heavily nasalized vowel is heard."

(3) In Brazilian Portuguese (Dahl 315-7) "some trace of the nasal consonant always persists" when vowels are nasalized by a following nasal.

Three comments are necessary. First notice the complementary relationship between the duration of oral closure and vowel nasalization in Hausa and Keresan. This is best handled as rightward migration of oral closure, while nasalization remains where it was. Next, we must reconsider the example of vowel 'deletion' in Japanese in the light of these new examples. Notational conventions do not currently permit us to represent 'trace segments' as such; they must either be represented as full segments, or not given segment status at all. Also, the notion of compensatory lengthening is beyond the scope of rules as normally written if the lengthening is strictly comple-

mentary. Even with multivalued features it is impossible in principle, given the standard notation, to express the fact that one segment donates a specific but infinitely variable portion of its duration to an adjacent segment. Finally, I call attention to some recent work by Ilse Lehiste (personal communication). She found that English words with the structure CVRC have essentially the same duration as corresponding words with CVC structure (e.g. cat versus can't). The generalization here is that VR and V both function as syllable nuclei as demonstrated by their nearly identical durations. This is not the case if an obstruent O is substituted for the resonant R (cat and cast do not have the same duration). Lehiste points out tentatively that while metathesis of VR ( $--\rightarrow RV$ ) is well-attested, metathesis of VO in words of the form CVOC is not observed. A conclusion that can be drawn here is that the oral closure of a nasal, at least in a syllable nucleus, is relatively more mobile than the closure in a non-nuclear VO sequence, which is a similar claim to the one being made here. Also notice that Lehiste's findings provide a motivation for compensatory lengthening of the vowel when the nasal is lost from VN sequences, since the length of the syllable nucleus apparently



which can be handled the same way. Also

$p \rightarrow b^m / \_\_.m$  (optional)

which can be treated again as regressive migration of nasalization.

Without recognizing the tendency for the nasality component of Maxikali nasals to migrate 'leftward', we have no way of capturing the essential identity of these three phenomena.

(3) In the Dakota dialect studied by Matthews (59)

$\tilde{V} \rightarrow V / \_\_.\text{nasal}$  allophone of b, t, k

To account for this phenomenon without componential migration we require two ordered rules:

$C \rightarrow [+nasal] / \left[ \begin{smallmatrix} V \\ [+nasal] \end{smallmatrix} \right] \_\_$  (1)

$V \rightarrow [-nasal] / \_\_ \left[ \begin{smallmatrix} C \\ [+nasal] \end{smallmatrix} \right]$  (2)

(Note: vowel nasalization does not occur before true nasals!). We can eliminate both the necessity for a strange dissimilation rule<sup>11</sup>(2) and rule ordering by positing componential migration.

## 7. Summary

### (1) Regressive nasalization

(a) Regressive nasalization occurs most readily before word-final nasals, less so before nasals followed by continuants, even less before nasals followed by non-continuant, and is most likely to be inhibited before nasals preceding vowels. These four post-nasal conditioning factors are arranged in a strict hierarchy such that those later in the foregoing list imply those earlier on. The post-nasal hierarchy can be explained by referring to sluggishness of the velum as an articulator (Bjork 1961), the requirement that the velum be raised in time to enable the pressure and airflow needs of post-nasal consonants to be met, and the tendency for vowels to be nasalized only by nasals in the same syllable.

(b) Vowels which undergo regressive nasalization are optimally low, back, and stressed.

### (2) Progressive nasalization

(a) Languages may have both progressive and regressive nasalization.

(b) Neutralization of distinctive nasalization is generally (but not always) observed in languages with progressive nasalization.

(c) It is necessary to recognize two vowel hier-

archies for progressive (and possibly regressive) nasalization--one based on anatomical pressures (connection of the palatoglossus muscles and the musculature of the velum) and the other based on speaker-controlled immobility of the velum.

### (3) Spreading nasalization

Nasalization does not spread from an initiating segment through a segment whose airflow or oral pressure requirements are so high that the velum is forced shut. The set of segments permitting penetration by nasalization in particular languages is observed to vary slightly.

### (4) Vowel shifts

When vowels become nasalized, they strongly tend to be backed rather than fronted. There is not a very marked tendency for vowels to lower when they become nasalized.

### (5) Nasal loss and nasalization

When, as is most frequently the case, nasals are lost to the left (rather than by assimilation to a following consonant producing gemination), they are lost through migration of the oral closure component of the nasal toward the following (almost invariably homorganic) consonant or word boundary, leaving the nasalization behind on the vowel as the information bearing component. Compensatory lengthening of the vowel is an automatic feature of this solution.

## Footnotes

<sup>1</sup>Ferguson mentions a single counterexample to this putative universal: in Iroquoian "one of the nasalized vowels posited for the protolanguage seems, on considerations of internal reconstruction, to have derived from earlier /a/ +/i/ or sequences like /awa/"(59). Beyond this, Bengali has at least one nasalized vowel which derived from a Vr sequence: śāp̃<sarp, 'snake,' c.f. Sanskrit srp̃. In Spanish of rural Panama (Robe 36) nasalized vowels appear in alternation with Vr and Vl sequences in absolute final position:

bamohaṣ̃ṛ	or	bamohṣ̃ṛ	'vamos a ver'
bamohaṣ̃ṛ	or	bamohaṣ̃ṛ	'vamos a ser'
bwenomux̃ṛ	or	bwenomux̃ṛ	'bueno mujer'
mỹḗl	or	mỹḗ	'miel'
ànimá̃l	or	ànimá̃	'animal'

In Sanskrit (Allen 39-46) nasalization of vowels is a feature of finality of the sentence or breath group. As mentioned earlier, vowels are nasalized following word-boundary and h as well as after nasals. in Thai.

<sup>2</sup>Arnold M. Zwicky ("Note on a phonological hierarchy in English," mimeo) claims that the following hierarchy recurs in rules of English:

Vowels    glides    r    l    n    m    ɳ    fricative    stop

and points out that in Ijo w, r, y and vowels are penetrated by nasalization, but l is not. Although the hierarchy established above for regressive nasalization is not as detailed as this one, the correspondences are nevertheless quite striking.

<sup>3</sup>On the basis of eight languages in the foregoing list (see asterisks), Theodore Lightner (1970) has attempted to formulate a universal rule for regressive vowel nasalization. He found the necessary formulation extremely complicated and abandoned in favor of a general tendency for languages to contain a rule of the form:

$$V\text{---}[+nasal] / \text{---} N \left\{ \begin{matrix} \# \\ C \end{matrix} \right\} \quad (\text{where } V \text{ and } N \text{ note separated by } \$)$$

Precisely this formula was suggested three years earlier by Milner (280) as a marking convention:

$$[u \text{ nasal}] \text{---} [+nasal] \left[ \begin{matrix} V \\ \text{---} \end{matrix} \right] N \left\{ \begin{matrix} C \\ [-seg] \\ : \\ : \\ : \end{matrix} \right\}$$

In view of the evidence presented above, it is at least clear that Lightner's 'tendency' must be considerably more detailed. Without going into the complexities of Lightner's abandoned rule schema, I will mention four reasons for the difference in our results:

(1) Lightner used a sample of languages which was too small to reveal cross-language regularities in the post-



nasal conditioning factors;

(2)he placed too much trust in languages for which there are only written records thus forcing himself into the bind of having to account for the absence of word-final nasalization in some languages merely because it is neither specifically attested nor the basis of revelatory reflexes in later stages of the languages;

(3)he was exclusively interested in the properties of a putative universal rule for regressive nasalization and not in either justifying the claim of universality or formulating constraints;

(4)he lacked sufficient data to enable him to specify the characteristics of the vowel in his rule (except for height).

<sup>4</sup>Consider, for example, Saciuk's remark (204) on Portuguese: "Very accurate measurements with mechanical devices indicate some nasalization in vowels preceded by N, but the degree of nasalization in this case is weaker than in the vowels that undergo the rules of nasalization, progressive nasalization, or secondary nasalization."

<sup>5</sup>In forms with a plural infix al/ar after a root-initial nasal consonant, nasalization is observed not only in the first vowel of the infix, but also in the second vowel

following the infix (Robins 93):

mĩāk--- măriāk      'to stand aside'

Compare the following form which has no infix:

mários              'to examine'

This situation, confirmed by kymography, seems best handled by a cyclic nasalization rule and a post-obstruent denasalization rule. On the first cycle, the unaffixed form is nasalized (miāk---mĩāk); then the infix is added and the rule applies again (---măriāk); finally, the vowel is denasalized after the obstruent. The weakness of this solution is that it is only observationally adequate. The generalization that needs to be captured is that the affixed form is 'double' in that it presents itself simultaneously to the nasalization rule both as itself and an unaffixed form.

<sup>6</sup>This wording is meant to exclude prosodic nasalization as is found in Desano (Kaye 1971) and Gbeya (Samarin 29).

<sup>7</sup>Some discussion is necessary here. Gibson has neglected to say exactly what it means for nasalization to spread "to the end of the word." I have taken her to be referring only to vowels, and this is reflected in my transcription of her examples (in her article Gibson only marks the phonemically nasalized vowel). I presume that if she had meant the reader to believe that Pame has nasalized voice-

less stops (whatever that might mean), she would have commented on it separately.

<sup>8</sup>Drachman and Drachman (1971) point out that there are at least two, and possibly three, ways to "dispose" of a nasal in VNC sequences: the length can be given to the preceding vowel as in the examples discussed in this section, or it may be given to the consonant (via gemination) resulting in V:C and VC:, respectively. If a language permitted neither vowel length nor gemination of consonants, it might simply delete the nasal, but no cases have turned up yet.

<sup>9</sup>This is not quite true. Clusters can arise morphologically as well (McCawley 1968).

<sup>10</sup>In Sanskrit, to cite another example, "if through morphological processes rr would occur, it never does-- instead the preceding vowel is made long, if it is not already long" (Allen 1962, 179). C.f. also Sanskrit

taddhi---ta:dhi

dus+dabha---du:dabha etc.

<sup>11</sup>In Picuris there is what appears to be dissimilation of nasality, but unlike in the (false) Dakota example, it is incomplete. Distinctively nasalized vowels are

most nasalized when not before nasals. After a nasal consonant, a nasal vowel is less nasalized at the beginning than at the end; before a nasal consonant a nasal vowel is more nasalized at the beginning than at the end. The environment in which nasalization is most diminished is the environment which, in other languages, is most likely to induce nasalization. (Consider, for example, Saciuk's remark (205): "The highest degree of nasality would appear in vowels that occur between two nasal consonants in the phonetic representation." Robe (36) says that in Panama Spanish, although vowels are only sporadically nasalized in other environments, they regularly receive slight nasalization between two nasals. Navarro (39; cit. by Saciuk) claims that Spanish exhibits completely nasalized vowels in this environment. In Pame (Gibson 258) slight non-contrastive nasalization occurs only between two nasals in a closed syllable.) Since there is apparently no reason for speakers of Picuris to try to denasalize distinctively nasalized vowels, some other account is preferable. Probably there is no disimilation at all, but instead the interaction of two kinds of nasalization of the kinds Delattre has shown exist in French (sect. 5). The 'disimilations'

in Picuris could then be regarded as artifacts of the switch-over from (to) ordinary velum lowering (which, Delattre has shown, is used for nasal consonants) to (from) equalization of the volumes of the oral and nasal pharynges. This speculation should be seriously considered if the degree of nasality to which distinctively nasalized vowels are reduced when adjacent to nasal consonants in Picuris can be experimentally shown to be equivalent to the degree of contextual nasalization of oral vowels.

## BIBLIOGRAPHY

- Agard, Frederick and Robert J. di Pietro. 1965. The Sounds of English and Italian. University of Chicago Press.
- Allen, W.S. 1961. Phonetics in ancient India. Oxford.
- 1962. Sandhi. Mouton and Co., The Hague.
- Bendor-Samuel, John T. 1966. Some prosodic features in Terena. In memory of J.R. Firth. Longmans, Green and Co., London.
- Bjork, L. 1961. Velopharyngeal function in connected speech. Acta Radiologica Suppl. 202.
- Bloomfield, Leonard. 1933. Language. Hold Rinehart and Winston.
- 1939. Menomini morphophonemics. Études phonologiques dédiées a la mémoire de M. le Prince N. S. Trubetskoy. T.C.L.P.8.105-15 (Repr. University Ala., 1964).
- Bright, William. 1957. The Karok language. University of California publications in linguistics #13. University of California Press.
- Bucca, Salvador and Alexander Lesser. 1969. Kitsai phonology and morphophonemics. I.J.A.L. 35.1.7-19.
- Buck, Carl. 1933. Comparative grammar of Greek and Latin. Chicago. (Cit. by Lightner).
- Chu, Chauncey C. 1970. How relevant is historical information to synchronical linguistical description?. P.I.L. 2:1.

- Dahl, Ivar. 1961. The pronunciation of Brazilian Portuguese. In honour of Daniel Jones. Longmans, Green and Co., London.
- Delattre, Pierre. 1968. Divergence entre nasalites vocalique et consonantique en français. *Word* 24:1.64-72.
- 1966. Studies in French and comparative phonetics. Mouton, The Hague.
- Drachman, Gaberell and A. Malikouti-Drachman. 1971. Studies in the acquisition of Greek as a native language: I. Some preliminary findings on phonology. Unpublished paper presented at L.S.A. meeting, December 1971.
- Drachman, Gaberell. 1969. Twana phonology. Working papers in linguistics #5, The Ohio State University.
- Einarsson, Stefan. 1949. Icelandic. The Johns Hopkins Press, Baltimore.
- Elert, Claes-Christian. 1964. Phonologic studies of quantity in Swedish. Stockholm-Göteborg-Uppsala: Almqvist & Wiksell.
- Fairbanks, G.H. and B.G. Misra. 1966. Spoken and written Hindi. Cornell University Press, New York.
- Ferguson, Charles A. 1963. Assumptions about nasals: a sample study in phonological universals. *Universals of language*. ed. Joseph H. Greenberg. M.I.T. Press.
- Fippinger, Jay and Dorothy. 1970. Black Tai phonemes, with reference to White Tai. *Anthropological ling.* 12:3.

- Foley, James. ms. Systematic morphophonology.
- Gibson, Lorna F. 1956. Pame (Otomi) phonemics and morphophonemics. I.J.A.L. 22:4.
- Gordon, E.V. 1957. An introduction to Old Norse. Clarendon Press, Oxford.
- Gudschinsky, Sarah.C. and Harold and Frances Popovich. 1970. Native reaction and phonetic similarity in Maxikali phonology. Lg. 46:1.
- Haas, Mary. 1949. Outline for types of linguistic structure. Mimeo.
- Halle, Morris. 1963. A descriptive convention for treating assimilation and dissimilation. Q.P.R. #64. M.I.T.
- Han, Mieko Shimazu. 1962. Japanese phonology. Kenkyusha, Tokyo.
- Harrington, R. 1946. A note on a linguavelar relationship. Jrnl. of Speech Disorders 11.
- Henry, Jules. 1948. The Kaikang language. I.J.A.L. 14:3.
- Hodge, Carleton T. 1947. An outline of Hausa grammar. Lg. 23:4 suppl.
- Holmer, Nils M. 1949. Goajiro (Arawak) I: phonology. I.J.A.L. 15:1.
- 1952. Seneca II. I.J.A.L. 18:4.
- House, A.S. and K.N. Stevens. 1956. Analog studies of the nasalization of vowels. Jrnl. of Speech and Hearing Disorders 21:2.



- Howard, Philip G. 1963. A preliminary presentation of Slave phonemes. Studies in the Athapaskan languages. ed. Hoijer et al.
- Jung, Myung-Woo. 1962. A contrastive study of English and Korean segmental phonemes, with some suggestions toward pedagogical application. Unpub. M.A. thesis.
- Kaye, Jonathan D. 1971. Nasal harmony in Desano. Linguistic Inquiry 2:1.
- Keller, R.E. 1961. German dialects. Manchester University Press, Manchester.
- Kenstowicz, Michael. 1969. Lithuanian phonology. Unpub. Ph.D. thesis, University of Ill..
- 1970. On the notation of vowel length in Lithuanian. P.I.L. 3:1.
- Levin, Norman Balfour. 1964. The Assiniboine language. I.J.A.L. 30:3.
- Lightner, Theodore M. 1962. Nasal diphthongs in Russian. Q.P.R. #70, M.I.T.
- 1963. Preliminary remarks on the morphophonemic component of Polish. Q.P.R. #71, M.I.T.
- 1970. Why and how does vowel nasalization take place? P.I.L. 2:2.
- Matthews, G.H. 1955. A phonemic analysis of a Dakota dialect. I.J.A.L. 21:1.
- McCawley, James. 1968. The phonological component of a grammar of Japanese. Mouton & Co., The Hague.

- McMahon, Ambrose. 1967. Phonemes and phonemic units of Cora (Mexico). I.J.A.L. 33:2.
- Milner, J.C G. 1967. French truncation rule. Q.P.R. #86, M.I.T.
- Moll, K.L. 1962. Velopharyngeal closure of vowels. JSHR 4.
- Moore, Samuel and T.A. Knott. 1955. The elements of Old English. Geo. Wash. Pub. Co., Ann Arbor Mich. (cit. by Lightner 1970).
- Narang, G.C. and Donald A. Becker. 1971. Aspiration and nasalization in the generative phonology of Hindi-Urdu. Lg. 47:3.
- Navarro, Tomas. 1963. Manual de pronunciación española. Hafner, New York.
- Noss, Richard B. 1964. Thau. Foreign Service Institute, Wash. D.C.
- Ohso, Mieko. 1971. Japanese loan phonology. M.A. thesis, The Ohio State University.
- O'rahilly, Thomas F. 1932. Irish dialects past and present. Browne and Nolan Ltd.
- Osborn, Henry A. Jr. 1966. Warao: phonology and morphophonemics. I.J.A.L. 32:2.
- Pandit, P.B. 1961. Historical phonology of Gujarati vowels. Lg. 37:1.

- Pankratz, Leo and Eunice V. Pike. 1967. Phonology and morphophonemics of Ayutla Mixtec. I.J.A.L. 33:4.
- Robe, Stanley. 1960. The Spanish of rural Panama. U.C.P.L. V.20. University of California Press, Berkeley & L.A.
- Robins, R.H. 1957. Vowel nasality in Sundanese, a phonological and grammatical study. Studies in linguistic analysis. Basil Blackwell, Oxford.
- Saciuk, Bohdan. 1970. Some basic rules of Portuguese phonology. Studies presented to Robert B. Lees by his students.
- Samarin, William J. 1966. The Gbeya language. U.C.P.L. #44.
- Sapir, Edw. and Harry Hoijer. 1967. The phonology of the Navaho language. University of California Press, Berkeley.
- Schachter, Paul and Victoria Fromkin. 1968. A phonology of Akan: Asante and Fante. Working papers in phonetics #9. U.C.L.A.
- Schane, Sanford. 1968. French phonology and morphology. M.I.T.
- Scott, N.C. 1964. Nasal consonants in Land Dayak (Bukar-Sadong). In honour of Daniel Jones. Longmans, Green and Co. Ltd, London.
- Shell, Olive A. 1950. Cashibo I: phonemes. I.J.A.L. 16:4.

- Shevelov, Geo. Y. 1965. A prehistory of Slavic. (cit. by Lightner 1970). Columbia University Press, New York.
- Spencer, Robert F. 1946. The phonemes of Keresan. I.J.A.L. 12:4.
- Stahlke, Herbert. 1970. Topics in Ewe phonology. Diss. Publ. by University of Ill.
- Taylor, Douglas. 1951. Morphophonemics of Island Carib (Central Ameircan dialect). I.J.A.L. 17:4.
- Taylor, Douglas. 1955. Phonemes of the Hopkins (British Honduras) dialect of Island Carib. I.J.A.L. 21:3.
- Thalbitzer, William. 1964. A Phonetical study of the Eskimo language. Copenhagen.
- Thompson, Laurence C. and Terry M. Thompson. 1966. A fresh look at Tillamook phonology. I.JA.L. 32:4.
- Trager, Felicia Harben. 1971. The phonology of Picuris. I.J.A.L.37:1.
- Wallis, Ethel E. 1968. The word and the phonological hierarchy of Mezquital Otomi. Lg. 44:1.
- Ward, Ida C. 1952. An introduction to the Yoruba language. W. Heffer and Sons Ltd., Cambridge.
- Welmers, William E. 1946. A descriptive grammar of Fanti. Lg. language dissertation #39. Lg. 22:3 suppl.
- Williamson, Kay. 1965. A grammar of the Kolokuma dialect of Ijo. West African language monographs #2.