

SYLLABLE-BASED GENERALIZATIONS IN ENGLISH PHONOLOGY

by

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ABSTRACT

This dissertation is concerned with the role of the syllable in generative grammar. I argue that the syllable is a necessary element in phonological descriptions by identifying aspects of phonology that seem to call for analyses in terms of syllabic structure and demonstrating the superiority of syllabic analyses over possible alternative solutions.

The largest part of the dissertation, Chapter II, is a study of phonological rules of English which have syllable-structure conditioning. I attempt to show, for example, that voiceless stops are aspirated when simultaneously syllable-initial and non-syllable-final. Much emphasis is placed on the role of syllable structure in conditioning phenomena observed at word juncture which are apparently sensitive to rate of speech, for example, the treatment of final /t/ in American English and rules of /r/-epenthesis and deletion in various American and British dialects.

Chapter I sets the stage for the investigations of Chapter II by discussing in general terms how it is possible to justify the use of the notion "syllable" in linguistic descriptions, by suggesting and defending certain basic hypotheses concerning syllabic structure, as well as by deducing a set of syllable-structure assignment rules for English. An important claim of Chapter I is that one must recognize "ambisyllabic" consonants on the phonetic level. The phonological implications of ambisyllabicity are seen in Chapter II.

The word "generalizations" in the title of the dissertation is a cover term for (a) phonological rules, and (b) constraints on lexical representations. It is often apparent that a given phenomenon is syllable-related (as I show, for example, with regard to the unusual distribution of [ŋ(g)] in English) without it being clear whether what is involved is a phonological rule (perhaps /ŋg/ simplifies to /ŋ/ syllable-finally) or a constraint on lexical representations (perhaps syllable-final /ng/ is barred from underlying representations). In Chapter III, I approach this problem in a general way, present evidence for "constraint" analyses of several phenomena generally taken to be rule-based, and put forth a general hypothesis about the ordering of syllable-sensitive rules.

Thesis Supervisor: Paul Kiparsky
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To Adele

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In the mid '50s, when the Brooklyn Dodgers were the dominant club in the National League, it impressed me greatly that while other teams had perhaps a great firstbaseman or a heroic centerfielder, the Dodgers had a star at every position. Like the Dodgers of my boyhood, the M.I.T. linguistics faculty is a team of heroes, and what competence I have gained in the practice of linguistics is due in large measure to the quality of my teachers, Noam Chomsky, Ken Hale, Morris Halle, Paul Kiparsky, David Perlmutter, and Haj Ross.

My thesis committee consisted of Professors Kiparsky (supervisor), Halle, and Ross. I am glad to acknowledge that whatever the quality of this thesis, it is far better than it would have been had any one of these three not shown the interest and provided the help that he did.

In my studies in phonology, I worked most closely with Professor Kiparsky, whose depth of understanding of matters phonological is, it seems to me, unequalled in the field. I am very grateful to him for his guidance, his suggestions, his friendliness, and for the seriousness with which he greeted my ideas.

In my four years at M.I.T., I spent many hours in Morris Halle's office, discussing (mostly arguing about) the theory of phonology. I have come away with a tremendous amount of respect for Professor Halle, not only because, like the great men of other sciences, he was the first to understand many of the concepts we generative phonologists now recognize as basic truths, but also because of his excellence as a teacher and his easy availability to his students.

I regret not having spent more time discussing the topics of this thesis with Haj Ross, for his extensive comments on a first draft of the thesis proved extremely valuable to me. Haj may consider himself to be first and foremost (cf. *foremost and first) a syntactician, but I would be proud to someday become as fine a phonologist as he is.

My fellow students provided a good deal of help, both of a theoretical nature and in their patience in the face of my tiresome questions about phonemic distinctions and phonetic detail in their native dialects. I am very appreciative of this assistance.

In short, I must acknowledge a good deal of help in the preparation of this thesis. Nevertheless, it would be a mistake for the reader to associate any of the blatant errors and other bits of foolishness he will surely encounter here with anyone else but me.

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INTRODUCTION

Chomsky and Halle's Sound Pattern of English is a monumental work, not only in its establishment of a theoretical framework in which to investigate the sound systems of natural languages, but also in its application of the theory to the analysis of a particular natural language, English. Yet in spite of the thoroughness with which the phonology of English is investigated, there appears to remain a class of important phonological processes in English which are not discussed in SPE. These processes are significant both in the major contribution they make to the determination of the phonetic form of utterances and in the theoretical interest of the formalism they require.

The processes I have in mind, of which the voicing and "flapping" of /t/ in American English in certain environments is an example, tend to be low-level, i.e., at the phonetic end of the phonological spectrum, productive, i.e., freely applicable to new and hypothetical forms which happen to meet these rules' structural descriptions, and, I would claim, sensitive to the syllabic structure of input strings. In the remainder of this introduction I attempt to explain why such processes are of interest to the generative grammarian.

Part of the foundation of the generative approach to the syntax of natural languages consists of the simple but highly significant observation that the class of sentences on which the native speaker of a language can make grammaticality judgements is unbounded in spite of the fact that the learned and inherent knowledge of the speaker is surely finite. The job of the syntactician is thus in principle a well-defined and

achievable one: to discover the underlying system of rules and conditions on rules that allows the generation of the unbounded class of sentences.

To the extent that the postulated system accurately reflects the knowledge of the native speaker, we are justified in saying that it is a correct model, that it has "psychological reality." Like the models produced by the other sciences, this linguistic competence model is based on observed facts and subject to empirical testing. But as in the other sciences, a major difficulty in the construction of linguistic models is the largely intuitive task of deciding which empirical data serve to reveal the underlying system and which involve distortions of perhaps unknown origin and can safely be excluded from immediate attention. Progress in any science is hampered under a methodology that insists that all "facts" are equally deserving of immediate explanation. Newton's laws of motion and law of gravitation, to take an example from physics, have proved to be insights of great significance and generality, and yet with regard to the simple test of letting fall pairs of objects of different densities, these principles account for the "facts" only in the highly unnatural setting of the vacuum chamber. An understanding of aerodynamics eventually allows one to account for the way in which objects fall in air, but one's acceptance of Newton's principles need not be postponed until aerodynamics is understood, and in fact could not be, because of the dependence of the latter on the former.

A good deal of current controversy among linguists is due to differing intuitions as to what facts should have first claim on our attention, and yet in syntax there is probably universal agreement that a certain type of observation is of very limited interest. Consider the commonly-

heard sentences (1)-(2) in the light of current analyses of negation and question-formation in English:

(1) I kid you not!

(2) How goes it?

We would certainly reject these sentences as evidence on the basis of which to modify our analyses. The reason for this is clearly the lack of productivity of these constructions:

(1') *She understands us not

(2') *How went it in Europe last summer?

Sentences (1)-(2) may be interesting from a cultural point of view in that they reveal on the part of present-day speakers a certain familiarity with an archaic form of the language, and an appreciation of anachronism. But we realize that considering (1)-(2) will only lead us astray if we want to produce a model of the linguistic competence of contemporary speakers of English, and this realization stems directly from the non-productive nature of the rules that would generate them. At best, sentences like these indicate that any analysis will be left with a finite residue of isolated sentences.

My purpose in making the above observations is to contrast the generative approach to syntax with the generative approach to phonology. Generative phonologists have been concerned in large part with phenomena evidenced in only finitely many forms, and phenomena for which the "productivity" test often fails.

For example, one postulates a Tri-syllabic Laxing Rule for English

because for most words the generalization holds that vowels three or more syllables from the end of the word are lax, even when the corresponding vowel in related forms not meeting the "tri-syllabic" condition are tense (for ex., sanity vs. sane). Nonetheless, (a) there exist glaring exceptions to this rule (rarity,¹ obesity, etc.); (b) the language expands its lexicon as though the rule didn't exist (Idaho, Omaha, etc.); (c) the exceptional forms show no tendency to regularize (one would be very much surprised to find a dialect in which Idaho is pronounced [ɪDəhow]); (d) there is no native-speaker intuition that words like Idaho, obesity are in any way deviant; and (e) there is no native-speaker intuition that a hypothetical form like [owkəsər], in which the Tri-syllabic Laxing generalization has been ignored, is any less in accordance with the general principles of English pronunciation than one like [akəsər], which obeys the generalization.

Is it correct for a science whose goal is to construct a model of psychological competence to be concerned with generalizations such as the Tri-syllabic Laxing Rule? Note that the mere fact that the generalization holds for the majority of English words is insufficient reason to assume that the rule is psychologically real. The majority of English words are less than nineteen segments long, but this latter generalization surely has no direct psychological representation. The origin of the particular arrangement of the data captured in the Tri-syllabic Laxing Rule is a historical rule, similar in form to the hypothesized synchronic rule, which was added to the phonology at a certain point in the history of the English language. What is at issue is whether the rule is still operative in its original form.²

Without attempting to settle this issue here, let us contrast the generalization about the tenseness of vowels three or more syllables from the end of the word with the observation that English /p, t, k/ are aspirated in $\# \text{ --- } V C_0 \#$ and unaspirated in $\# s \text{ --- } V C_0 \#$.³

The latter generalization is statistically correct, as is the one captured by the Tri-syllabic Laxing Rule. However, (a) there are simply no exceptions to the stated generalization about aspiration, and (b) new words coming into the language always obey the English aspiration rule, even if they are not in accordance with it in the source language. Most importantly, (c) there is strong native-speaker intuition that forms like $[t^h \text{ } \text{ } \text{ } s]$ and $[st \text{ } \text{ } \text{ } s]$ are possible, though non-occurring, words of English, while $[t \text{ } \text{ } \text{ } s]$ and $[st^h \text{ } \text{ } \text{ } s]$ are felt to be strongly deviant.

I hasten to point out that it would be naive to assume that the only psychologically-real generalizations in phonology are those for which this kind of direct evidence is forthcoming. On the other hand it is certainly foolhardy to assume that every generalization that the linguist can capture will be captured by the native speaker as well.

A survey of the literature of generative phonology makes it clear that the questionable status of Tri-syllabic Laxing is shared by many or most proposed phonological rules. One might trace the origin of this state of affairs in the following way.

Work in linguistics in this century has been characterized by a clear-cut separation of diachronic and synchronic investigations. Synchronic studies involve analyses of phenomena observed for a particular point in the history of a language, without regard for the historical origin of these phenomena or the correct analysis of them at some other

stage in the history of the language. But what sorts of phenomena are of interest to the synchronic investigator? The answer depends on the goal of the particular linguist. In pre-generative frameworks, one was interested in an analysis of the language, not in a model of the psychological constructs accounting for the competence of a speaker of the language. For example, Trager and Smith view as an advantage of their analysis (1951) of the vowel system of English that it is adequate for the description of all dialects of American English known to them. Now surely it is irrelevant to the linguistic development of the child growing up in Los Angeles that certain East Coast dialects have much more complex vowel systems than the dialect of his own linguistic community, so it is clear that Trager and Smith are analyzing an abstract entity, "American English," rather than the competence of particular speakers of American English. Similarly, Harris(1951) says that it makes no difference whether in English one assigns the phonetic segments [p^h] and [p] to the phoneme /p/ and [b] to /b/, or [p^h] to /p/ and [p] and [b] to /b/, as long as one states accurately the appropriate allophonic rules (p. 63). Clearly Harris is giving instructions for describing the language. He does not say, "the distribution of the phonetic segments [p], [p^h], and [b] in English is such that we cannot be sure whether speakers analyze [p] as deriving from /p/ or /b/."

Generative grammarians, on the other hand, are interested in producing psychologically-accurate models of speaker competence. This fact limits the range of phenomena of interest in synchronic investigations to those "known" by the native speaker, giving rise to the following notational problem. What is to be said about generalizations we have no

reason to believe to be part of the competence of the speaker but are nonetheless "facts" about the current stage of the language under investigation? Are they part of the synchronic description of the language? The answer is clearly no if we take seriously the assumptions of the generative approach to linguistics. For example, what is the status of Grimm's Law in English? Grimm's Law is certainly a diachronic rule. But it is also a fact about modern English that it displays the Grimm's Law alternations in many pairs of words, for example, father/paternal. Is this spirantization process therefore also a synchronic rule? Or, to take a different sort of example, is the fact that the English morpheme has on the average n segments, where n is in principle easily determinable, a synchronic fact?

There is no paradox here. The answer is that these are facts about modern English but are not part of a synchronic generative phonological analysis of English because they appear to play no role in the native speaker's internal organization of his knowledge about the sound system of his language. Now it is easy to exclude facts such as these from consideration but one is reluctant to discard too much of what has traditionally been considered phonology. Nevertheless it is possible that Tri-syllabic Laxing and many other of the rules discussed in the literature of generative phonology represent correct "facts" about modern English" but are not part of a "synchronic analysis" in the psychological sense that generative grammarians attach to the term.

The way in which the traditional goal of synchronic investigations, that of analyzing the "language," and the goal of the generative approach, to produce a model of speaker competence, come together in generative

phonological analyses and give rise to the problem discussed above can be seen clearly in the following pair of quotes from SPE. Consider first this definition of grammar:

we use the term "grammar" to refer both to the system of rules represented in the mind of the speaker-hearer, a system which is normally acquired in early childhood and used in the production and interpretation of utterances, and to the theory that the linguist constructs as a hypothesis concerning the actual internalized grammar of the speaker-hearer. (p. 4)

I have underlined portions of the quote to emphasize the fact that generative phonologists are indeed interested in modeling the actual psychological constructs which account for the speaker's competence.

Next consider this passage from SPE:

We see no reason to give up rules of great generality because they are not of even greater generality, to sacrifice generality where it can be attained. It seems hardly necessary to stress that if we are faced with the choice between a grammar G_1 that contains a general rule along with certain special rules governing exceptions and a grammar G_2 that gives up the general rule and lists everything as an exception, then we will prefer G_1 .
(p. ix)

It is not clear how one can be certain that, as opposed to the linguist, the language learner will not prefer G_2 . On the other hand, in a non-psychological approach, where one is merely interested in the most compact description of the facts of the language, the policy outlined in this

quote is clearly optimal. Thus this insistence on capturing as many generalizations as possible seems to be a hold-over from earlier approaches to synchronic analysis and to be at odds with goals expressed in the first quote. For how can we make the very strong claim that we are modeling the actual internalized system of rules if take as evidence for the nature of the system any generalization we can find in the data? Only, it would seem, by making the unsupported assumption that any generalization noticed by the linguist will be noticed by the language learner as well.

As pointed out above, we never make this assumption in syntax. Hypothesized rules must be supported by native-speaker confirmation of productivity. In support of the way in which generative phonology is done, one might point out that the nature of phonological phenomena is such that this kind of direct evidence is seldom available. But surely this observation cannot be used to condone the formulation of strong hypotheses on the basis of weak evidence. Rather, the observation, to the extent that that it is a correct one, suggests that analytic tools more powerful than generalization-capturing are necessary.⁴

But one might also question the validity of the observation. There certainly does exist a large class of phonological phenomena which can be directly tested. In view of the questionable status of phonological rules for which no direct evidence exists, and insofar as substantive arguments against such rules are not forthcoming, it has seemed to me that a productive course of action might be to limit one's attention first to rules whose status is not in doubt, attempt to reach general conclusions regarding form and applicability, and only later, armed with

these observations, return to the study of the more questionable generalizations.

I have embarked upon such an investigation, with various dialects of English as the objects of study, and report on my findings in this dissertation. I mention here two very general results.

The first is that one need not fear that by restricting oneself to a study of directly-confirmable phonological processes one will be hard-pressed for material. As in syntax, the typical situation is that as one proceeds, interesting new problems arise at a faster rate than old ones are solved. Nor are the solutions to such problems typically transparent. It is a mistake to use the term "low-level rule" disparagingly, as is often done, as though the expression "low-level" described these processes' inherent degree of linguistic interest and complexity.⁵

Secondly, the importance of the syllable in the description of low-level processes quickly becomes obvious. I set out to write a dissertation on productive phonological processes and soon found myself hampered by the absence of a generative theory of syllabication.

Thus, in its final form, this dissertation represents an attempt to outline a theory of the syllable and to apply it in the description of certain generalizations which are clearly a part of native-speaker phonological competence.

Footnotes to Introduction

1. rare, phonetically [rer], is from underlying /r̄ær/, according to the analysis of SPE. Upon suffixation and Laxing we expect [rærɪDi], but in fact observe [rerɪDi], as though Laxing has failed to apply. In some American dialects, all /æ/ in — r V has become [e]; what is of interest about the example rarity is that even in dialects in which Harry, marry [æ] are always distinct from hairy, Mary [e], rarity has [e].

See Appendix 3 of Chapter II for more discussion of dialectal variation in pre-/r/ vowels.

2. In doubting the psychological reality of Tri-syllabic Laxing as a phonological rule of English, one need not take the extreme position that sane and sanity, for example, bear no more than a suppletive relationship to each other. One possible alternative is a morphological rule which laxes vowels (or directly effects /ey/→/æ/, /iy/→/ɛ/, /ay/→/ɪ/) before a certain class of affixes. Evidence for this analysis over the phonological-rule account is available in (a) the large number of exceptions to the phonological generalization (Idaho, etc.) (see also points (b)-(e) in the text, above), and (b) the existence of monosyllabic affixes, in particular -ic, which lax preceding vowels with the same regularity as bisyllabic -ity.

3. See Section 1.1 of Chapter II for a full discussion of aspiration in English.

4. As alternative means of getting at the form of synchronic grammars, I have in mind the evidence available from phonological change (Kiparsky,

1968a, 1968b), from studies of meter (Kiparsky, 1973), from "slips of the tongue" (Fromkin, 1971; Stampe, 1972), from word games and secret languages (SPE:342-3; Hombert, 1973); for more discussion, see Zwicky (1974).

5. Low-level processes and fast-speech rules are often thought of together. While it is correct that fast-speech rules tend to be low-level processes, the converse is not true. Essentially all of the processes I discuss in this dissertation are obligatory at normal rates of speech.

CHAPTER I

PRELIMINARIES

Introduction

My general goal in this chapter and the next is to provide a formal basis for two assumptions which have been pervasive in traditional discussions of phonology but which have by and large not been adopted by generative phonologists. These assumptions are (a) that there exists, on the phonetic level, a well-defined unit of perception and production larger than the segment and smaller than the word, and (b) that this unit plays a very significant role in conditioning distributional statements, sound changes, synchronic phonological rules, etc., i.e., that it is of general phonological significance. The unit is of course the syllable.¹

In Chapter II, I discuss a large number of phonological processes of English, the statements of which become simpler, intuitively more meaningful, and, most importantly, descriptively more adequate, if use is made of a set of rules of syllable structure assignment ordered prior to the phonological rules proper. This chapter provides the necessary preparation by discussing the general question of how the claim that the syllable is a phonologically significant construct can be justified as well as by suggesting and defending certain general hypotheses concerning syllable structure and proposing a set of rules for assigning syllable structure to strings of segments in English.

Section 1 - Justifying Syllabic Phonology

1.1 It may prove helpful to approach the problem of how one might go about justifying the intuition that the syllable has an important pho-

nological role to play by first considering an analogy. Let us evaluate several possible solutions to a well-known problem of Sanskrit phonology, that of accounting for the class of segments /r, u, k, i/ as the leftward environment of a retroflexion rule. Assuming that this class of segments is somewhat unnatural when expressed in terms of a given distinctive-feature framework, what sort of observation could eliminate the problematical status of the "ruki" rule?

Suppose it were suggested that there exists some previously undiscovered feature, $[\pm F_x]$, such that /r, u, k, i/ are $[+F_x]$ and all other segments $[-F_x]$, or that Sanskrit contained a rule inserting the hitherto unknown boundary ϕ in the environment /r, u, k, i/ — , and that the correct environment for the ruki rule is simply $\overline{[+F_x]}$ or ϕ — . Obviously these proposals are of absolutely no theoretical value as solutions to the problem under consideration and represent no more than their proposer's prejudice as to where a solution will eventually be found. In the case of the new-feature "solution," no evidence has been given for the appropriateness of the feature beyond its use in simplifying the very rule we wish to understand, while the new-boundary "solution" eliminates a problematical retroflexion rule environment at the cost of replacing it with an equally problematical boundary-insertion rule environment.

Suppose, however, that the proposer of either of these solutions could go further and show (contrary to fact, as far as I know) that $[F_x]$ or ϕ as defined above could be used to condition not only the ruki rule, but several other rules of Sanskrit phonology as well. How would we re-evaluate the claims under consideration?

It is clear that in contrast to the earlier situation we would now

have to acknowledge that a discovery had been made - the discovery of a relationship between rules not previously recognized and of a probable need for modification of the theory, since by hypothesis /r, u, k, i/ is an unnatural class. However the situation remains the same with regard to the particular solutions put forward: we have been offered no basis on which to select one and not the other, or either rather than some third possibility.

In order to make a truly adequate case for either of the proposed solutions, its defender must go beyond the realm of phonological rules and establish a link to other phenomena relevant to the type of solution being proposed. For the new-feature solution, what would be required is the existence of particular articulatory or acoustic/perceptual properties corresponding to the proposed feature, a demonstration that the feature properly distinguished between /r, u, k, i/ and all other segments of the language, and evidence that the feature is appropriate in the phonological descriptions of other languages. In the case of the new-boundary solution, we would demand either the existence of some sort of special phonetic juncture at the points where ç is found or else a demonstration that the points of ç-insertion are well-defined from the point of view of the syntax of the language.

Keeping this discussion in mind, let us turn from the problem of the Sanskrit ruki rule to a problem of the type for which I would support a syllable-based solution.²

1.2 In the so-called r-less dialects of English, words like car, cart, cartel, but not rack and carry, are pronounced without phonetic [r]. The environments in which [r] is missing, from the point of view of ety-

mology and the r-retaining dialects, is that given in (1).

$$(1) \quad \text{---} \left\{ \begin{array}{c} C \\ \# \end{array} \right\}$$

This environment is problematical because the class of consonants (abbreviated by C in (1)) and word-boundary (#) do not form a natural class - in fact they have in common no features at all. (The theoretical framework assumed here is that of Chomsky & Halle, 1968.)

Regarding this problem, the hypothetical discovery discussed in the second part of the ruki analogy has already been made: /r/-loss is not an isolated example of the occurrence of the strange environment of (1). As has often been noted (for example, by Lightner, 1972:333), rules of this type are quite common in the world's languages; I offer detailed discussions of several such rules in English, including /r/-loss, in Chapter II. We have thus uncovered a problem for the theory of phonology.

As was the case with ruki, there are two obvious directions in which one might look in order to understand rules with environments such as (1). One might try to modify the distinctive feature system in such a way that consonant and word-boundary would constitute a natural class. Or one might look into the possibility that some sort of boundary is typically found immediately to the left of these units. Suggestions of both of these types have in fact been made, and in the remainder of this section I show how such proposals have failed to meet the level of adequacy outlined at the end of the ruki discussion.

1.3 Among others, Lass (1971) and Lightner (1972) have suggested that boundaries be specifiable for features normally taken to be reserved

for segmental units. In particular, they would expand the feature specification of word-boundary in such a way that it and the class of obstruents would form a natural class. I find this proposal unacceptable for two major reasons.

First of all, there is no hope of independently justifying the segmental features imposed on word-boundary in terms of articulatory or acoustic considerations. This is so because word-boundary is simply not articulated and is not present in the acoustic signal. Lightner (1972) tries to associate word-boundary with silence (p. 332), but of course this correlation fails in general: there is no cessation of vocal cord vibration and sound output at the points of sentence-internal word-boundary in the phrase John#is#a#bum as normally spoken.

Thus segmental feature specifications would have to be assigned to word-boundary purely on the basis of maximal simplification of phonological rules. That this is indeed Lightner's tactic in spite of his attempt to describe the articulation of word-boundary is made clear in the following quote (p. 334), which is typical of several statements he makes: "In many languages glottalized consonants lose their glottal quality before non-glottalized consonants and word-finally. Apparently # must be specified [-glottal]." It should be clear that Lightner has observed that many

languages have — $\left\{ \begin{array}{c} C \\ \# \end{array} \right\}$ and — $\left\{ \begin{array}{c} \text{unglottalized cons.} \\ \# \end{array} \right\}$ rules, not

explained why they do. Similarly, Lass' (1971) only motivation for viewing word-boundary as an obstruent is that it allows the simplification of certain rules (pp. 24, 27).

It might be countered that if it were possible to specify for word-boundary a single value of each of the distinctive features in such a way that this set of specifications were of universal phonological usefulness, a major theoretical contribution would be involved even if no explanation external to phonological rule-systems could be given as to why word-boundary takes on these particular specifications. However, the hope of determining a unique universal set of segmental feature specifications for word-boundary seems unrealizable. In English alone, for example, there exist both [C, #] and [V, #] rules; an example of the latter is a rule which tenses vowels in — [V, #]. (See also Halle, 1971.)

A second major objection to specifying word-boundary for segmental features is that boundaries do not participate in phonological processes the way segments do. In particular they do not occur in focus position in rules. Having boundaries bear segmental features weakens the theory by implying that segments and boundaries are phonologically on a par and opening up the unrealized possibility of rules which change the segmental feature specifications on boundaries.

Furthermore if word-boundary, which is allegedly [-syllabic], occurred in an environment in which glides become vowels, would its specification be changed to [+syllabic] and would it henceforth behave as a vowel rather than as a non-syllabic? Presumably not, leading to the need for complication of a general vocalization rule to exclude word-boundary.

I conclude that the proposal that word-boundary is specified for segmental features is untenable and that we must look elsewhere for an account of the naturalness of rules like /r/-loss.

1.4 I have argued that a particular common-feature type solution to the problem of accounting for rules involving [C, #] is inadequate and that in general no such solution could be correct. In turning to common-boundary solutions, in particular solutions in terms of syllable boundary, I argue only that past treatments of this type have been inadequate, for I believe that syllable structure is the key to understanding the [C, #] rules as well as other phonological processes. I exemplify the basic failing of certain analyses that have sought to simplify rules by reference to syllable boundary by briefly reviewing a paper of Hoard's.

Hoard (1971) discusses the environments for aspiration, consonantal tenseness and certain types of feature assimilation in English and claims that a general "syllabication" rule ordered before these segmental processes allows the statement of them to be simplified. Hoard's syllabication rule is (2) (his (3)), where /./ represents syllable boundary and M a "maximal initial cluster."

$$(2) \quad \emptyset \rightarrow /./ \text{ in env. } VC_0 \text{ — } \langle M \rangle \left[\begin{array}{c} V \\ \langle +\text{stress} \rangle \end{array} \right]$$

Thus in a string $/V_1C_1\dots C_nV_2/$, all the consonants are part of V_1 's syllable if V_2 is unstressed; otherwise as many of the rightmost consonants as is consistent with the constraints on initial clusters in English will be syllabified with V_2 , the remainder with V_1 .

Although Hoard shows that the various segmental rules, as he describes them, can be given simple statements in terms of this syllable boundary, it is significant that he never discusses the syllabication that results from (2) in terms of phonetic plausibility and conformance with traditional

descriptions of English syllabication. A few examples will serve to illustrate how far Hoard has in fact strayed in these regards. (2) gives ampl.i.fy, atl.as, lingu.ist, and ostr.ich. I think it is fair to say that any syllabication scheme for English that produces syllables like [ampl], [atl], [lingw], and [ostr] is not using the notion "syllable" in its traditional sense, in which the term has intuitive significance and some (admittedly elusive) phonetic reality. Since Hoard suggests no phonetic interpretation for his syllables, the conclusion seems forced that they are completely abstract units, set up to simplify a certain set of phonological rules. But then, as in the ϕ -boundary analogy, we are being offered an account which is essentially arbitrary.

1.5 In the remainder of this Chapter and in Chapter II, I will try to show that the intuitions of linguists like Hoard are basically correct: there is ample justification for using the traditional term "syllable" to refer to an important conditioning factor in many rules. I will attempt to go further than Hoard has gone, however, by showing that when rules assigning syllable structure to segment strings are correctly written, they not only provide the needed apparatus to properly account for the naturalness of a large class of phonological rules, but also produce correct syllabications on the phonetic level. In other words, I attempt to demonstrate that the kind of hypothesis-justification discussed in the final part of Section 1.1 is available with respect to the proposal that syllable structure is behind the [C, #] and other rules.

Section 2 - Phonetic Descriptions and the Syllable

In this section I would like to discuss the syllable's claim to a

place in phonetic representation. I begin the discussion with some remarks on "acoustic correlates" of phonetic units.

Recent work in phonetics makes it clear that the view that to each unit in a narrow phonetic transcription there corresponds a unique acoustic signal (i.e., a unique function relating sound pressure and time) is hopelessly naive. For example, although the phonetician transcribes the word Bob as [bab], with identical initial and final segments, the acoustic signals corresponding to these segments are radically different. In the first [b], the first and second formants (peaks in the amplitude-vs.-frequency curve) start low in frequency and rise to appropriate values for [a], while the "correlate" of the second [b] is a fall in formant frequencies. Furthermore, there is no indication whatsoever in the acoustic signal corresponding to [bab] of segmentation into three units - the acoustic parameters vary smoothly from beginning of utterance to end. In fact, if one records the word Bob and replays an initial fraction f for a listener who has not been told what to expect to hear, it is impossible to choose f such that the listener can unambiguously identify the first segment but not the second. If he hears enough of the utterance to know for sure that the first segment is [b], he will know as well that the second is [a].

Many other such illustrations of the lack of a one-to-one correspondence between phonetic segments and acoustic signals could be given. Furthermore, the same phenomenon is seen on the suprasegmental level. An obvious example involves English stress.

In phonetic transcriptions, one distinguishes between the American pronunciations of the noun and verb forms of the word pervert by means of a simple difference in stress placement, for segmentally both are [pɜrvɜrt].

Yet the acoustic manifestation of phonetic stress involves a very complex context-dependent interplay of at least three factors, fundamental frequency contour, intensity, and segmental timing (see the discussion in Sec. 4.4.2 of Lehiste, 1970, and the studies she refers to). There is nothing in the acoustic signal which directly reflects the primary, secondary, and reduced stresses that the phonetician perceives as the distinguishing features of the noun and verb forms of pervert.

Should we conclude from examples of this sort that traditional phonetic transcriptions are hopelessly inadequate and of no value? Obviously not. The correct conclusion is rather that phonetic representation is a level in the overall code relating meaning and acoustic signal that admits of a good degree of abstractness from the point of view of the acoustic output.

In support of the claim that this abstract phonetic level has psychological reality and cannot be dispensed with, one might bring to bear the following sort of argument. In spite of the obvious acoustic differences between the two [b]s of Bob, we are justified in identifying them because we have good evidence that the language user does. In historical sound change, such classes of distinct acoustic signals as initial and final [b] are often grouped together as focus or conditioning environment of the change. When speakers invent symbols for the perceived sounds of their language, the members of classes of this type are not distinguished.

This kind of argumentation is of course of just the sort that can often be used to defend the even more abstract phonological levels which are set up to capture, for example, regularities in the way that the phonetic form of a stem varies as a function of its environment. Nonetheless,

in their most general application, such arguments show the need for one or more phonetic/phonological levels in addition to the level of the acoustic signal.

One can, however, go further and differentiate between the phonetic level and the more abstract phonological levels. One distinction has to do with considerations of universal grammar. For example, although English does not distinguish, in final position, between the class of acoustic signals commonly referred to as unreleased [p] and the class of released [p], other languages do, and the English-speaking phonetician who fails to note the difference in preparing a narrow transcription is simply a poor phonetician. On the other hand, the rising-formants and falling-formants varieties of [b] are not distinguished in even the most careful of phonetic transcriptions, for these "allo-acoustic-signals" are universally determined by phonetic context.

To summarize the main point of these remarks, even the most concrete of the phonological levels, that of phonetic representation, is related to the acoustic signal by an extremely complex set of context-dependent rules. A phonetic representation does not capture the elementary physical attributes of an utterance directly, but rather encodes them in a way intimately tied up with the language capabilities of the human being.

With these considerations in mind, let us turn to the notion of syllabic structure. The first thing to be noted is that it is not a fair challenge to the linguist who would divide utterances into "syllables" at the phonetic level to demand instrumental proof of "syllable boundary." The relevant observation is rather that the notion of "syllable" as a phonetic unit is meaningful to the naive speaker and to the phonetician

in the same way that the concept [b] comprising the rising- and falling-formants variants is. Abercrombie says (1967:34):³

One unit seems an obvious starting point for this purpose (analyzing speech -DK), and that is the syllable. Most people seem to be able to say, without much difficulty, how many syllables are contained in a word or utterance; and with perhaps somewhat more difficulty, to say where each syllable begins and ends... The syllable would appear to be an intuitively recognizable unit even for primitive peoples.

We might ask why speakers and phoneticians perceive syllables. Again it is helpful to consider this question first with respect to a less controversial phonetic unit like [b]. Obviously one thing that rising- and falling-formants [b]s have in common is that they correspond to the same articulatory gesture, bilabial closure with voicing and closed velum, and it is reasonable to assume that this is what is behind our regarding initial and final [b] as the same segment.

Phoneticians have suggested such an articulatory correlate for the syllable. According to Pike (1947:60), phonetic syllables are "units of one or more segments during which there is a single chest pulse and a single peak of sonority or prominence." Similarly, for Abercrombie (1967:35) "each contraction (of the respiratory muscles), together with the resulting puff of air, constitutes the basis of the syllable."

The idea that each syllable of an utterance corresponds to a pulse of the chest musculature can be traced back to Stetson (1928), who viewed the syllable as being basically a "motor unit."

There is some evidence that this model is not entirely adequate and

that the articulatory correlate of the syllable is more complex (see Abercrombie, op. cit.), leading Ladefoged, for example, to conclude (1971:81) that "there is no single muscular gesture marking each syllable." But Ladefoged warns against "being overly simplistic in our view of physiological properties...we may still be able to define a physiological unit of this kind (the syllable) which will account for the timing and coordination of the articulatory movements. There is evidence...that speakers organize the sequences of complex muscular events that make up utterances in terms of a hierarchy of units, one of which is of the size of a syllable; and it is certainly true that speakers usually know how many syllables there are in an utterance. We will therefore assume that a neurophysiological definition is possible, even if one cannot at the moment state it in any way."

Also relevant to this discussion is Malmberg's (1955) claim to have experimentally isolated an acoustic correlate of syllable division in vowel-stop-vowel utterances in the relative timing of vowel-formant transition and stop interval.

A further point to be made in support of recognition of the syllable involves its role in word recall. Fudge (1969) points out that some aphasics apparently retain a knowledge of the syllable structure of words none of whose segments they are able to recall, and the same is apparently true of the normal speaker with a word "on the tip of his tongue" (Brown and McNeill, 1966).

Thus when one considers its strong intuitive meaningfulness, its constant appearance in phonetic descriptions, and our partial understanding of its acoustic and physiological basis, the syllable appears to have as

much claim to a role in phonetic representation as a segment like [b].

Section 3 - Ambisyllabicity

In all traditional treatments of English syllabication, a word like atlas would consist of two syllables, [æt] and [ləs]. Since each syllable is well-defined, it makes sense to speak of a "syllable boundary" as occurring between the [t] and [l] of atlas. This phenomenon of well-defined boundary is observed in a large class of cases in English, leading to the general assumption on the part of many phonologists⁴ that it is always possible to segment an English utterance into n well-defined syllables, i.e., to choose (n-1) intersegmental positions as syllable-boundary locations.⁵

However, this conclusion is not a logical necessity. There need not correspond to every pair of adjacent syllables a well-defined syllable boundary. For example, as opposed to a word like atlas, where the boundary between syllables is uncontroversial, it would seem completely arbitrary to insist that hammer contains a syllable boundary either before or after the [m].

In the past this fact has been typically either ignored (but see below), in which case one arbitrarily assigns a syllable boundary in a word like hammer, or else taken as evidence that the concept of the syllable is an untenable one. The position taken here is a middle one between these two extremes: it makes sense to speak of hammer as consisting of two syllables even though there is no neat break in the segment string that will serve to define independent first and second syllables.

Using Pike's term "sonority" (each syllable contains exactly one "peak

of sonority"), there appears to be a sonority trough at the [m] in hammer, as opposed to a complete break in sonority between the [t] and [l] of atlas. It would seem reasonable to maintain, then, that while hammer is bisyllabic, there is no internal syllable boundary associated with the word. As an analogy to this view of syllabic structure, one might consider mountain ranges; the claim that a given range consists of, say, five mountains loses none of its validity on the basis of one's inability to say where one mountain ends and the next begins.

The observation that polysyllabic words in English need not have well-defined syllable boundaries has in fact been made before. Careful phoneticians not committed to a theory of well-defined syllabication have suggested that intervocalic consonants in English may belong simultaneously to a preceding and a following vowel's syllable.

For example, in discussing words like being, booing, Trager & Smith (1941:233) say, "...in cases like these, the intersyllabic glide is ambisyllabic (i.e., forms phonetically the end of the first and the beginning of the second syllable), so that these words exhibit a syllabic structure exactly parallel to that of such words as bidding..."

Smalley (1968:154) points out that it is easy to identify the "crests" of syllables but notes that "it is not always possible to determine an exact syllable boundary. A consonant between two syllables may belong phonetically to both." He gives the English word money as an example of this phenomenon.

The difficulty speakers of English experience in saying, in many cases, just where one syllable ends and the next begins, referred to by Abercrombie (see quote above), is doubtless due to their uncertainty about arbi-

trary syllabication conventions in these ambisyllabic cases.

The only phonologists who to my knowledge try to deal formally with the phenomenon of ambisyllabicity in English are Anderson & Jones (1974). For them also, words like hammer, being, booing, bidding, and money would involve ambisyllabic segments. I will have more to say about their proposals below and in Chapter II.

Section 4 - Phonetic Syllabication: Formalism

In this section I will indicate what I believe to be the basic requirements for a theory of syllabic structure for the phonetic level.

The starting point would seem to be the binary feature [syllabic] (see SPE p. 354; Ladefoged, 1971:81). The class of [+syllabic] segments includes the ordinary vowels as well as the so-called syllabic sonorants, such as the last segment of the English word button in its most common American pronunciation, [bʌtʔ̩]. As far as I know, there is no controversy among phoneticians as to the syllabicity of particular segments found in English words, although a rigorous definition of this feature has never been achieved.

It would also seem uncontroversial to define the number of syllables contained in a given word or utterance as equal to the number of [+syllabic] segments in the string. Thus phoneticians and naive speakers of English are in agreement that photo, button, and wrestle have two syllables, that there are two easily distinguished pronunciations of wrestling, one with two syllables, the other, perhaps less common, with three, that four contains one syllable as pronounced by most Americans, two as pronounced by many, and so on.⁶

Given the one-to-one relationship between [+syllabic] segments and syllables, we can regard phonetic representations as consisting of segmental strings together with an indication of syllable membership, where the nth syllable contains the nth [+syllabic] segment as well as zero or more left- and right-adjacent [-syllabic] segments. For a word like atlas, which consists of two discrete syllables, and one like pony, involving an ambisyllabic element, Anderson and Jones (op. cit.) would use the notation indicated in (3), which allows improper bracketing:⁷

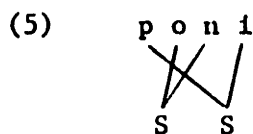
$$(3) \quad \begin{array}{cc} [\text{æt}][\text{ləs}] & [\text{po}[\text{n}]\text{i}] \\ \underset{1}{\mid} \underset{2}{\mid} \underset{2}{\mid} & \underset{1}{\mid} \underset{2}{\mid} \underset{2}{\mid} \end{array}$$

According to this notation, the first syllable of pony is [pon], i.e., the material in the brackets labelled 1, the second syllable [ni], the material of brackets 2. For reasons which will become clear immediately, I prefer to use the graphical representation of (4):

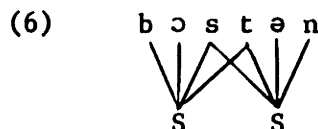
$$(4) \quad \begin{array}{cc} \text{æ} \text{ t} \text{ l} \text{ ə} \text{ s} & \text{p} \text{ o} \text{ n} \text{ i} \\ \begin{array}{c} \vee \quad \vee \\ \text{S}_1 \quad \text{S}_2 \end{array} & \begin{array}{c} \vee \quad \vee \quad \vee \\ \text{S}_1 \quad \text{S}_2 \end{array} \end{array}$$

Given the way the term "syllable" is understood, it would seem nonsensical to speak of discontinuous syllables. No one has ever suggested, for example, that a language could contain a bisyllabic form like [poni] in which [p] is a member of the second syllable. Worse yet would be the proposal that [p] could be the final member of this syllable. Free use of Anderson & Jones' improper bracketing allows these possibilities to be represented: $\text{p}[\text{on}][\text{i}]$. In the notation of (4), such a syllable structure cannot be represented, since even if [p] were associated with the final syllable, it would be interpreted as the initial element of that syllable,

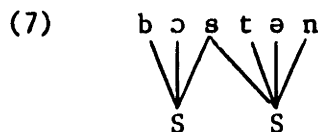
due to the more constrained nature of the graphical representation:



However, even the syllable structure represented in (5) involves a discontinuity. One obvious way of preventing this possibility is to adopt the convention that the lines associating syllables and segments may not cross. This assumption has a further desirable consequence. In Anderson & Jones' treatment, intervocalic consonant clusters can be ambisyllabic. In fact, they would (for phonological reasons, not phonetic ones) represent a word like Boston as [bɔ[st]ən]. But in no sense does this word consist of a syllable [bɔst] followed by a syllable [stən]. This syllabication possibility, represented in line-of-association form in (6), is correctly ruled out by the assumption that lines of association may not cross.



Since [s] appears to be an ambisyllabic element in this word, its structure is as shown in (7):

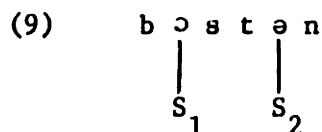


The assumptions being made here about the syllabic structure of strings of segments can be summarized as follows:⁸

- (8) a. Each [+syllabic] segment is associated with exactly one syllable.
- b. Each [-syllabic] segment is associated with at least one syllable.
- c. Lines associating syllables and segments may not cross.

It should be kept in mind that for a given segmental string, (8) may allow more than one syllabication; language-specific rules (and perhaps some universal ones) will determine the correct syllabication consistent with these general constraints.

As an illustration of the way in which (8) limits the possible syllabications of a given string, consider again the word Boston. (8a) insures that the structure indicated in (9) will be present:



Any further association involving the vowels would violate the "one-syllabic-one-syllable" principle.

(8b) and (8c) taken together insure that [b] will be associated only with S₁ and [n] only with S₂. Any other association would involve crossing, violating (8c), while leaving [b] or [n] unassociated would violate (8b).

Universal conventions (8a-c) allow several possibilities of assigning [s] and [t] to syllables and rule out many more. One of the possibilities permitted by (8) is (7), which I take to be the correct syllabication of

this English word. The claim being made in proposing the conventions of (8), of course, is that no language could allow a segmental string [bɔstən] with a syllabication other than those permitted by (8). In most of the remainder of this chapter I will be concerned with the question of how phonetic syllable structure is derived in English, i.e., with those rules of English phonology which assign syllable membership to segments.

Section 5 - Syllable-Structure Assignment Rules for English

5.1 (8a) requires a one-to-one relationship between syllables and syllabic segments. The first of the rules which produce proper syllabifications of strings of segments is thus (10):

(10) Rule I:

With each [+syllabic] segment of the input string associate one syllable.

Given the input Mississippi, for example, Rule I produces (11):

(11)

m	i	s	i	s	i	p	i
		S		S		S	

The remaining syllabication rules deal with associations between syllables and non-syllabics, for as we have seen, no further associations with vowels are possible.

5.2 As was noted in Section 4, our basic assumptions require that a word-initial (-final) consonant be syllabified with the first (last) syllable of the word. Furthermore, if we have an initial (final) consonant cluster, the entire cluster must be contained in the first (last) syllable.

Thus by studying what types of cluster occur initially and finally in words in English, we can discover at least a subset of the set of possible syllable-initial and -final clusters. We cannot be certain that this technique will reveal all the possible syllable-marginal clusters because of the possibility that some of the tautosyllabic clusters found word-internally will be systematically absent in word-initial or -final position.

There are, however, two pieces of evidence suggesting that in English all possible syllable-marginal clusters are indeed revealed in a study of possible word-marginal clusters. First of all, were this not true, we would expect to find medial clusters which could not be analyzed as a possible word-final cluster followed by a possible word-initial cluster. Such a situation is, however, never observed. Given an English word [...VC₁...C_nV...], it is always possible to find at least one i such that [C₁...C_i] is a cluster found word-finally and [C_{i+1}...C_n] is a cluster found word-initially. There could be no word like akpsa in English, corresponding to the fact that [kp] and [kps] are not possible word-finally, [ps], [kps] not possible word-initially.

This evidence, it must be acknowledged, is not absolutely conclusive, for it might be the case that a word like Medford, which could be syllabified into permissible word-marginal clusters, [med,ford], is in fact syllabified [medf,ord] or [me,dford]. The second important observation is that while there are admittedly cases in English where the syllabication of medial clusters is not immediately clear, we are never led to syllabifications which involve clusters not observed at word margins. We do not find phoneticians or naive native speakers debating, for example, whether album might be syllabified [a,lbum].

Thus I will accept as a safe working hypothesis the assumption that the set of possible syllable-initial (-final) clusters in English is identical to the set of possible word-initial (-final) clusters.

5.3 Even under this assumption, of course, there are many cases in which more than one syllabication will be allowed. pony, for example, might be [po,nɪ], [pon,ɪ], or, as I have suggested,



As a first step towards a determination of the actual rules which assign syllabication of intervocalic consonants in English, let us consider slow, over-precise speech, or even the type of speech one might use to imitate a science-fiction-movie robot.⁹ What we find in this sort of articulation in cases where more than one syllabication is consistent with the general constraints is a strong tendency to syllabify in such a way that initial clusters are of maximal length, consistent with the general constraints on word-initial consonant clusters. Thus we find, with syllable boundary optionally realized as pause, [po,ny], not [pon,y]; [Ja,cob], not [Jac,ob]; [ac,tress], not [act,ress]; [Bo,ston], not [Bos,ton] or [Bost,on]. I have chosen examples with unstressed final syllables deliberately, for the tendency towards maximal initial clusters is if anything even stronger when the final syllable is stressed: [De,troit], not [Det,roit]; [a,stound], not [as,tound] or [ast,ound].

In faster speech, many of these syllabication break down. For example, as mentioned earlier, in ordinary speech we must recognize the [n]

of pony as ambisyllabic.

Rather than attempt to write a single rule which will produce normal-speech syllabication, I will first set down the syllabication rule for slow speech, then suggest the existence of other rules which apply only in faster, i.e., normal, speech.

There are several reasons for taking this approach. First of all, as will be seen in Chapter II, it may be necessary to order certain phonological rules between the slow-speech syllabication rules and the rules which account for faster-speech modification of syllabic structure. Secondly, it appears to be the case that faster speech modifies syllabic structure in a well-defined way: additional lines of association are introduced. Thus the most natural account would seem to be one in which the obligatory associations are set up first, followed by optional (but normally invoked) rules which introduce additional structure. Thirdly, the ability to use over-precise "slow speech" is a part of competence. A single rule producing correct syllabications for normal-rate speech would leave this aspect of competence unaccounted for.

The slow-speech rule, which will henceforth be referred to as Rule II, is given in (12). (On the use of the term "permissible cluster" in this rule, see discussion below.)

(12) Rule II

$$\text{a. } C_1 \dots C_n V \begin{array}{c} \Longrightarrow \\ | \\ S \end{array} \begin{array}{c} C_1 \dots C_1 C_{1+1} \dots C_n V \\ \swarrow \quad \downarrow \quad \searrow \\ S \end{array}$$

where $C_{1+1} \dots C_n$ is a permissible initial cluster

but $C_1 C_{1+1} \dots C_n$ is not.

$$\text{b. } \begin{array}{c} V \ C_1 \dots C_n \\ | \quad | \quad \dots \quad | \\ x \dots x \end{array} \Longrightarrow \begin{array}{c} V \ C_1 \dots C_j \ C_{j+1} \dots C_n \\ \diagdown \quad \diagup \quad \diagup \quad \diagup \\ S \end{array}$$

where $C_1 \dots C_j$ is a permissible final cluster

but $C_1 \dots C_j C_{j+1}$ is not.

(x standing below a segment indicates that the segment is not associated with any syllable.)

Several points of clarification are needed with respect to Rule II. Given input strings spin, *kspin, mist, *mistk, Boston, IIa produces the associations shown by dashed lines in (13) (Rule I has already applied):

$$(13) \quad \begin{array}{ccccc} s & p & i & n & k & s & p & i & n & m & i & s & t & m & i & s & t & k & B & o & s & t & o & n \\ & \diagdown & \diagup & & & \diagdown & \diagup & & & \diagdown & & & & \diagdown & & & & \diagdown & & \diagdown & & \diagdown & & \diagdown \\ & S & & & S & & & & S & & & & S & & & & S & & S & & S & & S \end{array}$$

Rule IIb introduces the further structure shown in dashed lines in (14):

$$(14) \quad \begin{array}{ccccc} s & p & i & n & k & s & p & i & n & m & i & s & t & m & i & s & t & k & B & o & s & t & o & n \\ & \diagdown & \diagup & \diagdown & \diagup & \diagdown & \diagup & \diagdown & \diagup & \diagdown & \diagup & \diagdown & \diagup & \diagdown & \diagup & \diagdown & \diagup & \diagdown & \diagup & \diagdown & \diagup & \diagdown & \diagup \\ & S & & S & & S & & S & & S & & S & & S & & S & & S & & S & & S \end{array}$$

Since, as we shall see, no following rule will act to assign the initial [k] of hypothetical kspin or the final [k] of hypothetical mistk to a syllable, these forms will be rejected as possible words of English, since they violate universal constraint (8b).

Similarly, given hypothetical [...VkpsV...], mentioned earlier, Rules I-II produce (15):

$$(15) \quad \begin{array}{c} \dots V \ k \ p \ s \ V \dots \\ \diagdown \quad \diagup \quad \diagdown \quad \diagup \\ S \quad \quad S \end{array}$$

Unassociated [p] is the formal correlate of the native speaker's rejection of [...Vkps...] as a possible word of English.

Note in (14) that IIb has applied to the post-vocalic [st] of mist but not the post-vocalic [st] of Boston. This is a consequence of the fact that only in mist is [st] not assigned a syllabic association by IIa. The medial [st] of Boston has lost the opportunity to be syllable-final. Thus the slow-speech tendency toward maximal initial clusters rather than maximal final clusters is reflected in Rule II by the ordering (a), then (b).

Continuing our investigation of the operation of Rule II, consider the following problem. Given a language identical to English in all respects except that it allows syllable-initial /stl/, i.e., has words like stlit. How would Rule IIa treat an input of the form [...VpstlV...]? Since [l] is a permissible cluster but [tl] is not, Rule IIa could act to syllabify [lV], leaving the rest of the cluster unassociated. However, since by hypothesis [stl] is also a permissible initial cluster while [pstl] is not, another syllabication of the input string consistent with IIa is [stlV]. Thus the operation of IIa would be ambiguous in such a case.

I take it as a highly significant fact that we must turn to a hypothetical language for such an example. In English, the existence of prohibited initial cluster $[C_1 \dots C_n]$ implies that the cluster $[CC_1 \dots C_n]$ is also non-occurring initially, for any choice of C. It follows that there will never be more than one C_1 as defined in Rule IIa. The same results hold, mutatis mutandis, for final clusters and Rule IIb.

There is a further point to be made in connection with Rule II, hav-

ing to do with the expression "permissible initial (final) cluster" in the statement of this rule. The system of rules assigning syllable structure to strings of segments, as envisioned here, does not refer back to some general set of constraints on possible word-initial and -final clusters which is pervasive throughout the phonology. It is rather in the syllable-structure assignment rules themselves that these constraints are found. Furthermore, the constraints are not referred to by any other rules of the phonology. As far as I can see, no such "globality" is required.

I elucidate these points by means of two examples. Part of Rule IIa, left unstated in (12), states that [sp] but not [ksp] is an acceptable initial cluster. It is for this reason that given an input like *kspin, Rule IIa leaves [k] unassociated, resulting in rejection of the form as a possible word of English, as we have seen. Thus it is precisely in Rule IIa that the restriction against word-initial [ksp] is reflected formally. There is no need of an independent restriction which Rule IIa refers back to.¹⁰

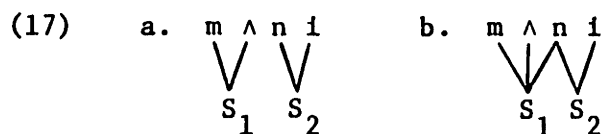
The lack of globality of the restrictions found in the rules of syllable structure assignment can be exemplified by means of the fast-speech rule outlined in (16):¹¹

$$\begin{array}{c}
 (16) \quad \# C_1 \text{ } \emptyset \text{ } X \# \\
 \quad \quad \downarrow \\
 \quad \quad \emptyset
 \end{array}$$

This rule is oblivious to the constraints of the syllable structure assignment rules. In the same way that it gives rise to [klekt] from collect, well-formed from the point of view of IIa, it produces initial [pt]

in fast-speech potato [pteyDə]. (Note how Rules IIa and (16) work together to account for the native speaker's intuition that [ptami], for example, is not a possible word of English except as a fast-speech reduction of acceptable hypothetical [pətami].)

5.4 The result of the application of Rules I-II to money is (17a), while the ordinary-speech structure is as shown in (17b):



For the reasons mentioned in the previous section, I assume the existence of one or more rules, ordered after I-II, whose effect is to introduce additional lines of syllabic association like the one linking S_1 and [n] in (17b). I investigate the conditions on one such rule in this section.

To begin, let us consider the slow speech rendering of a form like anemic. This word has the structure shown in (18) in slow speech, in accordance with Rules I-II.



The [n] in (18) is syllable-initial, as is the [n] in (17a). However in anemic there is no obvious change in the juncture between [ə] and [n] as speech rate increases, in contrast to the situation observed for a word like money. The syllabic break between [ə] and [n] in anemic appears to remain.

Examination of additional examples makes it clear that this junctural

difference between normal-rate speech money and anemic is related to the stress contour difference between them. Thus we have appear, attack, collide with syllable boundary between the unstressed vowel and the following consonant vs. happy, attic, collie with ambisyllabic consonants.¹²

On the basis of examples like these, there appears to exist a rule of the form (19a) or (19b):

- (19) In $\begin{array}{c} V_1 \quad C \quad V_2 \\ | \quad \vee \\ S_1 \quad S_2 \end{array}$ associate C and S_1 if
- a) V_1 is stressed
 - b) V_2 is unstressed

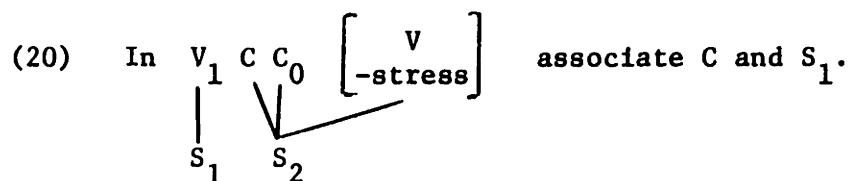
Either (19a) or (19b) will give correct results in all examples thus far considered. To distinguish between these possibilities, we must consider examples in which V_1 and V_2 are both stressed or both unstressed.

It seems clear that words like senile, rabbi, latex do not involve ambisyllabic medial consonants, indicating that (19b) is correct.¹³

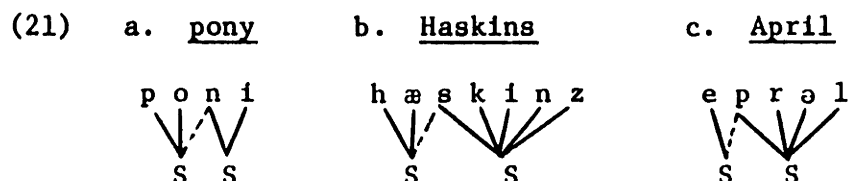
(19b) makes the prediction that the [t] of capítal and the [m] of eněmý will be ambisyllabic in normal speech. This prediction seems to me to be borne out in fact, although I find the judgement more difficult to make in this case. It can at least be said with confidence that the clear perception of juncture one finds between [ə] and [t] in a tall man is absent in capital; likewise for amino and enemy with respect to the [ə]-[m] junctures.

To account for the ambisyllabic [s] of ordinary-speech Boston, we must extend (19b) in the way shown in (20), so that the first consonant of an initial cluster of arbitrary length is syllabified with a preceding

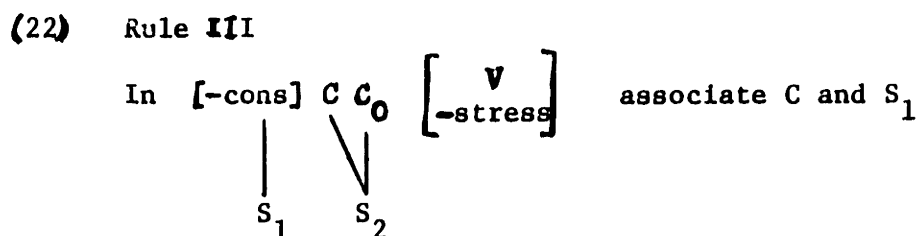
vowel.



(20) gives rise to the lines of syllabic association shown dashed in (21):



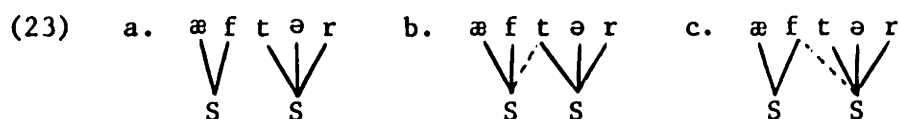
In forms like pony and April, a more accurate transcription than that given in (21) would show the diphthongal quality of the first vowel: [powni], [eyprəl]. Strictly speaking, then, (20) should not be applicable to these forms. To overcome this difficulty, (20) must be modified to (22), which will be referred to as Rule III.



The formulation in (22) takes advantage of the fact that glides and vowels constitute the class of [-consonantal] segments (see Appendix 1 to Chapter II for a discussion of the major class features). Note that the presence of S_1 in (22) implies the existence of a vowel to the left of "[-cons]" if the latter segment is not itself a vowel.¹⁴

5.5 Our investigation of the assignment of additional syllabic link-

ages to medial consonants has been so far limited to cases in which the leftward syllable is vowel- (or glide-) final. Turning to other cases, consider a word like after. Due to the restriction found in Rule IIa against initial /ft/ in English, this word has the structure shown in (23a) after application of Rule II.

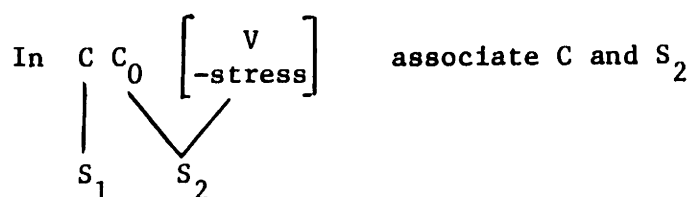


If the [-cons] restriction were removed from Rule III, it would apply to (23a) in normal-rate speech, producing (23b). However in this case and others like it (i.e., words with an interconsonantal syllable boundary at the output of Rule II), this syllable structure seems simply to be wrong. I therefore assume that Rule III should remain as it stands.

However the sharp syllabic juncture of (23a) does seem to be lost in faster speech, with [f] the ambisyllabic element, as in (23c). That is, in ordinary speech the syllabic structure of after seems entirely parallel to that of Astor, Haskins (21b).

This result suggests the need for a rule like that shown in (24):

(24) Rule IV



Note that Rule IV, whether ordered before or after III, will not affect the syllabication of words like hammer, Haskins, nor does its ordering with respect to III affect correct operation in the case of words like after.

As was the case with Rule III, a restriction to the effect that S_2 be unstressed must be included in Rule IV. There is no muddying of the juncture between [f] and [t] in Hàftónium.

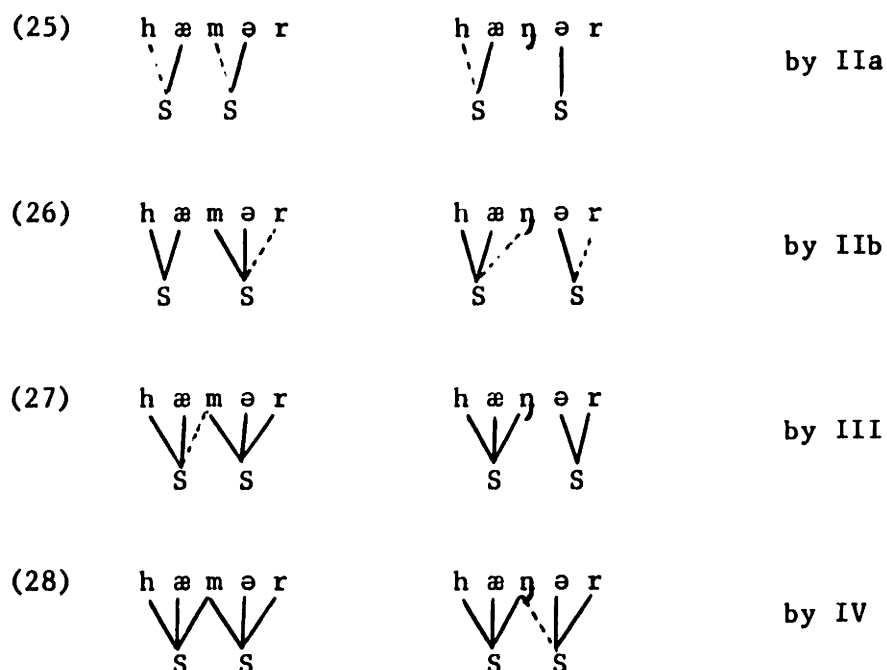
As it stands, Rule IV appears to be too general. Words like Medford, bodkin seem to maintain the interconsonantal juncture assigned by Rule II in spite of the fact that they meet the structural description of Rule IV. Now if IV applied to these words, it would give rise to syllable-initial [df] and [dk]. Although these are in fact clusters which are prohibited in the complete statement of Rule IIa, Rule IV cannot in general be conditioned by the constraints of IIa since IV must produce, for example, initial [ft] in after.¹⁵

It is possible that there exists a set of English-specific constraints on Rule IV, independent of those found in Rule II. A study of the relevant examples, however, suggests that IV may be subject mainly to universal constraints. [df] and [dk], for example, are not found as syllable-initial clusters in any language.¹⁶ Although some of the crucial facts are debatable, with regard to the proper statement of both the universal phonetic constraints and junctural properties of English clusters, Rule IV, constrained not to produce "impossible" clusters, seems to be required for English.

Note, incidently, that such a restriction is not relevant to the operation of Rule III, for the latter rule produces syllables closed a single consonant, against which there are no universal constraints.

Rule IV will usually operate only in the case of intervocalic clusters, since when a single consonant stands between vowels it will almost always be syllabified with the vowel to its right by Rule IIa, allowing only

vacuous application of Rule IV. The sole exception to this generalization involves /ŋ/, which does not occur initially in English. A medial /ŋ/ will be left unassociated by Rule IIa and will be linked to the preceding syllable by IIb, since /ŋ/ is possible finally in English. Thus medial /ŋ/ will be subject to Rule IV. (25), (26), (27), (28) show by means of dashed lines the application of Rules IIa, IIb, III, IV, respectively, to inputs hammer /hæmə r/ and hangar /hæŋə r/.



I take the final output (28), as providing some additional evidence for the correctness of the rules suggested, for in normal speech hammer and hangar are indeed juncturally indistinguishable, whereas in artificially-slow speech they differ.

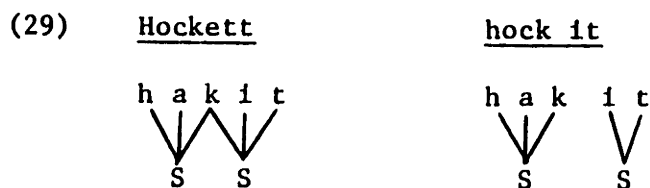
5.6 Ignored so far has been the question of the domain of application of the rules of syllable structure assignment.

Rule I, which simply sets up a syllable for each syllabic segment in

an input string, is not critical in this regard. Rule II, however, must not apply beyond the domain of the word. The phrase this time, for example, must not be syllabified [ðɪ ,staym]. Since there is always syllable boundary, and perhaps even pause, between words in slow speech, Rule II must be limited to the word.

Rule III appears to be limited to the word as well. Even in normal-rate speech, say veranda remains juncturally distinct from save Iran.¹⁷

On the other hand, it is not the case that normal-rate speech never involves inter-word syllabic linkages. At the output of Rule III, the word Hockett and the phrase hock it have the structure shown in (29):



But in ordinary speech Hockett and hock it are fully homophonous. Therefore the [k] of hock must be linked to the syllable of it.

Although Rule IV would serve to establish this association, it appears that IV must be limited to the word and another rule introduced to provide inter-word syllabic linking.

Rule IV is both too weak and too strong to describe inter-word linking correctly. Rule IV links the last consonant of syllable n to syllable n+1, which is consonant-initial in most cases in which IV applies. Across word boundary, however, a final consonant links only to a vowel-initial syllable: this array but *this parade. This restriction has long been recognized, and is usually illustrated in the literature on juncture in English by pointing out that sharp juncture is obligatorily retained between the

[t] and [r] of night rate.

Furthermore, inter-word linking seems not to be limited to following vowels which are unstressed. In connected speech, the [k] of the phrase Hock all of them seems as clearly ambisyllabic as that of Hockett.

For these reasons I postulate an independent Rule V:

(30) Rule V (connected speech only)

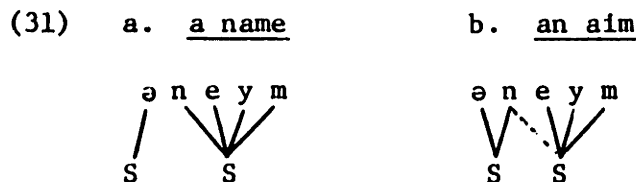
In C V associate C and S
|
S

Regarding the statement of Rule V in (30), observe that it is not necessary to show linkage between C and a previous syllable, for if C is linked only to S, Rule V will apply vacuously and need not be made inapplicable. Nor is it necessary to explicitly mention word-boundary in the rule, for within a word a prevocalic consonant will almost always have been linked to the following vowel by Rule IIa; when the consonant is /ŋ/, Rule IV will have provided the association.¹⁸ Within words, then, Rule V will always apply vacuously.

One must draw a distinction between Rules III and IV on the one hand and Rule V on the other with regard to conditions of applicability. It was pointed out that in contrast to Rules I and II, Rules III and IV are inhibited in slow speech but are required at normal rates of articulation. Now since even in normal speech one may pause between words, Rule V must be limited to stretches of "connected speech." An alternative, apparently equivalent, view, is that in normal speech Rule V is optional but usually applies.¹⁹

A problem much discussed by the pre-generative phonemicists was that

of accounting for the non-homophony of pairs of phrases like a name and an aim. The fact that both phrases contain the same segment sequence in normal-rate speech, [əneym], together with the structuralist methodology requiring determination of the set of phonemes of a language before investigation of morphological phenomena, led to the setting up of a phoneme of juncture to account for minimal pairs such as these. In the generative treatment of juncture proposed here, the difference between the two phrases is a consequence of word-boundary placement (i.e., a morphological consideration) and the fact that English has no rule which is the inverse of V, i.e., no rule which syllabically links word-final vowels to word-initial consonants. The phrase a name receives structure (31a) from Rules I-II, and no further rules apply. In an aim, however, Rule V provides the dashed line of syllabic association shown in (31b).



As a final observation on Rule V, note that its effect is to eliminate vowel-initial syllables. On the basis of cross-linguistic observations, we know that such syllable are more highly marked than consonant-initial syllables. Within words, Rule II acts to prevent vowel-initial syllables, if at all possible. Rule V steps in exactly where Rule II is powerless to create a consonant-initial syllable, in the case of a vowel-initial word. In this way we can account for the lack of symmetry mentioned above, the presence of Rule V in the phonology versus the absence of a rule linking word-final vowels with word-initial consonants.

5.7 In (32) I summarize the rules determining English syllabic structure that have been motivated in this section. I know of no other rules of this type.

(32) Summary of English Syllable-Structure Assignment Rules

(Domain of application of all rules except Rule V is the word.)

Rule I

$$[+syl] \longrightarrow [+syl]$$

|
S

Rule II

a. $C_1 \dots C_n \begin{array}{c} V \\ | \\ S \end{array} \longrightarrow C_1 \dots C_i C_{i+1} \dots C_n \begin{array}{c} V \\ \swarrow \quad \searrow \\ S \end{array}$

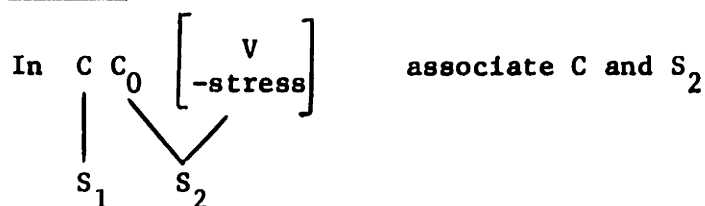
where $C_{i+1} \dots C_n$ is a member of the set of permissible initial clusters but $C_1 C_{i+1} \dots C_n$ is not.

b. $\begin{array}{c} V \\ | \\ S \end{array} C_1 \dots C_i \begin{array}{c} C_{i+1} \dots C_n \\ | \\ x \dots x \end{array} \longrightarrow \begin{array}{c} V \\ \swarrow \quad \searrow \\ S \end{array} C_1 \dots C_i C_{i+1} \dots C_n$

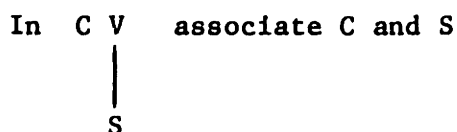
where $C_1 \dots C_i$ is a member of the set of permissible final clusters but $C_1 \dots C_i C_{i+1}$ is not.

Rule III (normal-rate and faster speech only)

In $[-cons] \begin{array}{c} C \\ | \\ S_1 \end{array} C_0 \begin{array}{c} \left[\begin{array}{c} V \\ -stress \end{array} \right] \\ \swarrow \quad \searrow \\ S_2 \end{array}$ associate C and S_1

Rule IV (normal-rate and faster speech only)

Condition: CC₀ must not be a member of the set of universally-prohibited clusters; certain highly marked clusters not universally proscribed may be excluded also.

Rule V (connected speech only)Section 6 - The Syllable and Phonotactic Constraints

6.1 It is usually assumed that each language has a set of "morpheme structure constraints," which place limitations on the phonological shape of possible formatives of the language. These constraints, together with the language's morphological and phonological rules, define the class of possible phonetic representations for words in the language.²⁰

In English, for example, there could be no word like [f \emptyset], since / \emptyset / is not an underlying segment (i.e., is ruled out by a morpheme-structure constraint) nor does any phonological rule serve to introduce it. [xat], on the other hand, is impossible in English for another reason, according to the analysis in SPE (p. 234). Although the presence of /x/ violates no morpheme-structure constraint, all occurrences of initial /x/ become /h/ by general rule. Finally, taking another example from the analysis of English in SPE, English has phonetic diphthongs in spite of the constraint

against them in lexical representations because of the existence of the Diphthongization Rule (p. 183).

6.2 Regarding morpheme-structure constraints, it should be noted that the restrictions embodied in Rule II go a long way towards distinguishing between permissible and non-permissible morphemes. Furthermore, in a theory with no explicit recognition of the syllable, the set of morpheme-structure constraints would be considerably more complex.

For example, consider the problem of accounting for the fact that atktin is not a possible word of English. No phonological rules are of relevance in ruling out this form. As we have seen, the constraints against syllable-final /tk/ and syllable-initial /kt/ contained in Rule II, together with the universal convention on syllabic association (8), suffice to exclude atktin.

Let us consider how the unacceptability of atktin would be accounted for in a theory not making use of the syllable. We would not want to have a constraint which simply excludes /tkt/, because the non-occurrence of this cluster is surely related to the absence of many other clusters, for example, /tks/. Nor could we simply rule out /tk/ or /kt/, for we must not exclude acceptable forms like Atkins and cactus. On the other hand, it is true that final /tk/ and initial /kt/ are not permissible. Thus we would have to recognize constraints against the configurations in (33):

$$(33) \quad *tk \left\{ \begin{array}{c} C \\ \# \end{array} \right\} \quad * \left\{ \begin{array}{c} C \\ \# \end{array} \right\} kt$$

However, as observed in Sections 1.2, 1.3, [C, #] is an unnatural class. As will be seen directly below and in Chapter II, it often arises when

syllable-conditioned phonological processes are not recognized as such.

There is a problem concerning (33) as hypothetical morpheme-structure constraints beyond the appearance of [C, #]. For certain choices of C, /tkC/ and /Ckt/ must not be excluded. Examining the case /tkC/, we find that unlike atktin, hypothetical atklin and atquin are possible words of English. The non-syllabics which may follow /tk/ are in fact just those which may follow /k/ in initial clusters. In a system a morpheme-structure constraints not recognizing the syllable, this fact will be represented as accidental. But this generalization (and many others like it) is perfectly predictable. As mentioned in Section 5.2, medial clusters in English simply obey the constraint that they must be analyzable into a possible final cluster followed by a possible initial cluster. Thus any attempt to write constraints on possible medial clusters will miss important generalizations. As we have seen, it will also leave unexplained why word-boundary is found co-occurring with classes of consonantal segments in morpheme-structure constraints. Thus the general problem of accounting for possible morpheme shapes provides additional evidence for the correctness of introducing the syllable into phonological descriptions.

However, it must be acknowledged that even in a syllabic treatment of morpheme-structure conditions certain well-known problems arising from the presence in the grammar of morphological processes like affixation do not find an immediate solution.²¹ For this reason I make no attempt to outline a general theory of phonotactic constraints. It should be clear however that any such theory must countenance the syllable as a significant phonological unit.

Footnotes to Chapter I

1. Some phonologists, of course, have tried to incorporate the syllable into a generative framework; cf. Vennemann (1974, 1972), Hooper (1975, 1972), Stampe (1972), Hoard (1971), and many papers, published and unpublished, by C.-J. Bailey, for example (1968, 1975). Although I have benefited from the work of these authors, I find myself in disagreement with them on some major points, as will become clear.

I am not aware of any serious attempt in the literature to show that the syllable and generative phonology are mutually exclusive. Leben (1973) is sometimes cited as an "anti-syllable" work, but Leben's arguments, if valid, do not bear on the claims I will make here. His main points regarding the syllable are that (a) the syllable is not appropriate as a unit on which to express certain phonological features, and (b) analyses have appeared in the literature in which reference to syllables is used merely as a notational trick to simplify rule statements, without providing any additional insights into the workings of phonology.

2. For serious discussion of the Sanskrit ruki rule, see Zwicky (1970) and the references cited there.

3. I take the inclusion of the word "even" in the last sentence of the quote not as a slur on "primitive peoples" but rather as an admonition that intuitions about syllable structure cannot be attributed to widespread literacy.

4. For example, those cited in the first paragraph of footnote 1; also, Abercrombie (1967), O'Connor & Trim (1953), and Fujimura (1975).

5. One reason for this assumption on the part of non-phonologists is the desire for a well-defined set of conventions for end-of-line word-breaking in written texts. In spite of the irrelevance of such conventions to the question of phonetic representations, they have influenced people's thinking on phonetic syllabication.

6. One should not be surprised to find a minority of cases in which even trained phoneticians would be unsure as to the syllabicity of a given production of some sonorant. Such instances of uncertainty should not be allowed to cast doubt on the basic correctness of [syllabic] as a binary feature. It must be kept in mind that this sort of problem is pervasive in phonetics.

In my transcriptions I use a tick mark [$\underset{|}{X}$] to indicate the [+syllabic] equivalent of a normally [-syllabic] segment and a bow [$\overset{\frown}{X}$] to indicate the [-syllabic] equivalent of a normally [+syllabic] segment. For example, monosyllabic pronunciations of four include [for] and [fo $\underset{|}{\text{ə}}$], bisyllabic pronunciations [fo ə] and [fo $\underset{|}{r}$].

7. In indicating syllabications I use broad transcriptions or even standard orthography where phonetic detail is not important.

8. There is an important relationship between the proposals I make here and the "autosegmental" theory of John Goldsmith, and in fact my own work has benefited from Goldsmith's insights.

A central notion of Goldsmith's theory is that the traditional view of phonological segmentation is wrong in that it assumes that a unique analysis of a stretch of phonological material into segments is appropriate for the specification of all the phonological "distinctive features;"

in his treatment, the various features, in particular the so-called "suprasegmental" ones, induce analyses potentially distinct from the traditional segmentation but related to it by means of well-formedness conditions, which may be said to preserve linearity.

In spite of the fact that in this dissertation I am not concerned with the possibility that there exist more appropriate domains of definition for certain phonological features than the traditional segment, in a broader sense I am working within the "autosegmental" framework. This is so because all theories of the syllable, including my own, are "autosegmental" in that they involve parallel analyses of phonological material into (traditional) segments and syllables.

Traditional treatments of the syllable differ from mine in that they impose a well-formedness condition which in my opinion must be relaxed, the requirement that each segment be associated with no more than one syllable. I retain, however, the remaining well-formedness conditions of traditional syllabication; these are stated in (8), in a form influenced by the work of Goldsmith.

It should be clear why I consider (8a) a traditional assumption regarding syllabication. (8b), together with the condition mentioned above which I reject, gives rise to the traditional view that each [-syllabic] segment is associated with exactly one syllable. (8c) corresponds to the implicit traditional assumption that a form like [ponɪ] may not consist of the syllables [pɪ] and [on], or have [po] as the second syllable, [nɪ] as the first.

9. Other situations in which this type of speech may be heard include dialog with infants, with foreigners, over noisy telephone circuits, etc.

10. No English word begins with /ŋ/, and, correspondingly, a word with medial /ŋ/, like hangar, has the slow-speech syllabication [hæ ŋ,ər]. Thus a restriction against initial /ŋ/ must be embodied in Rule IIa. (On the normal-speech syllabication of hangar, see the discussion of Section 5.5; on the question of whether [ŋ] is underlyingly /ng/, see Section 5 of Chapter III.)

Now note that although there are no native words with initial /ʒ/, the slow-speech syllabication of pleasure appears to be [ple,ʒər], not [pleʒ,ər], just as pressure is [pre,ʒər], not [preʒ,ər]. Thus there can be no restriction against syllable-initial /ʒ/. Although it might be supposed that there exist a constraint against word-initial /ʒ/, independent of the syllable-structure constraints, it seems more likely that a simple gap is involved, i.e., that it is accidental that there are no words with initial /ʒ/. In support of this analysis, note that the ordinary speaker of English pronounces the initial /ʒ/ of the Russian name Ženya with no apparent difficulty, while initial [ŋ] is accessible only to the student of phonetics.

11. There are additional restrictions on this rule that are of no relevance here. See Zwicky (1969).

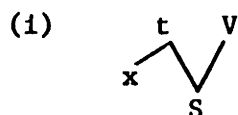
12. I offer some additional support for these claims. Even those phoneticians who speak of ambisyllabic medial consonants in the case of words like happy (see Section 3) do not do so in the case of words like appear. Dictionaries (for example, AHD, RHD) show a junctural difference between happy, etc., on the one hand, and appear, etc., on the other. This distinction is also recognized by phonologists who do not recognize ambisyl-

labicity, for example, Stampe (1972) and Hoard (1971).

13. Since the doubly stressed examples chosen have contour 1,3, the requirement for introduction of the additional line of association could not be "if stress on V_1 greater than stress on V_2 ." This possibility might be expected on the basis of the original examples (móněy vs. ănémic, etc.), together with the observation that the medial consonant of 3,1 words does not become ambisyllabic: týcoón, Kowloón.

14. In the notation I will use to write rules conditioned by syllable structure, the absence of a line of syllabic association in a rule statement does not imply that the rule's applicability is dependent on the actual absence of the line. In (22), for example, S_1 can have any number of additional leftward lines of association.

Where it is necessary to specifically exclude certain linkages, such exclusions are shown explicitly. In (1), for example,



/t/ may or may not be initial in S, must not be associated with the previous syllable, if any.

15. This is another example of the non-globality of the constraints on clusters found in Rule II.

16. /ft/, on the other hand, though not found initially in English, violates no universal restriction on possible initial clusters: Modern Greek ftinós, 'inexpensive,' Russian vtoroy [ftaroy], 'second.'

It may however be necessary to constrain Rule IV from producing cer-

tain highly-marked, though not universally proscribed, clusters. Further discussion of this point is found in Chapter II.

17. Because of Rule V, to be discussed below, this pair of phrases would be homophonous to the third syllable if Rule III applied to the first of the phrases.

18. Rule IV provides linking to following unstressed vowels only.

/...ŋ^ˈŋ.../, then, would seem to be a word-internal input to (30). However, /ŋ/ does not occur before stressed vowels in English word-internally, so the generalization in the text holds.

19. While the likelihood of applying Rule V may be greater in (i) than in (ii),

(i) Hock it!

(ii) After she decided which jewels to hock, it became clear...

it is certain that syntactic conditions are not relevant in the statement of Rule V, for it quite normally applies across the strongest of boundaries, as in (ii). Non-application of V in (ii) is more natural than in (i) simply because pause is more natural in (ii).

20. This position is taken explicitly by Postal (1968).

Shibatani (1973) argues that there must in addition exist "surface phonetic constraints." At least two of Shibatani's arguments for the recognition of SPCs are fallacious. Consider a language all of whose morphemes have the form CVC and all of whose suffixes have /t/ as the initial segment. Then all consonant clusters within words in this language will

have /t/ as the second element. According to Shibatani (p. 92), the latter generalization cannot be expressed without SPCs. Actually, SPCs are needed only to state the generalization directly. Even without SPCs the generalization is immediately deducible from the morpheme-structure conditions of the language and the rules of morphology (in particular, word = stem + suffix).

Shibatani also argues, p. 95-6, that although in the standard analysis of German one can account for the non-occurrence of final voiced obstruents by means of the final-obstruent devoicing rule, there must exist a SPC ruling out forms like *[bund], for German speakers will presumably immediately reject them as possible words of the language. According to Shibatani's line of reasoning, unless such a constraint existed, speakers could never reject hypothetical forms like [bund] since while it is true that /bund/ as an underlying form could not give rise to [bund], some other lexical representation might, and a speaker would have to run all possible underlying configurations through the rules of the phonology before being able to state with certainty that [bund] is impossible.

It seems to me that this sort of reasoning is psychologically naive. Placed in a twenty-foot-square room I immediately know that there is no way I can touch two opposite walls simultaneously, presumably without unconsciously considering all the possible ways I could orient my body, stretch my arms and legs, etc. Or to take an example from syntax, how do we immediately reject *John climbed the mountain the cliff? There is no constraint against surface NP V NP NP and there is an infinite number of deep structures and derivations to consider as possible sources.

21. If phonotactic constraints are literally morpheme-structure con-

straints, certain serious problems arise. Hooper, who shares the view that the syllable is directly relevant to the statement of phonotactic constraints, discusses these difficulties in Hooper (1975). She points out that under the standard morphological analysis of Spanish, a word like comprando 'buying' consists of the morphemes /kompr+a+ndo/, in which one morpheme contains the final cluster /mpr/, another the initial cluster /nd/. A study of Spanish words makes it clear that the presence of /mpr/ as a final cluster is directly conditioned by the presence of a following vowel-initial morpheme, cf /nd/ as an initial cluster by the presence of a preceding vowel-final morpheme. Intramorphemic constraints cannot account for the observed facts.

Another difficulty surrounding morpheme-structure constraints is that some morphemes have no independent phonological form. It is hard to imagine, for example, what sort of phonotactic constraints the past tense morpheme in brought is subject to.

On the basis of problems like this, Hooper concludes that phonotactic constraints must be stated at the level of the word, with no regard to morphemic boundaries. Spanish allows comprando because /koN/, /praN/ and /do/ are possible syllables; English allows brought because it is a permissible syllable.

Hooper notes, and in my opinion too rapidly dismisses, a problem arising under this hypothesis. In English the sequence voiced-obstruent/voiced-obstruent is generally absent in final position unless morpheme boundary breaks the sequence: robbed, dogs. This is a serious problem for her theory, for it suggests that some phonotactic constraints are stated at the morphemic level after all.

She attempts to circumvent the problem by noting that there do exist

some monomorphemic words with final voiced-obstruent/voiced-obstruent clusters, for example, adze, Ides, i.e., by suggesting that the constraint is not a real one, and argues that at one time the restriction was operative and word-based - rubbed was then bisyllabic and hypothetical adze excluded - and that now it is merely a historical accident that there exist so few examples of this configuration.

However while exceptions in /-dz/ like those cited do exist, there are simply no morphemes in /-bd/, /-ʝd/, /-gz/, etc., although these clusters are common when split by morpheme boundary. Thus Hooper has at best shown that English has no morpheme-based general constraint against all voiced-obstruent pairs, i.e., has argued against an artificially-strong hypothesis. Also to be noted is the fact that there are many more examples of clusters permitted across morpheme boundary but never within morphemes, for example, the well-known /ksθs/ of sixths.

Further direct confirmation of the morphemic status of many sequential constraints is available. For example, hypothetical forms like [nʌbd], [nɛgz] are interpretable only as preterites and plurals, not as monomorphemic words.

Thus both morpheme- and word-based systems of phonotactic constraints face serious problems, problems for which I have no general solutions to offer. If however one sets oneself the more restricted problem of accounting for the possible phonetic forms of monomorphemic words in English, the syllable seems indispensable, as I have tried to argue in the text. It is hard to see how any solution of the more general problem could obviate this need.

CHAPTER II

SYLLABLE-STRUCTURE CONDITIONING IN PHONOLOGICAL RULES

Introduction

In this chapter, I show how rules I-V, established to provide proper syllabic structure for phonetic strings, can be used to condition many phonological rules of English in a simple and natural way. Some of the rules discussed are clearly contained in a synchronic phonology of English, while others, though obviously actual phonological rules at some point in the history of the language, may have been lost from the phonological component.

Section 1 - The Phonological Development of Underlying /t/

A very interesting example of the use of syllabic structure to condition phonological rules is provided by the problem of accounting for the phonetic forms which correspond to underlying /t/. Where relevant, I will also comment on the allophones of the other voiceless stops.

There exist at least four distinct allophones of /t/ in all American dialects (1a-d), and two more in many (1a', c').

- (1) a. voiceless aspirated alveolar stop [t^h]: creativity
- b. unreleased voiceless alveolar/glottal stop (i.e., closure is made simultaneously at alveolar ridge and glottis) [tʔ]:
create
- c. released voiceless unaspirated alveolar stop [t]: stem, list
- d. voiced¹ alveolar tap [D]: creating

a'. voiceless aspirated alveopalatal stop² [c^h]: train

c.' released voiceless unaspirated alveopalatal stop² [c]:
strong

In the following subsections, the distribution of each of these allophones is studied, and, where appropriate, additional remarks on phonetic detail are made.

1.1 - Aspiration

A. The voiceless stops /p, t, k/ are all aspirated in the same environment. The usual description is that given in (2):

- (2) /p, t, k/ are aspirated if and only if they
- a. stand before a stressed vowel, and
 - b. do not follow /s/

In conformance with this description, the /t/s in after, stem, and Boston are unaspirated, for they fail to meet conditions (a), (b), and both (a) and (b), respectively, while ten and attempt have [t^h], since they satisfy both conditions.

Closer examination of the facts, however, shows that (2a) is a spurious generalization. (Thus the lack of aspiration in after must be traceable to a different source.) Let us consider briefly the phonetics of aspiration.

In words of the form #TVX# (T = voiceless stop, i.e., /p/, /t/ or /k/, X = any string of segments), first bilabial, alveolar, or velar closure is made and pressure is built up behind the obstruction. At a certain point in time, t₀, the closure is suddenly released and the tongue is quickly

brought into appropriate position for articulation of the following vowel. It is not, however, until an appreciable time later, t_1 , that voicing of the vowel begins. The interval of time ($t_1 - t_0$), the "voice onset time," is a period of voiceless escape of breath, or aspiration. A crucial fact to be noted is that voice onset time varies within quite wide limits in words of the type under consideration.

There is an obvious correlation between the length of the aspiration interval in the articulation of an aspirated stop and the amount of stress on the following vowel. Emphatically stressed words are very strongly aspirated: I said twó, not tén. Unemphatic primary-stressed syllables have less aspiration, secondary-stressed syllables still less, other things being equal (compare the stops in ríptòe).

Now if close attention is paid to the manner of articulation of the initial stops of words like tomorrow, Pacific, collide, where the stops stand before completely stressless vowels, it will be seen that there is still a noticeable period of aspiration, although it is shorter than before stressed vowels. The manner of articulation is quite distinct from that of the true unaspirated cases like spin, stem, skin, in which the onset of voicing is essentially simultaneous with release of the stop (see Lisker & Abramson, 1964). This aspiration of initial voiceless stops before unstressed vowels is typically overlooked in the literature, but see, for ex., Trager and Bloch (1941:225).

Thus although there may seem to exist a continuum in voice onset time when one considers in turn tén, tén, tèmpèraméntal, tómorrow, stem, there appears to exist a categorical distinction between the first four cases and the last.

In terms of Halle & Stevens (1971) proposals on the laryngeal features, it appears that the first four stops are [+spread glottis] while the fifth is [-spread glottis], with all five [-constricted glottis] and

[+stiff vocal cords]
[-slack vocal cords].

There are several techniques one may use to make oneself aware of this categorical distinction. First of all, if words like tomorrow, Pacific, and collide are uttered slowly and over-distinctly (but not necessarily in such a way as to introduce stress onto the first vowel), the aspiration will become even clearer. On the other hand, in my speech at least, no amount of emphasis will introduce aspiration in the post-/s/ cases: [st^hʌpɪt] is not possible for stop it!

A very direct confirmation of the claimed difference in articulation of the stops in tomorrow, Pacific, and collide on the one hand and stem, spin, and skin on the other can be made by speakers of English who have good control over the pronunciation of the voiceless unaspirated stops of languages like French, Spanish, and Italian. The English post-/s/ stops are just like the Romance stops, while the stops in # — ʔ are quite different. Furthermore, if one pronounces tomorrow, Pacific, collide with the Romance stops, the result is decidedly unnatural for English, in just the same way that it is unnatural to pronounce ten, pen, Ken with the Romance stops.

Finally, note that there is no contrast in English between voiceless unaspirated stops and voiced stops when not preceded by a sonorant. Thus there could be no sden, Bosden, akder contrasting with stem, Boston, actor. When English-speaking students of phonetics are first made aware of the

fact that the /t/ of stick is quite different from the /t/ of tick, they often identify the /t/ of stick with the /d/ of Dick. In fact, it has often been observed that in words with initial /b, d, g/, true voiced stops and voiceless unaspirated stops are in free variation for many speakers of English.³ On the other hand, the aspirates are always kept distinct from /b, d, g/ in English.

Thus if the /p, t, k/ of tomorrow, Pacific, collide are unaspirated, as usually assumed, /b, d, g/ should be freely substitutable, while if they are aspirated, as claimed here, the same perception of phoneme replacement should be noted upon substitution of /b, d, g/ that one observes when /b, d, g/ are substituted for /p, t, k/ in pen, ten, Ken. In fact it is the latter situation that is observed: introduction of initial /d, b, g/ in tomorrow, Pacific, collide results in the perception of different (non-existent) words, even if /b, d, g/ are not pre-voiced. Compare also Pacific with Basilica, tomorrow with the hypothetical name DeMorrow.

One must conclude, then, that (2a) is not a correct condition for aspirated (i.e., [+spread glottis]) articulation of the English voiceless stops.

B. The next question to consider is why the single segment /s/ appears in (2b). The answer would seem to be that /s/ is the only consonant that forms syllable-initial clusters with following voiceless stops. If this is true, the aspiration rule should not have to specify /s/. Partial confirmation of this hypothesis is available in the pronunciation of the show-business term of Yiddish origin shtick, the /t/ of which must be unaspirated.

Thus at least in monosyllabic words, voiceless stops that precede the

vowel in their syllable are aspirated if and only if they are initial in their syllable. These observations suggest rule (3):

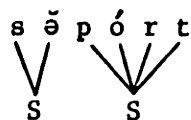
- (3) /p, t, k/ are aspirated if and only if they are syllable-initial

Notice that such a rule accounts for the aspiration of the initial stops of tomorrow, Pacific, collide, since these stops must be syllable-initial.

We will see that a slight modification of (3) is required.

C. Let us consider next words in which /p, t, k/ have a vowel somewhere to the left and somewhere to the right of them, i.e., words for which we must turn to the rules of Chapter I to determine the syllabic membership of the stop. Relevant examples, together with the syllable structure assigned by Rules I-V of Chapter I, are given in (4):

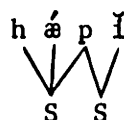
- (4) a. support



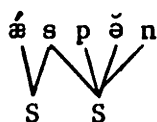
- b. capon



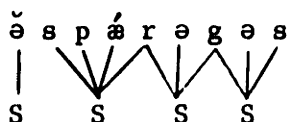
- c. happy



- d. aspen



- e. asparagus



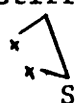
Of the five cases illustrated, only in the first two is aspiration observed. Here the /p/ is syllable-initial, which is in accordance with the generalization of (3). In (4d, e), the /p/ is not syllable-initial, nor is it aspirated, again as predicted by (3). (4c), however, presents a problem for (3) as it is stated, since the /p/ of happy is syllable-

initial, yet unaspirated. The key observation is that in this case /p/ is simultaneously syllable-final, a condition which does not hold for the aspirated cases. Thus the rule for aspiration of voiceless stops appears to be (5):

- (5) /p, t, k/ are aspirated if and only if they are both syllable-initial and non-syllable-final.

Or, in the notation introduced in Chapter I, and in terms of distinctive features,⁴

(6) Aspiration

$$\left[\begin{array}{l} -\text{continuant} \\ +\text{stiff v.c.} \end{array} \right] \longrightarrow [+spread\ glottis]$$


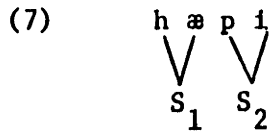
In the notation of (6), the presence of the lower x serves to insure that /p, t, k/ is syllable-initial, the upper x that /p, t, k/ is not syllable final.

Note that although all aspirated stops have a following vowel, the vowel need not be mentioned in rule (6) since conventions (8a-c) of Chapter I insure that a syllable-initial consonant must have a vowel somewhere to the right in the segmental string. Furthermore, it is not necessary that the vowel follow immediately. The non-syllabic segments that can follow the voiceless stops in initial clusters are /l, r, w, y/ (except /tl/, and in many dialects /ty/) and they do not impede aspiration: play pray, puerile, pew [p^h].

In summary, voiceless stops are aspirated after juncture, i.e., when

their only syllable membership is initial. More evidence for the correctness of this claim will become apparent as we proceed.

D. Note that in a word like happy, which is initially syllabified by Rules I-II in the way shown in (7),



the voiceless stop would be aspirated were it not for Rule III, which introduces a line of syllabic association between S_1 and /p/, thereby removing it from the domain of the aspiration rule. (Recall that Rule III was introduced not for this purpose but rather to account for the fact that in words like happy, hobby, hammer, the medial consonant is phonetically ambisyllabic.)

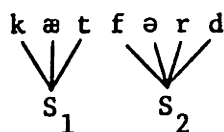
Observe further that in unnaturally slow speech, in which Rule III does not apply, i.e., in which the syllabication of (7) is correct, /p/ is aspirated. Thus the aspiration rule (6) is perfectly general and needs no further conditioning in terms of style of speech, etc. In addition, an example such as this illustrates that an aspiration rule stated purely in terms of segmental environment cannot be adequate, for it would fail to capture the fact that /p/ in slow-speech happy is aspirated and that it is aspirated for just the same reason that /p/ in pin is aspirated.

E. Aspiration rule (6) straightforwardly produces correct results in a wide range of cases. In addition to the five types of examples illustrated in (4), (6) correctly predicts the presence or absence of aspiration in words like pin, spin, Pacific, clap, clasp, claps, clasps. There

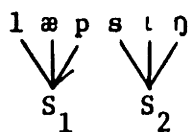
is a small set of examples, however, in which the lack of precision in the statement of Rule IV leads to possible difficulties. In some of these cases, aspiration is actually optional. I discuss these cases for completeness; I do not believe they challenge the correctness of the aspiration rule given in (6).

I examine first a case in which Rule IV, though potentially applicable to a voiceless stop, is not relevant to the operation of the aspiration rule. In words of the form /...VTC[̥].../, the output of Rules I-III (III is actually not applicable) is as exemplified in (8):

(8) Catford

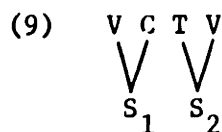


lapsing



Rule IV, if it applied, would introduce a line of syllabic association between the voiceless stop and S_2 , making the stop syllable-initial. However, since the stop remains syllable-final in any case, (6) should not be applicable, and, in fact, no aspiration is observed. (It is my impression that the [p] of lapsing tends to be ambisyllabic but not the [t] of Catford, implying that /ps/ but not /tf/ is a member of the set of permissible initials of Rule IV.)

Next consider words of the form /...VCT[̥]V.../ in which C is such that /CT/ is not a permissible initial cluster. Rules I-III produce (again III is not applicable):



intuition that the first stop is ambisyllabic just when the second is unaspirated, I will refrain from claiming the behavior of /k/ in napkin, Atkins as evidence of the correctness of the postulated system of rules.⁶

Turning to two final cases, consider the /t/ of words like after and Washington. As mentioned earlier in connection with after in the discussion of Rule IV in Chapter I, there is a strong intuition of ambisyllabicity with respect to /f/ in normal-rate speech (i.e., after is syllabically equivalent to aspen), indicating that Rule IV is applicable in this case, which is consistent with the observation that /ft/ is not a universally proscribed initial cluster. The line of association introduced by Rule IV removes after from the input of the aspiration rule, and in fact the /t/ of after is not aspirated except in very slow speech.

In Washington, on the other hand, /t/ must be aspirated, a fact which can be accounted for under the assumption that Rule IV fails to apply in this case since it would give rise to initial /ŋt/. Consistent with this account is the fact that there is no intuition of ambisyllabic /ŋ/ - the contrast between after and Washington in this regard is quite striking.

F. In summary, it may be necessary to acknowledge that there is an idiosyncratic component to the operation of Rule IV (unexpected exclusions from the set of permissible clusters, unpredictable optionality of operation). However one should keep in mind that the major hypothesis being examined in this chapter is that phonetically correct syllabifications, however obtained, are a major conditioning factor in phonological rules. There are no serious challenges to the aspiration rule of (6) as evidence for this hypothesis.

1.2 Unreleased Stops and Glottalization

A. "Release" of a stop refers to the reopening of the vocal tract after complete blockage. Now obviously all stops are eventually released, so it is important to understand the way in which the terms "released" and "unreleased" stop are used.

In my most natural pronunciation⁷ of a word of the form #XVt#, like mat, the vowel is terminated by cutting off the airstream by what appears to be simultaneous closure of the glottis and placement of the tip of the tongue on the alveolar ridge. Due to the glottal closure, no significant amount of pressure is built up behind the oral cavity occlusion. Thus when the tongue-tip is dropped, which may occur almost immediately, or, if /t/ is utterance-final, may be after a rather long interval of time, there is no sound produced. Such a stop is unreleased in the sense that the eventual release is irrelevant to the acoustic form of the phone.

There is another way in which a stop may be unreleased. There may be no glottal closure and hence a positive pressure behind the occlusion, but if the stop is utterance-final, the pressure may remain unreleased until the velum is lowered to resume normal breathing. The nasal release is silent and such a stop is considered unreleased. This sort of articulation seems to be common in the case of final /p/, although /p/ also may involve glottalization.

Returning to the pronunciation of mat described above, if there is glottal closure and little or no pressure build-up behind the tongue in this articulation of /t/, is it distinct from a pronunciation involving glottal closure and no raising of the tongue, [mæʔ]? The answer is yes, significantly so. As the tongue-tip is raised to alveolar position, the

oral resonances, which had corresponded to the tongue position for [æ], begin to change, and have changed significantly by the time the oral cavity oscillations have died out due to the glottal closure. In [mæʔ], on the other hand, the oral resonances remain essentially constant, since there is no movement of the tongue. I use the symbol [tʔ] to indicate simultaneous alveolar and glottal closure.⁸

In contrast to the /t/ of mat, in a word like stem there is no glottal stricture; pressure is built up behind the alveolar obstruction, and is suddenly released as voicing for the vowel begins.

Returning to the phonetic nature of unreleased /t/, the following quote from Heffner (1950:136) is of interest:

If the breath stream is wholly occluded by the vocal bands while it is also stopped at any one of the positions possible for the tongue or lips, the result is a glottalized stop. The air confined between the glottis and the lingual or labial occlusion may by (a) compressed, (b) rarefied, or (c) merely confined.

Heffner goes on to describe the compressed glottalized stops, or ejectives /p', t', k'/, produced by a raising of the larynx, and the rarefied glottalized stops, or suction stops /'p, 't, 'k/, produced by a lowering of the larynx, but has nothing further to say about his third category, in which there is closure of the glottis but no raising or lowering of the larynx. It would seem that the unreleased /t/ I have described fits into this category.

I would suggest, again making use of Halle & Steven's (1971) laryngeal features, that both of the unaspirated stop types described above, the released and the unreleased, are [-spread glottis], but that the re-

leased stops are [-constricted glottis] while the unreleased stops are [+constricted glottis]. The released and unreleased unaspirated voiceless stops, as well as the aspirated stops, would all be [+stiff vocal cords, -slack vocal cords].

Let us now proceed to investigate in a systematic way the environments in which the two variants of unaspirated stops are found.

B. I consider first /p, t, k/ in utterance-final (i.e., pre-pausal) position, and discuss two subcases, with preceding vowel and with preceding consonant.

It seems to me that there exists a clear distinction in the behavior of the three stops in the first subcase, V — Pause, exemplified by words like mat, map, Mac. I find that /t/ must be unreleased, with a released /t/ sounding over-precise and artificial. /p/ also tends to be unreleased, but release is not as unnatural as in the case of /t/. /k/ on the other hand definitely tends to be released. I have no explanation for this state of affairs, but it is important for what follows to state the facts explicitly.

The second subcase involves the behavior of the voiceless stops in the environment C — Pause. Where C is an obstruent, release seems to be required: apt, list, clasp, ask. When C is a sonorant, though, unreleased /p, t, k/ seems to be the norm in many cases. However we must pay careful attention to phonetic detail here if we are not to be led astray.

Consider first cases where nasal consonants appear to precede the stops: camp, can't, hank. The facts here appear to be just identical to the V — Pause case: /t/ and /p/ strongly tend to be unreleased, /k/ to be released. Now in words of this type, the vowel is clearly nasalized

and it is difficult to tell whether a nasal consonant is actually present. Malécot, who studied this problem instrumentally, reports (1960) that in pairs like hit/hint, back/bank, cap/camp, the distinction resides almost entirely in the nasality of the vowel: [hit] vs. [hĩt], etc. Thus the case in question, which appears to be of the form C — Pause, reduces to the V — Pause case, where V is here a nasalized vowel, and we have a potential explanation for the fact that pre-pausal stops behave identically after vowels and after what appear to be nasal consonants.

After /l/, on the other hand, I find it possible, though not obligatory, to release all the voiceless stops, even /t/: alp, belt, milk. I would relate this to the release of /p, t, k/ after the obstruent consonants (on the noted possibility of non-release after /l/, see below), and generalize that voiceless stops are released in C — Pause.

The remaining sonorant is /r/, which works just like the vowels: release in heart is unnatural, in harp somewhat less unnatural but clearly not preferred, and in hark greatly preferred.⁹

At this point it is once again necessary to consider questions of phonetic detail, this time with respect to the properties of English /r/. To avoid a lengthy discussion I have included this material, which will be needed elsewhere in this dissertation as well, as Appendix 1 to this Chapter. The principal result is that the English /r/ of rain, heart, etc., is a glide, not a sonorant consonant. The features that distinguish /r/ from the other glides involve specification of tongue shape only.

Once /r/ is recognized as a glide, the observed pre-pausal allophones of /p, t, k/ in harp, heart, hark can be seen to follow from a more general fact. Observe that it is not only when following a pure vowel, as in

mat, map, Mac, that /p, t, k/ take the allophones described above, but also when following a diphthong: tight, type, tyke. Thus the leftward environment must include vowels and glides, that is, must be [-consonantal] (see Appendix 1). Words like heart, harp, hark, then, come under this environment, and the fact that one observes the same allophones of /p, t, k/ here as in tight, etc., can be taken as additional evidence for the claim of Appendix 1 that English /r/ is [-consonantal].

Let us summarize now the results of our investigation of the pre-pausal allophones of /p, t, k/. Following a [-consonantal] segment, for example the oral vowel /æ/ of mat, the nasal vowel /ɔ̃/ of can't, the glides /y, r/ of height, heart, /t/ is unreleased, /p/ is preferably unreleased, /k/ is preferably released. Following a [+consonantal] segment, for example the stop /p/ of apt, the fricative /s/ of list, the sonorant /l/ of belt, all three stops are released.¹⁰ From this point on I will limit my attention to /t/. As mentioned earlier, I have no explanation to offer as to why the three stops behave differently in the pre-pausal environment.

Assuming that the underlying form of /t/ is the allophone that is not glottally stopped, we could state the result of the above observations as rule (11):

(11) [-cons] t Pause

↓

[+C.G.]

(C. G. = constricted glottis)

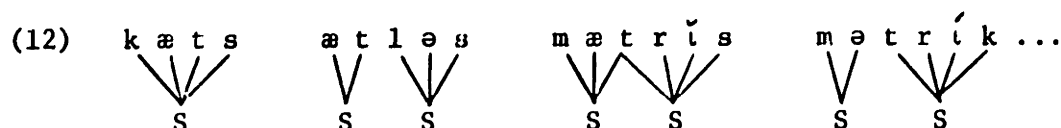
This is only a tentative statement of the rule, for additional results will make it possible to derive (11) as a special case of a more general rule,

as well as to eliminate the imprecise term "pause."

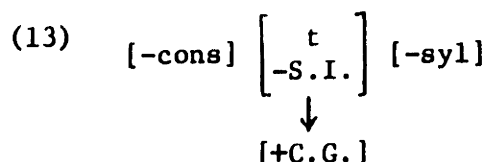
C. I turn now to the behavior of /t/ in the environment — [-syl]. In words like cats and atlas, but not mattress and matriculation, there appears to be glottalization of the pre-consonantal /t/, as was the case with pre-pausal /t/.

Pre-consonantal glottalization has the same left environment condition as pre-pausal glottalization. As opposed to cats, where glottal stricture accompanies the oral articulation of the /t/, in a word like casts the glottis is completely inactive during the articulation of /sts/.¹¹ Furthermore, it is only [+consonantal] non-syllabic segments that prevent glottalization. Compare casts [...sts] with heights [...ytʔs] and hearts [...rtʔs].

Considerations of syllabic structure provide a ready explanation for the observed difference between cats/atlas and mattress/matriculation. Only in the latter case will /t/ be syllable-initial by Rule II. The application of Rule III to mattress establishes a syllabic link between /t/ and the first syllable, but of course the original association as first element of the second syllable remains:



Thus the crucial observation is that the pre-consonantal /t/s which glottalize are non-syllable-initial:



(13), like (11), is a tentative statement, to be generalized when additional facts are taken into account.

D. The final environment to be considered is — [+syllabic]. In this environment, glottalized stops are never observed: ten, stem, attic, Boston, attack. Now Rule II will always assign a pre-vocalic /t/ to the following vowel's syllable, and once again, whether or not Rule III applies, /t/ retains its [+syllable-initial] structural description. Thus here as before syllable-initial /t/ fails to glottalize. Although the glottalization rule could be written in such a way as to exclude the environment — [+syllabic], since pre-vocalic /t/ never glottalizes, doing so would obscure the simple generalization that before segments of all types, post-non-consonantal /t/ is glottalized when not syllable-initial. Additional strong evidence that this generalization is correct will be presented in Section 1.3.

E. (14) is a summary of the environments in which we have discovered glottalized /t/:

(14) a. [-cons] — Pause

b. [-cons] $\overline{[-S.I.]}$ [-syl]

As we have seen, the [-syllabic] specification can be removed from (14b) since /t/ will never be [-S.I.] when it is followed by a [+syllabic] segment:

(14b') [-cons] $\overline{[-S.I.]}$

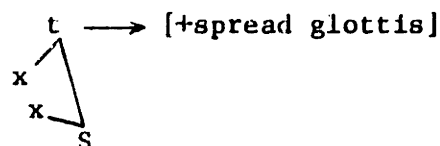
But now observe that (14a) is just a special case of (14b') and can thus be dropped from a general glottalization rule. (15), then, accounts for all the occurrences of glottalized /t/ that have been mentioned (and all known to me):

$$(15) \quad [-\text{cons}] \begin{bmatrix} t \\ -\text{S.I.} \end{bmatrix} \downarrow \\ [+C.G.]$$

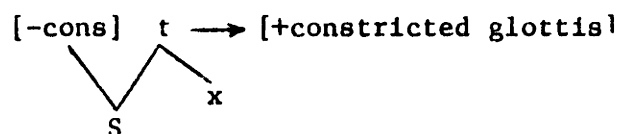
1.3 Summary and Extension Beyond Word Level

A. We have now isolated two environments, the statements of which are exceedingly simple in terms of syllabic structure, where particular allophones of /t/ are found. Repeated here, they are¹²

(16) Aspiration



(17) Glottalization



As has been pointed out, the other voiceless stops, /p, k/, follow the same aspiration rule as /t/, while the glottalization rule seems to me to be fully accurate only for /t/, although it also predicts /p/'s behavior correctly in most cases.

B. We have thus far limited our investigation of the distribution of

aspirated and glottalized /t/ to strings which do not exceed the domain of the word. When this limitation is dropped, additional strong evidence in favor of the syllabic approach becomes apparent.

We saw in Chapter I that there is a need for a rule which associates a final consonant with the initial syllable of a following vowel-initial word. We might ask whether this rule, V, interacts with either the aspiration rule or the glottalization rule.

C. Since Rule V does not apply in the case of consonant-initial words, words with initial /p, t, k/ will remain syllable-initial and non-syllable-final in connected speech, so that aspiration of initial voiceless stops is predicted by (16) for all speech-rates. This is a correct prediction.

When /p, t, k/ is final, Rule V will associate /p, t, k/ to a following word-initial vowel in connected speech. However, whether or not Rule V applies to make /p, t, k/ syllable-initial, its original syllable-final structure must remain, excluding it from the domain of the aspiration rule (16). This is also a correct prediction, for whether tap Ann, hit Ann, shake Ann are pronounced with or without pause, /p, t, k/ must not be aspirated.

Finally, word-internal /p, t, k/ is unaffected by the operation of Rule V and thus displays the same allophone whether in an isolated word or in a connected phrase.

Thus (16), derived by means of a consideration of words in isolation, holds on all domains. We have now discovered four major advantages for the syllabic analysis (16) of English aspiration over the traditional segmental one (2): a) more accurate description of the facts (recall discussion

of tōmorrow, etc.); b) the availability of a single, simple, potentially explanatory rule covering all cases; c) the availability of a simple rule, not explicitly conditioned by speech-rate, which automatically accounts for the alternation between slow-speech aspiration vs. normal-speech non-aspiration of medial stops like that of happy; d) the lack of any need to limit the rule to the domain of the word: if this limitation is not imposed on (2) it will predict aspiration in tap Ann, for example.

Of these four difficulties surrounding (2), note that by means of an improved segmental version one can hope to overcome only the first. In regard to (c), observe that although any need to condition the syllabic aspiration rule with respect to speech rate is eliminated by introducing this conditioning elsewhere in the grammar, viz., in Rule III, the latter rule is independently needed, so that (c) does indeed count as a major indication of the correctness of the syllabic approach to aspiration.

D. Let us now examine potential inputs to the glottalization rule which go beyond the domain of the word.

As we have seen, word-initial /t/ is always syllable-initial and thus should never be glottalized, even in connected phrases, if (17) is correct as it stands. Initial /t/ is in fact never glottalized.

Final /t/ is always non-syllable-initial in isolation, and thus is glottalized if preceded by a non-consonantal segment. In connected phrases, however, Rule V will introduce a line of association to the initial syllable of a vowel-initial word. We thus predict - and in fact observe -

- a) glottalization of the /t/ of hit Ann if and only if spoken with pause;
- b) glottalization of the /t/ of hit Bill, hit Ron whether or not spoken

with pause.

Thus (17), like (16) is a single, simple rule which describes the behavior of /t/ both internally and at word-boundary, both in isolated words and in connected speech.

Recall that in subsection 1.2D I observed that glottalized /t/ is never found before vowels (only words in isolation were under consideration), but suggested that the glottalization rule, rather than be written to explicitly exclude this environment, make use of the fact that /t/ is never [-S.I.] before vowels in order to subsume the — [-syllabic] and — [+syllabic] environments under a single generalization. We now have additional evidence for the correctness of this choice. Were the glottalization rule written in such a way as to predict no glottalization in the environment — [+syllabic], it would have to be limited to words in isolation, for the pre-vocalic /t/ of hit Ann is glottalized if the phrase is spoken slowly and distinctly (i.e., in such a way that Rule V does not apply). (17), on the other hand, is correct as it stands for all domains and all speech styles.

One further observation on (17) might be made. In the discussion of pre-consonantal /t/ in 1.2C, it was noted that cats and atlas, but not mattress and matriculation, have glottalized /t/. This observation was related to the differing syllabic structure of the two pairs of words, not to the type of non-syllabic following /t/. Here also an advantage beyond formal simplification of the isolated-word rule is apparent. Were the non-glottalization of the /t/ of mattress accounted for by reference to the following /r/, the behavior of /t/ in both mattress and hit Ron could not have been accounted for by means of a single rule.

E. It must be realized that the presence vs. absence of word-boundaries cannot be used to condition the glottalization rule and thus account for the unglottalized /t/ in mattress vs. the glottalized /t/ in hit Ron without reference to syllabic structure. This is so because the /t/ in a phrase like hit Ann exhibits these same two allophones, yet is syntactically the same whether spoken over-distinctly (i.e., in such a way that Rule V does not apply) or normally (i.e., with application of V).¹³

In order to see more clearly the nature of the difficulty encountered by an analysis of glottalization in terms of word-boundary, consider some comments on "glottal reinforcement" (the process whereby /t/ becomes /tʔ/ or /ʔ/¹⁴) from Selkirk (1972). On p. 196, she states that "glottal reinforcement occurs when a voiceless stop is preceded by a vowel, liquid, or nasal, and followed by another consonant" and¹⁵ that it also takes place "in pausa, i.e., — ##]." But of course "in pausa" and "— ##" are not equivalent. In a phrase like hit Ann, the /t/ will be glottalized if and only if there is a pause between hit and Ann, while, as noted above, hit and Ann are separated by ## whether spoken over-distinctly or normally (cf. also fn. 13). Note that even in the sentence of (18), where there is a maximally strong syntactic boundary between hit and Ann,

(18) Just as he was looking for someone to hit, Ann walked in

the same facts obtain, glottalization if and only if juncture. In fact, one can get the non-glottalized allophone of /t/ when a vowel follows /t/ even in a syntactically independent sentence:

(19) Joe is liable to get hit. Ann doesn't stand for any nonsense.

Rule V, which is oblivious to syntactic boundaries, is as free to apply here as in hit a ball, although there may well exist extra-grammatical considerations which lead to a higher incidence of its operation within sentences.

E. In summary, it should be clear that the type of structure which conditions the aspiration and glottalization rules is independent of syntactic structure, and thus that correctly written rules for these phenomena will apply on any syntactic domain.¹⁶

1.4 Underlying Representation of the Voiceless Stops

When not aspirated or glottalized by Rules (16)-(17), /p, t, k/ surface, with one important exception, as released unaspirated unglottalized voiceless stops [p, t, k]. In view of the wide variety of environments in which such stops are found (for example in spin, happy, clasp, clasps, tap[^]Ann, I will assume that /p, t, k/ are underlying, that is, that in lexical representations the voiceless stops carry the feature specifications shown in (20):

$$(20) \quad \left[\begin{array}{l} \text{-continuant} \\ \text{-spread glottis} \\ \text{-constricted glottis} \\ \text{+stiff vocal cords} \\ \text{-slack vocal cords} \end{array} \right]$$

The important exception referred to above concerns /t/ and is the subject of the next section.

1.5 "Flapped" /t/

A. A historical change which is unusual in having apparently affected all American dialects and no current British ones involves the addition of

a rule which turns /t/ into an alveolar flap or tap in certain positions. In this section I arrive at a general statement of the environment in which this process occurs and show the relevance of the rule to the theory of syllabic phonology.

B. "Flapped" /t/, for which I will use the symbol [D], is heard in the American pronunciation of words like butter, city. "Flap" refers to the characteristic motion of the tongue-tip in articulating [D], which is quite different from normal stop articulation.

The literature on the phenomenon of "flapped" /t/ reveals a large degree of confusion as to the phonetic nature of this segment and its dialectal variation. In Appendix 2 to this chapter, I try to summarize what can safely be said about the phonetics of "flapped" /t/ and provide an adequate description for the needs of this section. I turn now to a discussion of the distribution of [D].

/t/ is usually described as flapping in the environment $\acute{V} \text{ --- } \check{V}$. The requirement that the second vowel be unstressed can be exemplified by the pair látěr [D] vs. látèx [t^h]. The failure of /t/ to flap in latex further shows that it is not only a following main stress that prevents flapping, but in fact any [+stress] vowel. It also shows that the absence of flapping in a word like áttáck is due not to the [-stress] specification of the first vowel but rather to the [+stress] specification of the second. In fact, the [+stress] requirement on the first vowel of the environment given above appears to be simply in error, the result of looking at too small a sample. For example, the /t/ in words such as capital, obesity is flapped.¹⁷

We are thus led to the environment $V \text{ --- } \begin{bmatrix} V \\ -str \end{bmatrix}$. The next point to

be considered concerns the possibility of an optional non-syllabic segment between the focus and either of the vowels.

To the right, such an additional segment, even a glide, is out of the question: [D] is impossible in words like Atkins, atlas, mattress, amateur (even when not [...č...]).

However, the occurrence of [D] in such words as loiter [loyDər], shouting [šawDɪŋ], shows that at least a glide is permissible to the left of focus. Furthermore, words such as forty and winter have flapped /t/.

Selkirk (1972) discusses the flapping of /t/ and /d/ and states the environment for this process as (21) (p. 197)

$$(21) \quad v \left(\begin{Bmatrix} 1 \\ n \end{Bmatrix} \right) \text{---} \begin{bmatrix} v \\ \text{-stress} \end{bmatrix}$$

Apparently her omission of /r/ from the left environment is a mere oversight, for in "/r/-retaining" as well as in "/r/-dropping" dialects, unflapped /t/ in parting is as unnatural as it is in potting.¹⁸ On the other hand, one of the environments she does include is far from universal. Many speakers who never fail to flap in all the environments so far discussed have unflapped /t/ in $V1 \text{---} \check{V}$ (malted, shelter).

It seems clear that a fully adequate restatement of (21) requires reference to the observations of Section 1.2B, where it was noted that although glottalization of /t/ appears possible between sonorant and pause in many cases, all such examples reduce to the environment [-cons] --- Pause, when phonetically accurate observations are made.

As argued in Appendix 1 and elsewhere in this Chapter, English /r/ must be viewed as a glide. Thus the examples better, loiter, shouting,

parting are all covered by the rule in (22):

$$(22) \quad t \rightarrow D / [-\text{cons}] \text{ --- } \begin{bmatrix} +\text{syllabic} \\ -\text{stress} \end{bmatrix}$$

(Note that the lack of specification for the feature [syllabic] in the leftward environment allows both glides and vowels in this position. Of course, when the [-cons] position is filled by a glide, a vowel is required to its left, but this requirement need not be stated in the rule, for the sequence [C, #]-glide-/t/ does not occur.)

Now in words like winter, we appear to have a [+cons] segment, /n/, before flap. But as with words like hint, this /n/ nasalizes the preceding vowel and then may be deleted. In the flapped pronunciation of winter /n/ has in fact been elided: [wĩDər]. In fact, many Americans have two pronunciations of words like winter, [wĩntər] in careful speech, and [wĩDər] otherwise. It is important to note that this variation cannot be attributed to any optionality of the flap rule, for where no /n/ precedes the candidate for flap, as in better, unflapped /t/ is unnatural even in very careful speech. Thus it appears that nasal-consonant loss is an optional (but preferred) rule, and that upon deletion of the /n/, /t/ finds itself in the environment for (obligatory) flapping.¹⁹

Since nasalized vowels are certainly [-consonantal], Rule (22) covers the flap in winter. Remaining to be discussed is the possibility of flapping after /l/, as in shelter. If /l/ is consonantal, i.e., if the tip of the tongue contacts the roof of the mouth in its articulation, flap seems to me to be simply impossible; i.e., the result is a sequence not heard in any American dialect. I would relate the tendency of many, including my-

self, not to flap /t/ after /l/ to our tendency to maintain a consonantal pronunciation for /l/. When I do flap the /t/ of words like shelter, I must produce a non-consonantal /l/, and I believe that this is what is universally done by those speakers who habitually have flapped /t/ in this position. Cf. footnote 10.

Thus (22) seems to be an accurate account of the cases discussed so far. Let us now consider initial and final /t/, respectively preceded by vowel- (or glide-) final words and followed by vowel-initial words, to determine whether flap occurs across word boundary.

C. Where /t/ is initial, it does not flap even if the requirements of (22) are otherwise met: buy tomatoes cannot be pronounced [bayDə...].

However, word juncture following /t/ does not impede flap. The normal pronunciation of get#a horse and get##Annette home on time is [gɛDə...], suggesting that (22) must be extended to (23):

$$(23) \quad t \rightarrow D / [-\text{cons}] \text{ --- } (\#(\#)) \begin{bmatrix} +\text{syllabic} \\ -\text{stress} \end{bmatrix}$$

This treatment leaves as an arbitrary fact the presence of optional word-boundaries on only one side of focus. However there is an even bigger mystery concerning the flapping of word-final /t/.

I noted an absolute restriction against flap of pre-stress /t/ when only words in isolation were under consideration; attack and latex, for example, cannot be pronounced with [D]. Yet across word-boundary, /t/ can be flapped if pre-vocalic even if the following vowel is stressed: get##Ánn home on time also has [D]. In addition, note that for dialects in which latter = ladder, the phonetically transcribed portion of the phrase we [sɛDáskər] on the radio can be interpreted as set Oscar or

said "Oscar". In other words, the [-stress] condition in (23) can be relaxed if and only if the word-boundary option is taken:

$$(24) \quad t \rightarrow D / [-\text{cons}] \text{ --- } \underset{a}{\langle \#(\#) \rangle} \left[\begin{array}{c} +\text{syllabic} \\ \underset{b}{\langle -\text{stress} \rangle} \end{array} \right]$$

condition: $\sim a \Rightarrow b$

Although the standard notation for phonological rules allows expression of the facts as we have observed them, (24) is a highly complex and arbitrary description of what is after all a natural phonetic process.

Actually, (24) must be further complicated if it is to achieve descriptive adequacy. Recall from Section 1.3D that in a phrase like hit Ann, the glottalized allophone of /t/ is observed if the words of the phrase are not allowed to flow together. This is as predicted by Rule (17), since in such speech Rule V does not apply to link /t/ to the syllable of Ann and thus add the structural condition [+S.I.] to /t/. It is only when Rule V does apply (i.e., the normal case) that [D] is heard in hit Ann. Furthermore, in the overprecise type of articulation described in connection with the motivation of Rule II in Chapter I, flap is not observed word-internally: better [bɛ, t^hər]. Incorporating these additional conditions into (24) leads to (25):

$$(25) \quad t \rightarrow D / [-\text{cons}] \text{ --- } \underset{a}{\langle \#(\#) \rangle} \left[\begin{array}{c} +\text{syllabic} \\ \underset{b}{\langle -\text{stress} \rangle} \end{array} \right]$$

Conditions: 1. $\sim \underline{a} \Rightarrow \underline{b}$

2. if a, within connected phrases only

3. does not apply in artificially-slow speech

Note that conditions 2 and 3 are not general ones on phonological rules

and indeed have to be stated explicitly in (25): compare the SPE rules of Tri-syllabic Laxing, Velar Softening, etc., which cannot be "inhibited."

I have looked at the phenomenon of flapped /t/ in detail because it provides additional evidence for the correctness of the hypothesis that a class of phonological rules cannot be properly conditioned without reference to syllabic structure. When two crucial observations are made, most of the complexity and arbitrariness of (25) evaporates.

First of all, for a given occurrence of /t/ to be flapped, it must be tautosyllabic with a following [+syllabic] segment. Thus we observe [D] in hit Ann only if Rule V has applied, associating /t/ with the syllable of Ann. Note that this tautosyllabicity condition is met in all instances of word-internal [D] as well.

Secondly, only /t/s which have not been aspirated are candidates for flap. Word-initial /t/ is always syllable-initial and never syllable-final and is thus always aspirated by (16). On the other hand, word-final /t/ is never aspirated, as we have seen. In this way one can account for the lack of symmetry mentioned in connection with (23). Similarly, in artificially slow speech, in which Rule III does not apply, the /t/ of better will be left [+S.I., -S.F.] and will be subject to (16), while in normal speech, III bleeds Aspiration. Finally, within words, /t/ following a [-consonantal] segment will be aspirated in pre-stress position in all cases (cf. Rules IIa, III, and (16)), while across word-juncture, /t/ is never aspirated, even if a stressed vowel follows (cf. Rules IIb, (16)).

Thus if the input segment to the flap rule is taken to be a simple unaspirated /t/, and if furthermore this rule is ordered after Aspiration (16), (25) reduces to (26):

$$(26) \quad t \rightarrow D / [-\text{cons}] \text{ --- } [+syl]$$

In summary, if the various environments in which /t/ cannot be flapped are examined, it will be found that they fall into two categories, those in which /t/ will have been aspirated by Rule (16) (tack, attack, latex, buy tacks, buy tomatoes), and those in which the structural description of (26) is not met (tack, stem, mats, mast, Boston, Atkins, hit//Ann). I would claim then that (26), ordered after Aspiration (16) and applicable on all syntactic domains, is a correct account of /t/-"flapping" in American English, and that the complexity of (25) is a direct result of the failure to recognize the phonological significance of the syllable.

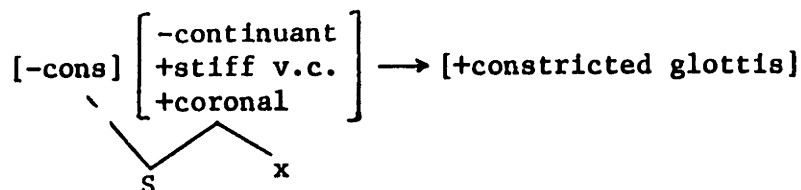
1.6 "Sonorization"

A. I summarize now the results so far achieved in our study of the allophonic development of /t/.

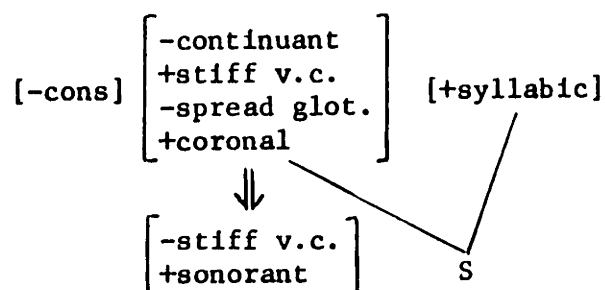
(27) Aspiration

$$\left[\begin{array}{l} -\text{continuant} \\ +\text{stiff v. c.} \end{array} \right] \rightarrow [+spread \text{ glottis}]$$

Syllable-initial non-syllable-final voiceless stops are aspirated.

(28) Glottalization

Non-syllable-initial /t/ is glottalized following a non-consonant.

(29) Flap (ordered after (27))

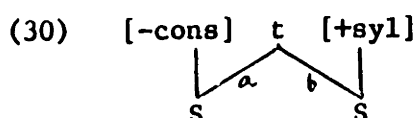
/t/ is flapped between a non-consonant and a tautosyllabic vowel.

I am not sure how to characterize fully the flap [D] in distinctive features. I represent it in (29) as [-stiff v. c.] to indicate that it is voiced. The sonorant specification is included in order to capture the tapped articulation, based on the general classification of trilled /r/s as sonorants. Further specification may be necessary, for example to represent the fact that [D] is a single-tap trill.

B. The fact that Rules (28) and (29) each have [-consonantal] in the leftward environment suggests that a further generalization might be captured. The following remarks represent speculation on my part as to what is involved.

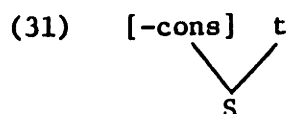
Observe that flapping will always and only occur in the configuration

of (30):



To see that whenever /t/ is flapped it is ambisyllabic, note that if line-of association a were not present, /t/ would be [+S.I., -S.F.] and therefore would be aspirated, while if b were not present, the environment for (28) would be met and /t/ would be glottalized. Although (30) holds in exactly those cases in which /t/ is flapped, the question of interest is how much of the specification of (30) is actually contained in the flapping rule.

Next note that what Glottalization and Flap have in common is the configuration of (31):



Beyond this distributional similarity, flapped and glottalized /t/s have something in common phonetically.

As mentioned above, taps and trills are always described as sonorants, sounds whose articulation does not result in any significant pressure build-up in the vocal tract, and this characterization seems to be an accurate one. [D] then should be classified as [+sonorant]

Now as pointed out in Section 1.2A, the glottalization of /t/ in words like mat deprives the alveolar obstruction of the opportunity of exercising its normal function of cutting off the airstream and holding back the resultant pressure build-up. Whether or not it is the glottalization in

[tʔ] that is the primary cause of the absence of pressure build-up, the fact remains that if we follow our definition of sonorant strictly, the [tʔ] of mat is [+sonorant].²⁰

Since glottalized and flapped /t/, but none of /t/'s other allophones, are phonetically sonorants, it follows that /t/ surfaces as [+sonorant] exactly when it stands in the configuration (31). This observation suggests a rule of "sonorization," preceding the rules of Glottalization and Flap:

$$(32) \quad \text{Sonorization}^{21}$$

$$\begin{array}{c} [-\text{cons}] \left[\begin{array}{l} -\text{continuant} \\ +\text{coronal} \\ +\text{stiff v.c.} \end{array} \right] \rightarrow [+sonorant] \\ \quad \quad \quad \swarrow \quad \searrow \\ \quad \quad \quad \text{S} \end{array}$$

Any output of (32) will be subject to either the Glottalization rule, which adds the feature specification [+constricted glottis], or the Flap rule, which specifies [-stiff v.c.] (and is thus more properly a voicing rule). The requirement for "Voicing" is simply that a vowel follow, in the same syllable, while in the inverse of this environment, the glottalization rule applies. Thus Voicing and Glottalization are as stated in (33):

$$(33) \quad \text{Voicing/Glottalization}$$

$$\begin{array}{c} \begin{array}{c} t \\ [+son] \end{array} \rightarrow \left\{ \begin{array}{l} [-\text{stiff v.c.}] / \begin{array}{c} \text{---} [+syl] \\ \quad \swarrow \quad \searrow \\ \quad \quad \text{S} \end{array} \\ [+constricted glot.] \quad \text{otherwise} \end{array} \right\} \end{array} \quad \begin{array}{l} (a) \\ (b) \end{array}$$

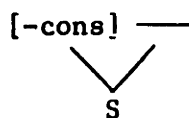
Rule (33) produces a glottalized /t/ in all those cases in which /t/ has

been made [+sonorant] by (32) except where a vowel follows in the same syllable. There are thus several ways in which glottalization can occur:

a) in utterance-final position: I saw the cat; b) pre-consonantly: cats, the cat sipped; c) before a word-initial vowel preceded by pause: the cat // ate.

If a following vowel is in the same word, /t/ will never be glottalized, since Rule II insures that /t/ will be syllabified with the vowel, thus triggering Voicing. Across word-juncture, syllabic linking in ordinary speech is established by Rule V, with the consequence that we get [D] not [tʔ] in this context, unless a pause blocks Rule V.

C. It should be understood that if this analysis in terms of Sonorization is correct, the lack of pressure build-up behind the [tʔ] of mat has as its direct cause the altered type of tongue-tip articulation introduced by the sonorization rule, not the simultaneous constricting of the glottis. Note that we know independently that coronal articulation is consistent with the feature specification [+sonorant] as well as with [-sonorant]. Coronal sonorant consonants can arise in ways which are not of direct interest to us here, as in the case of /n/, in which the lowered velum prevents pressure build-up. Directly relevant, though, are Spanish /r/ and /rr/ (single and multiple-tap trills, resp.), whose sonorant (no pressure build-up) nature can only be the result of the way in which the tongue-tip is controlled. /D/, which is very similar to Spanish /r/ (cf. Appendix 2) clearly also has this special type of coronal articulation as the cause of its [+sonorant] specification. Entailed by the analysis in (32)-(33) is the claim that this sonorant type of coronal articulation is imposed on /t/ in American English whenever it stands in the configuration



and that /t/ would surface as a voiceless /r/ when not in the Voicing environment were it not for the following glottalization rule, which makes Bernoulli oscillation, even to the extent of one tap, impossible. Although admittedly speculative, I find this analysis appealing not only for the formal simplification it allows but also because as far as supra-glottal articulation is concerned, the /t/s of mat and matter seem very similar; assigning them to different major classes, obstruent vs. sonorant, simply seems wrong.

With the proviso that not all the feature specifications may be correct as they stand, I offer the following analysis of the allophonic development of /t/ as an alternative to that given in (27) - (29):

(34) a. relevant feature specifications of the segment underlying

[t], [t^h], [tʔ], [D]:

-sonorant
-continuant
+coronal
-spread glottis
-constricted glottis
+stiff vocal cords
-slack vocal cords

b. Aspiration (as in (27))

c. Sonorization (as in (32))

d. Voicing (as in (33a))

e. Glottalization (as in (33b))

f. Rule Ordering:

b/c then d then e (but cf. fn. 21)

Note that the /t/s of stem and apt will be affected by none of the rules (34b-e) and thus will surface with the feature specifications of (34a), i.e., as [t].

1.7 The Alveopalatal Allophones

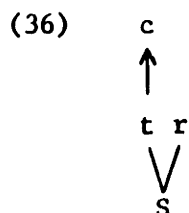
In presenting an analysis of the allophonic development of /t/, I have left (what appears to be) the easiest task for last. I refer to the investigation of the alveopalatal variant [c], [c^h] of /t/, found in words such as train, strong in many dialects.

The most obvious observation is that [c, c^h] occur only before /r/.²² Furthermore, the aspirated variant occurs just where other aspirated stops are found, in [+S.I., -S.F.] position. Examples are train, tremendous, attract, nitrate. When this condition on syllable structure is not met, /c/ shows up unaspirated: strong, mattress. Thus it is clear that the Aspiration Rule (27) is involved in the derivation of [c^h].

Alveopalatalization does not occur across word boundary: night rate [tʔ]. There are two ways of accounting for this fact. In the standard view of phonological rules, word-boundary is not "transparent" and must be mentioned in a structural description if it is to be allowed to appear in input strings. Thus by simply writing the rule as in (35), one correctly predicts that [cr], [c^hr] will be found only within words:

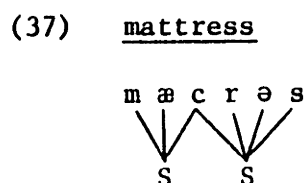
(35) t r
 ↓
 c

On the other hand, word-boundaries seem not to be relevant in many low-level allophonic-type rules, as we have seen. Furthermore, since syllable-structure conditioning appears to be needed in many such rules, one must also consider the following formulation of the alveopalatalization rule:



To see that (36) gives the desired results, note that within words /tr/ must always be followed by a vowel and that Rule II will always syllabify /trV/ together. In /...t##r.../ on the other hand, none of the syllabification rules is applicable, for II through IV apply only within words and V links final consonants only to initial vowels.

/c/ never glottalizes or flaps. Expressed as (28) and (29), Glottalization and Flap need no special restriction to prevent application to /c/, since /c/ will never meet the structural description of these rules.²³ In the reanalysis of (34) we can assume that Sonorization applies only to anterior coronals (i.e., to /t/ but not to /c/), since otherwise an input like that of (37) would trigger Sonorization:



This would seem to be an entirely natural assumption since coronal taps

and trills are usually (always?) alveolar, not alveopalatal.

In summary, the alveopalatal variants of /t/ are accounted for by supplementing analysis (34) with the alveopalatalization rule (36) (or (35)), ordered before Sonorization, or by adding (36) to analysis (27)-(29), with no explicit ordering statements required.

Section 2 - /r/-Loss

2.1 Two of the most discussed phenomena in works on English dialectology are the widespread loss of "post-vocalic" /r/ and the complex dialectal treatment of pre-/r/ vowel quality. The variable retention of "post-vocalic" /r/ is the subject of this section, phenomena concerned with vowel-quality in — /r/ of the next

As is well known, a word like card is pronounced without phonetic /r/ in most of England and Australia and in parts of the eastern and southeastern United States. /r/ is for the most part retained in all phonological environments in Scotland, Ireland, Canada, the mid-western and western United States, as well as much of the eastern U. S.

The so-called "r-less" dialects are of course not completely /r/-less, for no dialect deletes the initial /r/ of rain, for example. The usual statement is that /r/ is deleted in post-vocalic position, but even this description is inaccurate, for the /r/ of Mary is not deleted except perhaps in fast speech in certain dialects. What seems to be behind references to "post-vocalic" /r/ is an implicit assumption of syllable structure: /r/ which follows a vowel and stands fully within that vowel's syllable is subject to deletion: car, card. I believe this view is basically correct and will incorporate it into my treatment of /r/-loss.

While historical pre-consonantal /r/, for example in card, is irretrievably lost in the r-less dialects, the traditional description has it that deleted final /r/ re-appears before vowel-initial words: Mister! [Ø], Mister Smith [Ø], vs. Mister Adams [r] is observed for most r-less dialects. However, before the generative phonologist concludes that the r-less dialects differ from the r-ful ones only in containing a rule which deletes /r/ before consonant and pause, he must consider the phenomenon of "intrusive /r/." An unetymological /r/ is often observed between a vowel-final and a vowel-initial word in r-less dialects: law and order [lɔrənɔDə]. In fact, it is typically the case in /r/-less dialects that a pair of words like tuner and tuna are identical to each other in all environments, for example being pronounced with final [ə] in This — seems all right and with [ər] in This — isn't any good. This fact suggests a general lexical loss of /r/ in the environment — [C, #] and an /r/-epenthesis rule in V — V.

It turns out that if one studies carefully the various dialects in which card is pronounced without /r/, several different patterns emerge, leading to different synchronic solutions for different dialects. The one synchronic grammar that seems not to exist is one sometimes taken to be the normal case in r-less dialects, a grammar which has final /r/s correctly placed in the lexicon from the point of view of etymology, and only one phonological rule involving /r/, a deletion rule before consonant and pause. That is, there seems to be no naturally-occurring dialect (some British speakers strive towards this norm) that consistently has [ə] in tuner-Pause and tuner seems and [ər] in tuner is that does not also have [ər] in tuna is.²⁴

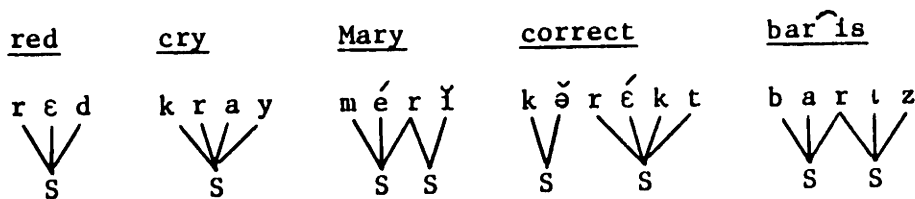
2.2 I will discuss below what appear to be the underlying forms and relevant phonological rules of some common r-less dialects. Let us consider first the historical change which gave rise to these dialects.

There can be little doubt that /r/-loss first came into the language through the addition of a rule which had the effect of deleting /r/ (or reducing it to [ə]) before consonant and pause. This assumption is uncontroversial (see for ex., Kurath 1964:76), and is the only one that allows an adequate explanation of the patterns of /r/-loss and -epenthesis in the current dialects.

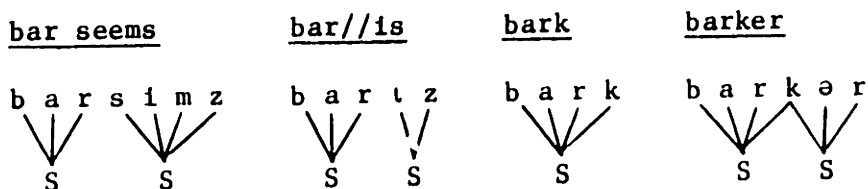
Thus /r/ was lost in essentially the environment in which /t/ is glottalized (cf. Section 1). It will be seen that the same sort of facts which force a syllabic analysis of glottalization make a purely segmental account of the original loss of /r/ impossible.

Examples of the environments in which /r/ was retained and lost are found in (41):

(41) a. /r/ retained

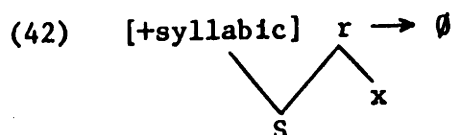


b. /r/ lost

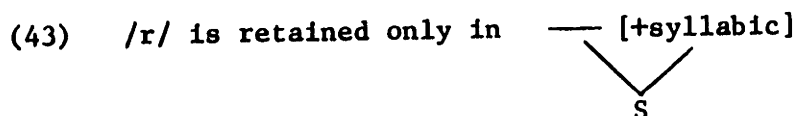


Stated in terms of syllable structure, a very simple rule accounts for

this pattern:



According to (42), post-vocalic /r/ is lost unless it also serves as a syllable-initial segment. The inverse environment is also extremely simple:



That is, /r/ is retained only when syllabically linked to a following vowel.²⁵

No statement of /r/-loss stated entirely in terms of segmental and syntactic-boundary environment could be adequate, for in phrases like those in (44), /r/'s environment is fixed, yet retention is conditional on whether the words of the phrase (or discourse) are pronounced in a flowing or staccato manner:

- (44) a. the bar#is
 b. the bar##allows
 c. [Face the bar!] [It....]

Furthermore, within words pre-vocalic /r/ is always retained, so that a non-syllabic account could not be patched up by adding a condition such as "/r/ is retained before vowel except in slow speech." From the point of view of syllabic structure there is no mystery connected with these facts. Rule II, which applies in all speech styles, assigns the structu-

ral description [+syllable initial] to pre-vocalic /r/ in words, removing it from the input of Rule (42), while in the phrases of (44), independently-motivated Rule V causes /r/ to become initial in the following syllable in connected speech, bleeding such inputs from (42).

In summary, (42) is a formally simple rule which correctly describes the behavior of /r/ in the prototype /r/-dropping dialect both word-internally and -finally and on all syntactic domains.

2.3 I turn now to a survey of some well-known "r-less" dialects and offer synchronic analyses where sufficient data is available to me.

A. As far as I can see, there is no evidence of lexical retention of /r/ in southern British English ("R. P.") in those environments in which it was deleted by (42). The example concerning tuna and tuner given in Section 2.1 holds for this dialect: both words have [ə] before consonant and pause, [ər] before vowel-initial words in connected speech. Thus the analysis that seems required is a syllable-structure constraint (stated in Rule IIb) against post-syllabic /r/, alone or in clusters, together with a rule of epenthesis, a first approximation to which is stated in (45):

$$(45): \emptyset \rightarrow r / \{ə, ə\} \text{ --- } V$$

Rule (45) introduces [r] between words like tuna/tuner [ə], fear [-ɪə], fair [-eə], and a following vowel-initial word.

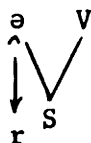
Epenthesis quite often takes place after the low vowels [ɑ:] (far, Shah) and [ɔ:] (sore, saw) in this dialect.²⁶ However, in spite of this observation, the fact that in producing final syllabic nuclei in English

that are not followed by [w] or [y] the tongue tends to glide into a mid-central position²⁷ suggests that all cases of /r/-epenthesis may actually be occurring in the environment $\underset{\wedge}{ə} \text{ — } V$. The only potential difficulty such an analysis would encounter involves words like tuna/tuner, which would normally be described as ending in [ə], rather than [ə_̃]. However one would not expect a rule applying in $V \underset{\wedge}{ə} \text{ — }$ to fail to apply in $\underset{\wedge}{ə} \text{ — }$. I will assume then that if the distinction between [ə] and [ə_̃] is more than an artifice of the notation, tuna/tuner ends in [ə], i.e., is [tuwnə_̃], and that aside from a modification to be introduced directly below, (46) is an accurate description of "linking" and "intrusive" /r/:²⁸

$$(46) \quad \emptyset \rightarrow r / \underset{\wedge}{ə} \text{ — } V$$

Now /r/-epenthesis is like the rules of Section 1 in that it is sensitive to junctural phenomena other than syntactic boundaries. In the same way that the /t/ of hit Ann is flapped only if the words are pronounced as a connected phrase, so epenthetic /r/ is observed in beer_{#1}is, where #₁ stands for a syntactic boundary of arbitrary strength, only if there is no phonetic "break" between the words. I propose to account for this fact in a way analogous to the treatment of sandhi phenomena in Section 1, that is by placing a syllable-structure condition on the epenthesis rule which will be met only if Rule V of Chapter I has applied:

$$(47) \quad /r/-\text{Epenthesis}$$



Note that in addition to the imposition of a syllable-structure condition in (47), the latter rule differs from (46) in taking [ə̞] to [r] rather than inserting [r] after [ə̞]. (47) seems phonetically accurate, producing [tuwnərɪz] and [bɪrɪz], and is also more attractive phonologically: as outlined in Appendix 1, /ə̞/ and /r/ are quite similar, apparently differing only in that the latter segment alone is [+high] and [+coronal]; an epenthesis rule would have to introduce all the features necessary to specify /r/, while the structural change of (47) is merely [+high, +coronal].

B. The /r/-less dialects of Eastern New England display /r/-epenthesis and appear to require an analysis essentially identical to that of standard British English. Epenthesis after the low vowels, [a:] (car, spa) and [ɔ:] (for, saw) is regularly observed (in fact, for it or saw it, car is or spa is without [r] would be highly unusual in connected speech).

Here, as in R.P., I know of no evidence supporting retention of post-vocalic /r/ in lexical entries.

C. /r/-less speech is very widespread in the southeastern part of the United States, especially in coastal regions. A feature of this dialect often remarked upon is the general absence of "linking" and "intrusive" /r/ (see, for ex., Bronstein, 1960:118). Thus not only tuna is but also tuner is is pronounced without [r] even in connected speech, in this dialect.

At first glance it appears that Southern speech²⁹ has the simplest grammar of all with respect to post-vocalic /r/, full lexical loss and no rule of epenthesis or deletion. Both tuna and tuner would be underlyingly /tunə/ and would always appear as such on the surface.

The situation is complicated, however, by the necessity of accounting

for [ə]/[r] alternations within words, at morpheme boundary: stare [steə] or [steə], staring [sterɪŋ]; structure [...ʃə], structural [...ʃərəl] is observed in many dialects.³⁰ Two possible analyses suggest themselves: (a) underlying final /r/ in words that alternate, /ə/ otherwise, and an /r/-deletion rule; (b) underlying final /ə/ in all words of the relevant type and an /r/-epenthesis rule applicable before vowel-initial suffixes. Neither of these solutions is fully satisfactory, as far as I can see.

There is a technical problem in the case of (a), involving the precise environment of the deletion rule. Suppose the rule is written as

$$r \rightarrow \emptyset / \text{ — } \#$$

By the standard assumptions, as input to the phonological component staring is /ster#ɪŋ/, and this rule would incorrectly lead to loss of /r/. On the other hand, if the rule is modified to require — ##, /r/ would be improperly left undeleted in those cases in which the boundary conventions³¹ provide only a single word-boundary between words. For example, due to the fact that at and of are not members of major lexical categories, only one word-boundary would separate them from /r/-final words in phrases like stare at them, structure of the sentence, and a — ## rule would be unable to reduce /r/ to /ə/.

Possibility (b) could be directly tested if there existed word of the relevant type normally heard only uninflected (thus always with [ə]) which were nevertheless possible inputs to productive suffixation rules involving vowel-initial suffixes. If (b) is correct, we would expect ex-crescent [r] in such words when suffixed. Unfortunately there is an extreme paucity of crucial examples, due to a general absence of vowel-vowel

sequences within words in English on the phonetic level. Possible test cases include rumba+ing, subpoena+ing, Selma+ite. As far as I can determine, excrescent /r/ is not to be expected in these cases. Possibilities (a) and (b) thus both meet serious problems, and in my ignorance of additional relevant facts concerning the dialect, I will have to let the matter stand unresolved.

D. An interesting situation exists in New York City, which is located between traditionally r-less and r-retaining regions. r-less pronunciations of words with historical /r/ (card [kɑ:d]), as well as "intrusive" /r/ (I saw it [əysɔrɪt]) are well attested here, but the overall pattern is quite different from that of England and New England.

The investigations of Labov (1966, 1972) are of great value in this regard. Labov is interested in the correlation between certain linguistic and sociological variables. He discovered in New York City a consistent connection between the retention of post-vocalic /r/, fricative pronunciation of th, etc., and considerations such as socioeconomic class of the speaker, his class aspirations, formality of speech, and so on. In spite of the complexity and inherent interest of these findings, only one rather simple point is of relevance to the aims of this section. In words like tuner (when not before a vowel-initial word) and card, the percentage of retention of /r/ varies from a few per cent to near 100%, the actual figure depending on the factors mentioned above. When /r/ is not pronounced, tuner and card become homophonous with tuna and cod. Now the crucial fact is that whatever the percentage of /r/ in tuner and card, the naive³² New York speaker has exactly 0% occurrence of /r/ in tuna (when not before vowel) and cod. This fact forces the conclusion that in

spite of their frequent homophony, card and cod, tuner and tuna are underlyingly distinct. The obvious choice of distinguishing feature is inclusion of /r/ in the lexical representation of tuner and card but not tuna and cod.³³ Thus we must conclude that the synchronic grammar of this dialect contains an optional /r/-drop rule. In common with other "fast-" or "casual-speech" rules, it has the properties of being invoked more often in colloquial or hurried speech, of being avoided by speakers who strive to speak clearly and "correctly," and so on. The form of the rule is just that of the historical rule (42).

What is surprising about the situation in New York is that in addition to this rule of /r/-deletion there must exist an /r/-epenthesis rule, for as mentioned earlier, "intrusive /r/" is a common phenomenon of this dialect: tuna seems, always [ə], vs. tuna is, often [ər]. (47) appears to be fully adequate for New York.³⁴

I would like to make a brief remark on the theoretical significance of discovering a rule and its inverse ($r \rightarrow \emptyset$, $\emptyset \rightarrow r$) in a single dialect. It seems to me that this is neither a problem for the theory nor particularly difficult to understand. Consider a native speaker of an /r/-retaining dialect who (consciously or unconsciously) wishes to imitate the speech pattern of England or New England. His attention would quickly be drawn to two types of unfamiliar patterns, words like card being pronounced without [r] and phrases like tuna is with intrusive [r]. These peculiarities could rapidly be incorporated into his own speech by addition of (42) and (47) as late rules. We know in fact that dialect imitation typically takes place in just this way. If these rules are retained in optional form, we have the New York City pattern. In view of the fact that current

New York City speech is the result (among many other influences) of the imposition of an r-less norm of early-19th-century British origin on an r-retaining base (see for ex., Kurath, 1964:76), this account seems entirely reasonable.

Section 3 - Pre-/r/ Vowel Quality

3.1 A comparison of English orthography and pronunciation gives a hint as to the quality changes /r/ has induced in preceding vowels. To give just one example, the vowel of orthographic C_0aC_1 is [æ] except when the initial consonant of C_1 is r, in which case it is [ɑ] (map, mat, Mac, mass, but mar, mark).

Although the sound change responsible for this particular spelling inconsistency has affected nearly all dialects of English, other pre-/r/ vowel mutations took place only in some dialects; furthermore there are many cases of rules with identical structural descriptions in various dialects but different structural changes.

Most of the important changes of the type under consideration had already taken place before the wave of post-vocalic /r/-dropping of the early 19th century, so that current r-less dialects display a wide range of altered vowels before lost /r/. Even dialects in which /r/ is not pronounced in cart have a vowel in this word which is more back than the vowel in cat, for example.

It is beyond the scope of this chapter to attempt anything approaching a general survey of the dialectal treatment of pre-/r/ vowels. What is of direct interest is that most of the historic and synchronic rules involve syllable-structure conditioning, a claim which I will attempt to

establish as true by means of a few examples involving easily confirmable facts.³⁵

3.2 In the mid-18th century, words like cat, carry, car, cart had the same vowel ([æ] in America and in the major British dialects). Sometime thereafter, [æ] shifted to [a] or [ɑ] when followed by final or preconsonantal /r/ (car, cart), but remained otherwise (cat, carry)³⁶ (Kurath, 1966:177-9). Expressed in standard form, the phonological rule accounting for the result of this sound change is (48):³⁷

$$(48) \quad \begin{array}{ccc} \text{æ} & \text{r} & \left\{ \begin{array}{c} \text{C} \\ \# \end{array} \right\} \\ \downarrow & & \begin{array}{cc} (a) \\ (b) \end{array} \\ [+bk] & & \end{array}$$

The appearance of the unnatural class $\left\{ \begin{array}{c} \text{C} \\ \# \end{array} \right\}$ in (48) suggests that this rule is actually syllable-conditioned. Noting that according to the syllable-structure assignment rules of Chapter I, only car and cart have a following /r/ wholly within /æ/'s syllable, we might relate cases (a) and (b) of (48) by re-writing (48) as (49):

$$(49) \quad \begin{array}{ccc} \text{æ} & & \left[\begin{array}{c} \text{r} \\ -\text{S.I.} \end{array} \right] \\ \downarrow & & \\ [+bk] & & \end{array}$$

where [-S.I.] is an abbreviation for "not the initial segment of any syllable;" cf. fn. 4.³⁸

Use of syllable-structure conditioning in (49) allows elimination of the unnatural [C, #] in (48). However, it should be noted that the /æ/ → /ɑr/ rule differs in two important respects from rules discussed earlier in this chapter which at first glance appear quite similar, for

example, /r/-loss.

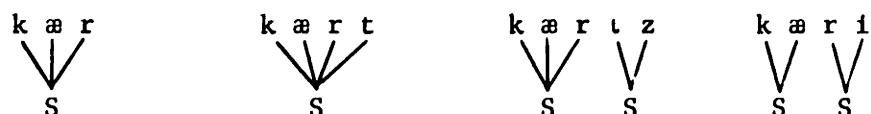
The first difference is that the unnatural environment in the non-syllabic account of /æ/-backing is [C, #], of /r/-loss [C, Pause]. To see the second difference, which is intimately related to the first, recall that once syllable structure has been assigned by Rules I-V, rules like /r/-loss apply freely without regard to boundaries assigned by the syntax. Now observe that (49) cannot be allowed to apply in a similar manner, for the /r/ of car, which is [-S.I.] when car is spoken in isolation or stands before a consonant-initial word, becomes [+S.I.] by Rule V when spoken in a connected manner before a vowel-initial word, yet the the [ɑ] of car does not revert to [æ] under these circumstances in contemporary dialects.

To see how the challenge to the correctness of (49) entailed by these observations might be overcome, consider the structure of four key inputs car, cart, car^his, and carry at various points in the syllable structure derivation:

(50) Syllable structure of

car [ɑ] cart [ɑ] car^his [ɑ] carry [æ]

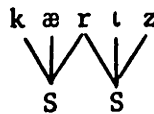
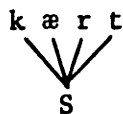
a. after Rules I-II



b. after Rules III-IV (IV is not applicable)



c. after Rule V



It is clear that Rule (49), if it is to produce correct results, must be ordered before Rule V, since after application of V, car is and carry are syllabically indistinguishable, yet one has [ɑ], the other [æ], and since [ɑ] is found in car is whether or not spoken in such a way that V applies. On the other hand, (49) must follow Rule II, which distinguishes between the /r/s of car/cart and carry.

The differences between rules like /r/-loss on the one hand and /æ/-backing on the other are theoretically significant, and will be discussed further in Chapter III, where the ordering solution suggested here will be re-examined. As we proceed in this chapter, we will encounter other rules which are like (49) with regard to the properties just discussed.

3.3 In all major contemporary dialects of English, curse, first, and herd have the same vowel, [ɜ] or [ɜ̃]. The appearance of u, i, e in the spelling is an accurate representation of the Middle English vowels in these words; the rule which served to neutralize this historical distinction is the subject of this section.

It is only before /r/ that /u, i, e/ merged, but the merger failed to take place before /r/ followed by a vowel: hurry [ʌ], mirror [ɪ], merry [ɛ].³⁹ Thus we have the following historical rule of assimilation:⁴⁰

$$(51) \quad \begin{bmatrix} +\text{syl} \\ -\text{cons} \\ -\text{low} \\ -\text{long} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{high} \\ -\text{round} \\ +\text{back} \\ +\text{coronal} \end{bmatrix} / \text{---} \begin{bmatrix} r \\ -\text{S.I.} \end{bmatrix}$$

(51) of course is a rule operating in just the same environment as (49), and the remarks made in connection with (49) regarding the desirable elimination of [C, #], as well as the need for pre-Rule V ordering, are relevant here. It is significant, however, that these rules represent independent sound changes, (51) having taken place before the time of Shakespeare (Kurath, 1964:122), (49) around 1800.

3.4 In Sections 3.2 and 3.3 I discussed rules affecting /i, e, æ, u/ before /r/. The remaining short vowel of Middle English, /ɔ/, was also influenced by a following /r/.

In many dialects, the same sort of conditioning observed in rules (49) and (51) is observed in connection with /ɔ/. We find in most dialects of the eastern and southern United States, as well as in standard British English (RP), odd, orange [ɑ] ([ɒ] in RP) contrasting with or, orb, orbit [ɔ] or [o], all five words corresponding to earlier short /ɔ/. Thus although the dialectal development of M.E. /ɔ/ is extremely complex, it is clear that the history of the dialects just mentioned involves a rule sensitive to the environment — $\begin{bmatrix} r \\ -S.I. \end{bmatrix}$.⁴¹

Section 4 - Glide Sequences

I have argued in Appendix 1 and elsewhere in this chapter that English /r/ should bear the feature specification [-consonantal], i.e., that it is a glide like /w/ and /y/, not a sonorant consonant like /n/ and (in most dialects) /l/. An examination of the pattern of glides associated with the reflexes of Middle English long vowels and diphthongs provides more evidence for this claim, as well as an additional illustration of

the way in which syllable structure conditions phonological processes.

Although the vowels of both code and core derive from M.E. / \bar{o} /, underwent vowel shift together, and currently have mid back rounded syllabic nuclei, many or most current speakers of English do not perceive them as the same vowel. The most obvious phonetic difference between them is that only the vowel of code is followed by a /w/-glide: [kɔwd] vs. [kɔr].⁴²

This observation is part of a more general fact about modern English: tense vowels are not diphthongized before the glide /r/ in monosyllables:

- (55) feed [fiyd], fear [fir]
 moon [muwn], moor [mur]
 cage [keɪ̯j], care [ker]
 roam [rowm], roar [ror]

Where the syllabic nucleus is a high vowel, following homorganic glides are hard to hear, but I believe the first two pairs of transcriptions are generally correct for American English. The third and fourth pairs of examples should be uncontroversial.

(55) illustrates the reflexes of the Middle English non-high long vowels in pre-/r/ and non-pre-/r/ position. In the case of the high vowels, the facts are different. Cf. (56):

- | | | | | |
|------|--------------|--------------|---------|---------|
| (56) | A | B | C | D |
| | tide [tayd]; | tire [tayr], | [ta:r], | ?[tayr] |
| | out [awt]; | hour [awr], | [a:r], | ?[awr] |

In the most widespread American dialects, the glides are retained even before /r/, following the reflex of a M.E. high vowel, but the /r/ is made

syllabic (column B); in some dialects the bisyllabicity of words like tire is extremely obvious: [tay-yə(r)]. A minority of speakers drop the glides (column C), as is the general rule in the case of the other vowels (cf. (55)). I am not familiar with pronunciations in which the glide is retained and /r/ is kept truly non-syllabic (column D), like the /l/ of tile.

Thus there appears to be a general principle operating to prevent the sequence [VGr] in monosyllables (G = glide). But this observation is surely related to the fact that no sequence of two glides is ever found in English monosyllables: *[wy, yw]. If, as I have argued, English /r/ is a glide, the absence of [VGr] falls out from the general restriction on GG sequences.⁴³ In fact, none of the possible combinations of [r] and glide occur in monosyllables: *[rw, ry, wr, yr].

Furthermore, no other non-syllabic shares this property of not forming sequences with glides. Examining the most obvious possibility, we find /l/ following glides in tail [teyl], tile [tayl], toll [towl], toil [toyl], and, accepting the hypothesis under discussion, in Carl [karl]. I take these observations as additional evidence that /r, w, y/ form a natural class among the English non-syllabics.⁴⁴

Extending the domain of the investigation beyond monosyllables, we find that GG sequences do occur, provided the glides are not tautosyllabic. For example, [yr] is found in tyrant, [wr] in Lowry, [yr] in wayward, [rw] in Harwell. Thus Rule II of Chapter I apparently disallows GG sequences as parts of initial and final clusters, while a syllable-final glide is free to abut a syllable-initial glide of a following syllable.

Furthermore, if the synchronic Vowel Shift/Diphthongization analysis of SPE is correct, there must be a rule of glide deletion in the environ-

ment (57a) ((57b) in a theory not recognizing the syllable),

$$(57) \quad \text{a.} \quad \begin{array}{c} \text{---} r \\ \vee \\ s \end{array} \qquad \text{b.} \quad \text{---} r \left\{ \begin{array}{l} c \\ \# \end{array} \right\}$$

or a restriction on the general diphthongization rule preventing application in this environment.

Section 5 - Raising of /æ/

5.1 Most Americans make a very obvious distinction in the vowels of pairs of words like mat/man, in spite of the fact that both of these words show the same vowel in pronouncing dictionaries. There are at least four differences in the vowels exemplified by mat and man:

- (58) a. the vowel of man is longer than the vowel of mat
 b. the vowel of man is nasalized; the vowel of mat is not
 c. the vowel of man is articulated with a higher tongue position than the vowel of mat
 d. the vowel of man is tense, of mat, lax

Distinction (58a) is simply a special case of the well-known generalization whereby vowels in English are considerably shorter before voiceless segments than elsewhere (Houe and Fairbanks, 1953; Peterson and Lehiste, 1960), and will not be of interest in this section. Likewise the nasalization of vowels before nasal consonants is a general process in English, so that (58b) does not represent a special property of /æ/. met and men, for ex., differ in the way described in (58b).

On the other hand, in the most common dialects of American English, only /æ/ is tensed and raised (58c, d) before nasals.⁴⁵ In many of these

dialects, /æ/ is tensed and raised before all voiced segments (mat ≠ mad) and before fricatives even if unvoiced (mat ≠ mass);⁴⁶ however, I limit the discussion below to tensing/raising before nasals.

5.2 The phonetics of tensed/raised /æ/ (for which I will use the symbol /E/) presents a problem for a distinctive-feature framework that countenances only three tongue-height levels, and I comment on this matter now before turning to the distribution of /E/.

Although phoneticians often point out that the two "mid front" vowels of English, the vowels of met and mate, differ in tongue height, it has been argued (see, for ex., Halle, 1973b:930) that the basic distinction between these two vowels, /ɛ/ and /e/, is captured by the feature [tense] (/ɛ/ is [-tense], /e/ [+tense]), and that the height difference is merely a secondary effect of the tensing.

The relevance of /E/ to this hypothesis is that /E/ has approximately the height of /ɛ/, not /e/, yet unlike /ɛ/, is tense.⁴⁷ Thus even among [+tense] vowels there appear to be two heights distinguished within the "mid" range.

Representing /E/ as a tense counterpart of low /æ/ does not seem an acceptable way out of this problem. While two vowels might differ slightly in height as a secondary result of some other feature difference, to claim that a vowel with the specification [+low] (/E/ under the hypothesis being examined) and one with the specification [-low] (/ɛ/) have the same height seems an abandonment of the usual assumption regarding the phonetic significance of distinctive-feature specifications. Secondly, it may be necessary to make a three-way distinction between /æ/, a tense low

vowel, and a tense vowel having the height of /ɛ/ (= /E/): see the discussion of the variants heard for the vowel of bad in New York City speech in Labov (1966) as well as Trager's (1930) discussion of "/Æ/."

It is beyond the scope of this section to attempt a resolution of the question of how many vowel heights a correct distinctive-feature system should allow (see Kiparsky, 1968b; Ladefoged, 1971; Halle, 1973b; Kiparsky, 1975). I have included these remarks here because I would like to see future discussions of the problem take into account American /E/ as well as to make explicit the nature of the vowel-quality distinction referred to in this section.

5.3 In some dialects a following /m/ or /n/ triggers /æ/ → /E/ under all circumstances, and the simple rule of (59) is an adequate description:

$$(59) \quad \begin{array}{c} \text{æ} \quad \{m, n\} \\ \downarrow \\ E \end{array}$$

(/æ/ never occurs morpheme-finally, so there are no boundary phenomena to consider).

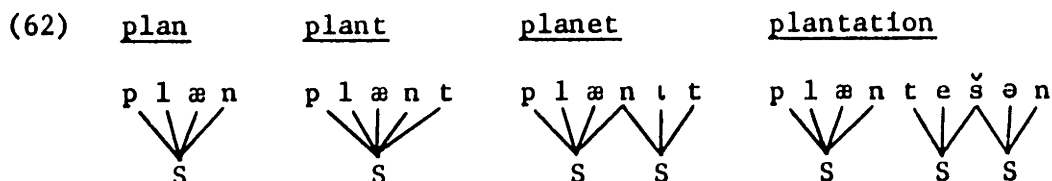
Also common, though, are dialects in which man and plan have [E] while manage and planet have [æ].⁴⁸ The crucial difference between man and manage is not syllable count, however, for in these dialects mandible and plantation have [E]. If syllable structure is not taken into account, the rule accounting for the distribution of [E] must be written as in (60) (which also correctly predicts to [E] of words like plant):

$$(60) \quad \begin{array}{c} \text{æ} \quad \left\{ \begin{array}{c} m \\ n \end{array} \right\} \left\{ \begin{array}{c} C \\ \# \end{array} \right\} \\ \downarrow \\ E \end{array}$$

Once again we encounter the unnatural grouping [C, #] in a rule environment. Here, as before, if one thinks in terms of syllable structure, the conditioning becomes quite straightforward: to effect $/\text{æ}/ \rightarrow /E/$, the nasal consonant must reside entirely in the syllable; if it simultaneously serves as initial consonant of the following syllable (manage) or is not in the syllable at all, it does not affect $/\text{æ}/$:

$$(61) \quad \begin{array}{c} \text{æ} \\ \downarrow \\ E \end{array} \quad \left[\begin{array}{c} m, n \\ -S.I. \end{array} \right]$$

We have of course seen this sort of conditioning several times already in this chapter. That (61) correctly accounts for the distribution of [E] can be seen by considering the syllabic structure assigned by the rules of Chapter I to the following key words:



Only in the case of planet is /n/ syllable-initial and only here does $/\text{æ}/$ remain.

As was the case with the $/\text{ær}/ \rightarrow /ar/$ rule discussed in Section 3.2, (61) is accurate in words only. The phrase plan it, as normally spoken, has the same syllabic structure as planet (see (62)), yet the phrase has [E], the word [æ], in the dialects under discussion. See Chapter III for further investigation of this phenomenon.

Section 6 - The Simplification of /nyu/

The simplification of /yu/ to /u/ after coronals, widely observed in current dialects of English, provides another illustration of the need for phonological descriptions in terms of syllable structure.

It is generally assumed that at an earlier point in the history of English, words like new, dew were universally pronounced with prevocalic /y/ which has been lost in many contemporary dialects. (See, for ex., Kurath 1964:77-8.) The change is usually described as loss of /y/ after coronals, for in all dialects the /y/ of pew and cue remains.

The facts, however, are not quite so simple. While it is true that /yu/ never simplifies after non-coronals, it sometimes also fails to reduce after coronals. In what follows, I limit my attention to the coronal /n/.

Even in dialects in which new is never pronounced with [y] (henceforth the [nu] dialects), the glide is found in annual, continue, and sometimes in avenue. The intuition of speakers of such dialects is that even though [nyu] represents a strange clustering of segments, annual [ænyuəl] is unexceptional since it consists of the acceptable sequence [æn] followed by the acceptable sequence [yu].

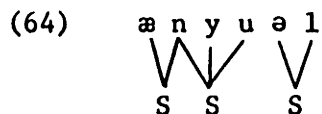
Suppose we assume that the following rule was added to the phonology of the [nu] dialects:

$$(63) \begin{array}{c} n \quad y \\ \diagdown \quad \diagup \\ x \quad S \end{array} \rightarrow \emptyset$$

As in the case of several other rules discussed in this chapter, the requirement is that the conditioning element be entirely in the syllable of

the segment affected.

Now at the point at which (63) enters the language, new is [nyu], i.e., [ny] is a possible initial cluster. Thus the rules of Chapter I provide the following syllable structure for annual,



while in new the /n/ is exclusively syllable-initial. (63) operating on new and annual, then, produces the desired result.⁴⁹

While (63) seems to correctly characterize the rule that caused the change of /nyu/ to /nu/, it is not likely that it exists in the synchronic grammar of speakers of the [nu] dialect. Consider a child learning English in an environment in which the adult speakers have (63) as an obligatory rule. Not hearing any words like [nyu], the child's language-learning mechanism will assume that /ny/ is not a permissible initial cluster, the underlying form of new will be /nu/, and (63) is not needed.⁵⁰

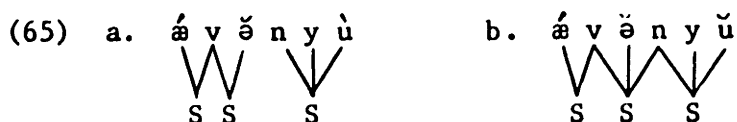
Thus I would propose (63) as a historical rule of the current [nu] dialects and as the innovation added to the phonology by [nyu] speakers who come under the influence of the (apparently expanding) [nu] dialect.

The explanation for the retention of /y/ in continue is the same as that given for annual: Rule (63) does not apply in the environment of [+S.F.] /n/. It is interesting to speculate on why the /y/ of avenue may have been lost in the subset of dialects in which this word has [nu] while continue has [nyu].

Trisyllabic words with initial main stress and no stress on the penult fall into two classes, those with secondary-stressed final vowel (lībĕrâte),

which according to SPE are derived by means of the final-stress clause of the Main Stress Rule and the Alternating Stress Rule, and those with unstressed final vowel (Mádĭsŏn), which have been subject only to the antepenult case of the M. S. R. In the case of words with a tense vowel in word-final position, it is often not clear whether the tenseness is underlying, in which case the word belongs to the first class, or derived by means of the final-vowel tensing rule of SPE from an underlying lax vowel, in which case the word is a member of the second class. Buffalo is an example of such a word. The difference between the stress patterns $\acute{X}\ddot{X}\grave{X}$ and $\acute{X}\ddot{X}\grave{X}$ is difficult to hear without the aid of the reduced/tense vowel distinction which occurs only before consonants and in the case of low vowels.

Now in those words with [ny] in which (63) fails to apply, the failure is due to /n/'s being [+S.F.], which in turn, in the cases of interest here, is the result of Rule III, which associates the initial consonant of S_{n+1} with S_n if the vowel of S_{n+1} is unstressed. Thus depending on whether avenue is a member of the first or second class of trisyllabic words described above, it will have syllabic structure (65a) or (65b),



with the additional line of association in (65b) produced by Rule III due to the lack of stress on the final vowel. Since (65a) but not (65b) meets the structural description of Rule (63), we have a way of relating the variability in preservation of [y] in avenue to an ambiguity in stress contour through a general convention of syllable structure assignment.⁵¹

Section 7 - Simplification of /ŋg/

There are certain facts which lead Chomsky & Halle (1968) to propose a special analysis of phonetic [ŋ] in English, in spite of the fact that triplets like those in (68),

(68)	a. Kim [m]	kin [n]	king [ŋ]
	b. simmer [m]	sinner [n]	Singer [ŋ]
	c. ramp [mp]	rant [nt]	rank [ŋk]
	d. Ander(son) [nd]	amber [mb]	anger [ŋg]

show that the three occurring nasals of English have at least partially similar distributions.

The facts concerning /ŋ/ that motivate the special analysis of SPE are summarized in (69):⁵²

- (69)
- a. [m] and [n] but not [ŋ] occur in # — V
 - b. [m] and [n] occur freely in V — V in morphemes, while there is only a limited number of examples of [ŋ] in this environment
 - c. only [n] occurs with a following homorganic voiced stop in — #. (Note that [m] patterns with [ŋ] in this regard.
 - d. [m] and [n] but not [ŋ] occur after the reflexes of underlying tense vowels
 - e. there are [ŋ]/[ŋg] alternations but no [n]/[nd] or [m]/[mb] alternations⁵³

Most of these facts can be accounted for by means of the analysis in

(70), which is essentially the treatment proposed in SPE (cf. pp. 85, 369, 419).⁵⁴

(70) a. /ŋ/ does not occur in lexical representations; all surface occurrences of this segment derive from /n/ in the environment — {k, g}

b. Nasal Assimilation Rule (approx. statement):

$n \rightarrow \eta / \text{ — } \{k, g\}$

c. /g/-Deletion Rule (ordered after (70b)):

$g \rightarrow \emptyset / \eta \text{ — } \#$

d. morpheme-structure constraint: $*\#[+nasal][+cons]...$

While there are serious problems with this analysis, some of which will be discussed below, others in Section 5 of Chapter III, it is quite an attractive account of the facts in (69).

The absence of initial [ŋ] (69a) follows directly from (70a) and (70d). Fact (69b) is also a direct consequence of (70), (70a) prohibiting underlying /V_ŋV/ and (70c) producing free [ŋ] only before #. Similarly, the obligatory character of (70c) prevents the occurrence of [...ŋg]. (The absence of [...mb] is not covered by (70).)

Fact (69d) is accounted for by (70a), together with a general rule which laxes vowels before non-coronal clusters (SPE: 172, 241), ordered before (70c). Finally, since (70c) deletes /g/ only before #, [ŋ]/[ŋg] alternations are to be expected in the case of suffixal derivation from words with final /-ng/ underlyingly (69e).

I turn now to a major difficulty faced by (70). There is an additional fact, not recognized in SPE, which shows immediately that the analy-

sis of (70) is not fully adequate to describe the distribution of [ŋ].

In words like those in (71),

- (71) angma 'velar nasal consonant,' angstrom, anxiety
tungsten, Yngve

we find [ŋ] not followed by either [g] or #.

Assuming that (70a) is correct, the domain of /g/-Deletion (70c) must be expanded, for we find /ŋg/ simplifying to /ŋ/ not only before # but also before consonants, as illustrated in (71). To achieve descriptive adequacy, (70c) must be generalized to (72):

- (72) ŋ g {C, #}
 ↓
 ∅

Once again we encounter the configuration {C, #}, and here as before there is good evidence that the absence of syllable-structure conditioning is behind the appearance of this unnatural class.

Before turning to specific evidence in favor of a syllabic account of /g/-deletion, let us establish that the extension of (70c) to apply before consonants is required in general. As mentioned in (69b), there are some occurrences of [ŋ] before vowels as well (for ex., hangar), suggesting that the presence of free [ŋ] in the words of (71) might simply be exceptional.

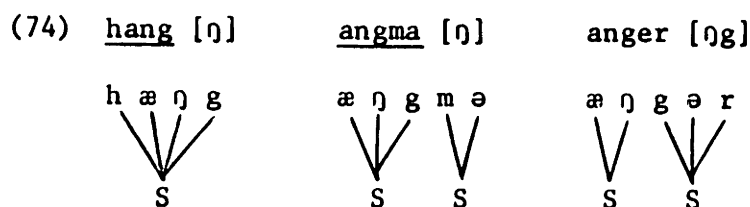
In fact, however, the strongest kind of evidence is available to the effect that the words of (71) represent a true generalization about English. Not only are there no occurring words like those in (71) but with [ŋg], there could exist none. Hypothetical [æŋgmə] is fully as deviant as

non-occurring [#æŋg#], which SPE's analysis correctly excludes. (In contrast, *[hæŋgər] is an accidental gap: cf. anger.)⁵⁵

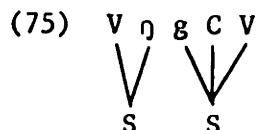
If (70a) is correct, the facts so far discussed call for the /g/-deletion rule stated in (73),

$$(73) \quad \eta \left[\begin{array}{c} g \\ -S.I. \end{array} \right] \\ \downarrow \\ \emptyset$$

as can be seen from the syllabifications of three key examples by the rules of Chapter I:⁵⁶



Next note that (73) predicts a class of exceptions to the /ŋgC/ expansion of (72). Where C is such that /gC/ is a permissible syllable-initial cluster, and C is followed by a vowel, the output of Rule II will be as shown in (75) (contrast angma in (74), with non-permissible /gm/):



Here /g/ is [+S.I.], so that if (73) is correct, /g/ should not be deleted. That is, words of the form [...VŋgCV...] should be possible just when /gC/ is a permissible syllable-initial cluster. This prediction is borne out: the non-syllabics which can form initial clusters with /g/ are /l, r, w, y/

(glow, grow, Gwen, gules), and these are just the non-syllabics which tolerate preceding [ŋg]: anglicize, angry, anguish, angular.⁵⁷ I conclude that if all surface [ŋ] is from /ŋg/, (73), and not (70c), is required in the phonology of English.⁵⁸

Section 8 - Stress Placement

8.1 One of the most obvious applications of the syllable to problems of English phonology is in accounting for a class of exceptions to the generalization, derivable from the Main Stress Rule of SPE, that vowels in the environment of (76) are stressed.

$$(76) \quad \text{--- } C_2 \text{ V } C_0 \text{]}_N$$

As has often been pointed out (for ex., by Kahn, 1972; McCawley, 1974; Anderson & Jones, 1974), SPE's weak clusters, like /br/, which apparently do not meet the C_2 part of the structural description in (76), are possible syllable-initial clusters, while most of SPE's strong clusters, like /nd/, are not possible syllable-initial clusters.

I have avoided using the phenomenon of the weak cluster in stress assignment as evidence for the correctness of the view that phonological rules may be conditioned by syllable structure because there is a basic weakness in such an argument. The stress rules of English are first of all riddled with exceptions and secondly fail the simplest attempts to confirm them directly, in many cases. As examples of the first point, one might mention with respect to environment (76) words like vanílla, Manischéwitz on the one hand, and tálísmān, chárăctěr⁵⁹ on the other. As for the second point, consider a word like Poppoñesset, in which there

is no question of either of the last two vowels being tense. Persons unfamiliar with this Massachusetts town name do not insist on antepenult stress, as might be expected if the correct model of their psychological competence included the Main Stress Rule of SPE; in fact, penult stress strikes me as more natural (I have never heard the word pronounced), in direct contradiction to the M. S. R.

In contrast, most of the rules I have discussed to this point cannot be challenged in this way and thus are good examples to use in trying to reach conclusions of a general nature about the form of phonological rules. Nevertheless, I have made certain observations concerning the relationship between accentual phenomena and syllabic structure, and I would like to mention them here in the hope that they will add to our general understanding of stress placement in English.

8.2 The basic claim of those who would use syllable structure to condition the Main Stress Rule is that the C_2 condition in (76), which serves to distinguish, for example, Cánada from veránda, represents an incorrect generalization. In this alternate view, the crucial consideration is whether or not the penult syllable is closed by one or more consonants; closed penults receive stress, while open penults allow stress to fall on the antepenult, if present. Under the general assumptions made by those who would assign discrete syllabifications to words, initial clusters are as large as possible consistent with certain general constraints. Thus for the two words in question we have Ca,na,da and ve,ran,da; only the second has a closed penult.

If the open/closed penult analysis is correct, then the general oc-

currence of antepenult stress in (77),

$$(77) \quad [\# \text{ x v } c_0 \check{v} c_0^1 \check{v} c_0 \#]$$

is due to the fact that a single intervocalic consonant is always syllable-initial, from which it follows that there is no chance of a closed penult; when c_0^1 is replaced by c_2 there is the possibility of syllable boundary internal to the cluster, which would result in a closed penult.

Thus the crucial cases for deciding between the two hypotheses would seem to be words which meet the structural description in (76) but whose penult cluster is such that it is a possible syllable-initial. Viewed in this way, the ante-penult stress of words like algebra, vertebra counts in favor of the open/closed penult analysis.

Of course, this latter hypothesis makes the prediction that (76) will fail not only when c_2 is a possible initial cluster of the type called "weak" by SPE (viz., clusters consisting of $C\{r, w\}$) but when c_2 is any cluster which is possible syllable-initially.

Although I have not made the kind of statistical study necessary to reach a final judgement in this matter, there are certainly many cases of this type that work in the way predicted by the open/closed penult principle. Examples are Álístair,⁶⁰ Árista, mínister,⁶¹ óchestra, sácristan. This principle obviates the need for any special treatment of a large class of words in final orthographic -y: índustry, tápestry, chémistry, ámnesty.

On the other hand, there are certainly examples in which the open/closed penult principle appears to fail: Aláska, Nebráska, asbéstos. In order to properly evaluate the significance of these examples, one must

take cognizance of the large number of exceptions to the rule of antepenult stress assignment, whether formulated as in SPE or restated in terms of syllable structure. Relevant to the examples Alaska, Nebraska is the fact that observed penult stress where antepenult stress is expected is the rule in U. S. state names rather than the exception: Alabáma, Colorádo, Kentúcky, Mississíppi, etc. Even beyond the domain of place names, the occurrence of penult stress in words with a penult of the form $\check{V}C_0^1$, where both principles predict antepenult stress, is so great as to lead to the conclusion that both types of stress placement must be allowed for the structure in (77). Penult stress in these cases may be the result of abstractness in underlying representations, as suggested in SPE:146-52, or of stress marking in the lexicon. In either case the factor that results in the differential stress of Mississíppi and América is ad-hoc and lexical.⁶²

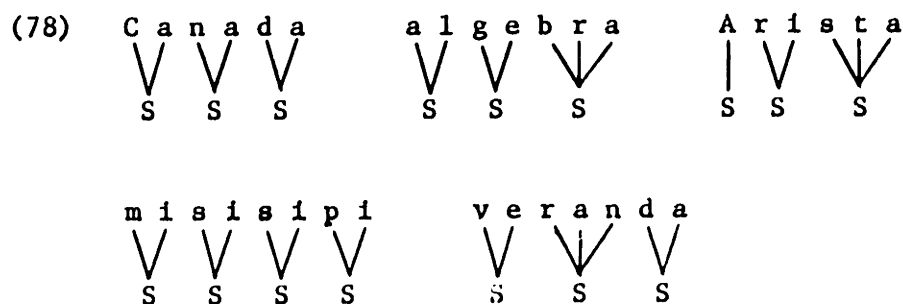
For this reason, one should not expect to be able to decide between the principles being compared here on the basis of words with penult stress. On the other hand, when words with antepenult stress are examined, it is found that the majority of them can be accounted for by either the Main Stress Rule of SPE unbuttressed by the special weak cluster provision, or the open/closed penult principle. Most of the residue is in accordance with only the latter principle (algebra, Arista), although many words of this class come under the SPE weak-cluster analysis (algebra).⁶³ On balance, then, if stress is to be assigned by phonological rule, syllable-structure conditioning seems desirable since it allows doing away with the special case of the weak cluster definition (for algebra) and subsuming additional cases under a general rule (Arista). It should be noted, however,

that most of the additional cases involve the cluster /st/, rather than other possible syllable-initial clusters, such as /sp/.

Before turning to other aspects of stress assignment, let us determine how the open/closed penult principle might be incorporated into a phonology containing the system of syllable-structure assignment rules of Chapter I.

Observe that if main-stress assignment is to be conditioned by considerations of syllable structure, the stress assignment rule must be ordered between syllable-structure assignment rules II and III. It must follow II in order to make use of information concerning possible syllable-initial clusters; it must precede III since III makes use of stress information.

This result is not problematical, for the additional lines of syllabic association assigned by Rules III and IV do not appear to be relevant in any way to stress assignment. (Recall that this was not the case with regard to many of the rules discussed earlier in this chapter.) Rules I-II produce the following syllabifications of the relevant examples of this section:



Only in the case of veranda is the penult syllable closed, and as noted above, it is only when this condition is met that we can predict stress placement with confidence in words whose last two vowels are lax.⁶⁴

It appears then that one part of a basically correct phonological generalization for English is (79):⁶⁵

(79) Closed penult syllables are stressed

(ordered between syllable-structure assignment rules II and III)

8.3 I outline in this section another application of syllable structure to a problem of stress assignment.

It is usually possible to predict whether an initial syllable which stands before a stressed syllable will itself be stressed. A first approximation to a correct generalization is that the vowel of such a syllable will be stressed if and only if it is tense or is followed by two or more consonants: Òhío, Àlbérta, but Dăkóta. This observation was incorporated into the system of stress rules of SPE by means of "Auxiliary Reduction Rule II." In Halle's modified system of stress rules (1973a), two rules, the Initial Stress Rule and the Destressing Rule, work to produce the same effect, as well as to allow accounting for generalizations regarding the stress patterns of bisyllabic words observed by Oehrle (1972). The ISR blindly stresses vowels in initial syllables, while the DR removes stress from the first vowel in a word provided it is lax and followed by a single consonant.⁶⁶

Although more often than not producing correct results, the rules of Halle (1973a) regarding stress on initial syllables admit of a large number of exceptions, many of which can be eliminated by means of a syllable-sensitive reformulation, as I will show below. For completeness, as an aid to those who would study these problems further, and to avoid

giving the incorrect impression that attention to syllable structure provides a cure-all for the ailments of English stress-assignment, I mention as well types of exception which remain unexplained even under a syllabic treatment.

There are first of all cases in which it appears that the Destressing Rule simply fails to apply. Some examples are given in (82):⁶⁷

- (82) a. alloy, Kellogg, monarch, reggae, (Walter) Matthau,
sapphire, satire
- b. baboon, ballet, cafe, chateau, Hanoi, hello, raccoon,
tattoo

At best these exceptions require lexical marking; at worst they challenge the basic generalization.

There are also many exceptions of the opposite type, in which Destressing appears to have applied in spite of the fact that its structural description is not met (alternatively, the ISR has failed to apply in these cases). I am aware of four classes of exceptions of this type.

First of all, there are certain prefixes of Romance origin which are destressed (in verbs only) in spite of a consonant cluster which follows the vowel: cōmbát, pěrmít. (Suggestions for building this observation into the formalism are contained in SPE and in Leben, 1974.)

Secondly, there are vowels in initial syllables which should retain stress by virtue of their apparent underlying tenseness, but lose both tenseness and stress. Examples are bīnoculars (cf. bīnary), mājority (cf. mājor), mīnority (cf. mīnor), pēnultimate (cf. pēnult), psýchia-trist (cf. psýche, psýchologist), stābility (cf. stāble), týrannical

(cf. t̄yrant), v̄ocabulary (cf. v̄ocal). (In all examples except majority and stability, stress- and tenseness-loss are optional.)⁶⁸

Thirdly, stress is not infrequently lost in $\#C_0 \overline{[-tns]} C_a C_b \acute{V} X \#$ when C_a is a sonorant: Kēntucky, Mānhattan (especially as pronounced in New York), Lōmbardo, Būlgaria (opt.). When the sonorant is /r/, reduction is found in a very large number of examples: Bērmuda, Bērnoulli, bērserk, Vērmont, vērnacular, Vīrginia, etc. Regarding this generalization, note that if, as argued in this dissertation, /r/ is to be grouped with the glides rather than with the consonants, we should expect it to occur in syllabic form underlying, as the glides do (syllabic /w, y/ = /u, i/). Now if Bermuda, for example, is underlyingly /b̥r̥m.../, this expectation is borne out and moreover words like Bērmúda become well-behaved with respect to the initial-stress generalization. Words like Bērlín, on the other hand, which are fairly rare, would be exceptions to Destressing, like Hànói. (Cf. Appendix 1, where phonetic syllabic /r/ is discussed.)

Fourthly and finally, when in $\#C_0 \overline{[-tns]} C_2 \acute{V} X \#$ cluster C_2 is of the type permissible syllable-initially, loss of initial stress appears to be the rule: Āstáir, āstrónomy, Dētróit, Dūbróvník, Mādríd, mōsquíto, sūpréme. I studied words of the form $[\# C_0 V_s t \acute{V} X \#]$ fairly systematically and found very few exceptions to this generalization (one is gùstátion). Far more common are examples like āstónish, cūstódian, dīstínguish, gēstált, nōstálgia. Even very uncommon words often follow this generalization: Āstýanax.⁶⁹

Thus it appears that the proper environment for initial destressing is open syllables, this generalization encompassing examples like

Àlbérta and Dākóta, as well as examples like Mădríd.

I conclude that Halle's (1973a) treatment of initial stress in English can be improved by recognizing /r/ as an underlying simple vowel and by destressing initially in open syllables, rather than in $\#C_0 \overline{[-tns]}$ C V X#.

Section 9 - Halle's Rule-Writing Convention

9.1 Halle has suggested a convention for writing phonological rules which would eliminate the need for the appearance of the unnatural class [C, #]. In view of the fact that the hypothesis that phonological rules may make reference to syllabic structure draws some of its support from its ability to perform this same desirable function, a look at Halle's proposal would seem to be in order.

Halle suggests that rules that apply within word boundaries be written to indicate this fact, and that variables be used where necessary to complete a structural description. Using the /æ/-raising rule of Section 5 as an example, instead of writing the environment as shown in (83),

$$(83) \quad \text{--- } N \begin{Bmatrix} C \\ \# \end{Bmatrix} \begin{matrix} (a) \\ (b) \end{matrix}$$

one would express case (a) of the rule as (84),

$$(84) \quad \# X \text{ --- } N C Y \#$$

where X and Y are variables. Then case (b) can be incorporated into (84) by means of the introduction of cost-free parentheses:

$$(85) \quad \# X \text{ --- } N (C Y) \#$$

Thus one could argue that the appearance of [C, #] in rules is merely an artifact of improper rule-writing conventions.

In what follows, I will argue that the availability of the rule format illustrated in (85) does not diminish the need for syllable-structure conditioning of phonological processes. I will try to demonstrate that Halle's proposal does not really represent an improvement over a theory in which rules like (83) can be written (Sec. 9.2); that it allows the writing of rules for which there is no demonstrated need (9.2, 9.3); and that it does not provide the apparatus for representing certain observed natural-language processes closely related to those for which it was proposed (9.4).

9.2 (83)/(85) also represents the environment for vowel nasalization in French (subsequent rules delete the nasal consonant and effect vowel quality changes to produce the correct phonetic output; see Schane, 1968). While it is not immediately clear why a nasal consonant should induce tensing and raising of a preceding vowel, as it does in the case of the English rule of Section 5, the French rule is simply one of feature assimilation.

According to the syllable-structure account of French Nasalization, a vowel assimilates to a following nasal only if the nasal is tautosyllabic,⁷⁰ a condition which is surely to be favored by a proper rule-evaluation scheme. On the other hand, I would argue, (85) and Halle's convention are as far from a formal account of the naturalness of French Nasalization as (83).

To see this, note first that in a non-syllabic theory, in order to

avoid writing French Nasalization as (83) (i.e., in order to avoid representing the process as consisting of two unrelatable parts), one must either (a) try to show that C and # form a natural class, a possibility which Halle (1971) and I (Chapter I) agree must be rejected, or (b) try to show that once the rule has been written for one of the two environments in (83), the other environment comes "for free." It is approach (b) which is taken in Halle (1971).

The first question to be asked in comparing this approach with the syllabic account is what formal consideration serves to value (84) more highly than (86), which involves an equivalent "feature count."

(86) # X — N V Y #

Cross-linguistic considerations make it clear that (84) is indeed more natural than (86), where a vowel-nasalization context is at issue.

Let us assume that this question can be answered in a satisfactory way, although no answer has yet been suggested, and consider the generalization of (84) to (85). Note that the convention that parentheses do not add to the cost of a structural description provides no formal explanation for the fact that (85) is more natural than (84). Even more importantly, since parentheses are "free," why isn't (87) as highly valued as (85)?⁷¹

(87) # X — (N C Y) #

The only possible answer to this question is "because the second expansion of (87) is (88),

(88) # X — #

and (88) is not a natural nasalization context." In accordance with such reasoning, as opposed to (87), (85) is a natural generalization of (84) because its second expansion is the highly valued (89):

(89) # X — N #

That is, the logic of this argument is that (85) is highly valued because it expands to (84) and (89), each of which we know from cross-linguistic considerations to be natural nasalization contexts. But (84) and (89), judged independently, are exactly equivalent to (83). Since there is no other way of justifying (85) as the proper generalization of (84), it must be concluded that (85) is a notational variant of (83), at least insofar as the [C, #] configuration is concerned.

9.3 Most of the rules in which [C, #] appears to the right of focus have an environment of the form (90) if the focus segment is [-syllabic], (91) if [+syllabic]:

(90) — $\left\{ \begin{array}{c} C' \\ \# \end{array} \right\}$

(91) — $C'' \left\{ \begin{array}{c} C''' \\ \# \end{array} \right\}$

where C' , C'' , C''' represent various classes of [-syllabic] segments. /t/-glottalization and /r/-loss are examples of the first type, /ær/ → /Or/ and French Nasalization of the second.

As far as I can see, this fact is accidental from the point of view

of Halle's suggested convention. There is no formal distinction between (92a) and (92b), for example.

- (92) a. $C \rightarrow [] / \text{---} (C X) \#$
 b. $V \rightarrow [] / \text{---} (C X) \#$

On the other hand, when rules with right-of-focus $[C, \#]$ are translated into syllabic form, the reason behind this correlation becomes clear. Rules of the form (90) describe the behavior of a syllable-final consonant, (91) the behavior of a vowel in a closed syllable. Were the focus $[+\text{syllabic}]$ in (90) or $[-\text{syllabic}]$ in (91), structural descriptions which are completely undistinguished from the point of view of syllabic structure would be involved. That is, in the latter cases syllabic considerations offer no formal simplification while the former cases are found to reduce to (93) and (94),

$$(93) \left[\begin{array}{c} C \\ +S.F. \end{array} \right] \rightarrow [] \quad \text{or} \quad \left[\begin{array}{c} C \\ -S.I. \end{array} \right] \rightarrow []$$



when the classes of consonants involved and general initial/final cluster restrictions are taken into account.

9.4 The demonstration that Halle's (1971) rule-writing convention does not eliminate all the undesirable configurations of segment and boundary that the syllable-structure theory does is quite straightforward.

Recall the rules discussed earlier in this chapter in which pause functions on a par with a class of [-syllabic] segments. As we saw, it is indeed pause or syllabic juncture and not word-boundary that is involved. The theory of Halle (1971) has nothing to say about these rules, which find such natural expression in terms of a syllabic theory.

Finally, note that as pointed out in Chapter I, in the realm of phonotactic constraints statements like that in (95) are required,

$$(95) \quad *tk \left\{ \begin{array}{l} C' \\ \# \end{array} \right\}$$

where C' is the class of non-syllabics prohibited from forming initial clusters with a preceding /k/. As argued in Chapter I, such constraints must be viewed as restrictions on possible syllable structure:

$$(96) \quad \begin{array}{ccc} *V & t & k \\ & \searrow & \swarrow \\ & S & \end{array}$$

Thus (95) represents another type of occurrence of $[C, \#]$ in phonology which is not covered by Halle's proposed convention, for re-writing (95) as $\dots(C'X)\#$ does not invalidate the criticisms of (95) made in the next-to-the-last paragraph of Section 6 in Chapter I.

Appendix 1 - The Distinctive-Feature Description of English /r/

In the distinctive feature system I use in this dissertation, the major class features are [syllabic], [consonantal] and [sonorant]. The definitions I give below of the latter two are based on M. I. T. class lectures by Morris Halle. The first, however, [syllabic], is a feature that is easy to use but extremely hard to define, as discussed in Chapter I, Section 2. I follow standard practice in taking vowels and "syllabic sonorants" to be [+syllabic], all other segments to be [-syllabic]. It is with [-syllabic] segments that I will be concerned in this appendix.

A segment is [+consonantal] if there exists an obstruction in the central passage of the oral part of the vocal tract. "Obstruction" is taken to mean that a pair of articulators is brought at least close enough together to produce turbulence in a stream of air moving past them. Thus stops, fricatives, nasal consonants, etc., are [+consonantal], while glides are [-consonantal].

The class of [+sonorant] ([-obstruent]) segments is defined as the class of segments whose articulation does not result in a pressure build-up in the vocal tract. The nasal consonants, for example, fit this description, since in spite of the outward airstream and oral closure associated with these segments, the open nasal passage insures that no pressure can build up in the oral cavity. Similarly, /l/ is a sonorant, since in spite of tongue to roof-of-mouth contact, the wide lateral openings prevent pressure build-up.

Since [-consonantal] segments involve no obstruction at all, there will a fortiori exist no pressure build-up and such segments will be [+sonorant]. We thus have the three major classes of [-syllabic] segments

shown below:

- a. $\begin{bmatrix} -\text{cons} \\ (+\text{son}) \end{bmatrix}$ no obstruction: the glides
- b. $\begin{bmatrix} +\text{cons} \\ +\text{son} \end{bmatrix}$ obstruction not causing pressure build-up: the nasals and liquids
- c. $\begin{bmatrix} +\text{cons} \\ -\text{son} \end{bmatrix}$ obstruction causing pressure build-up: the obstruents (stops, fricatives, affricates)

Where does /r/ fit into this taxonomy? The "corresponding" sound in other languages is classified with the liquids, but English /r/ in its most common American and British variants is extremely rare among the world's languages and is quite different from the more common "/r/ sounds." The most striking characteristic of English /r/ is that at no time during its articulation is there any obstruction, in the sense defined above.⁷² Thus on the phonetic level at least, English [r] must be a [-consonantal] sonorant, i.e., a glide.

I would like to make some suggestions as to how English /r/ should be distinguished from other glides. In producing /r/, the tongue tip is retroflexed and the sides of the tongue are tensed and curled up, a configuration which is quite similar to that involved in the production of retroflex consonants in the languages of India and elsewhere, with the obvious exception that in the case of English /r/ the tongue-tip remains sufficiently far from the roof of the mouth that a [+consonantal] articulation is impossible (compare the diagrams on pp. 168, 180 of Smalley, 1968).

On purely articulatory grounds, the feature specifications [+high], [+back], and [+coronal] seem justified in describing English [r]. In

M. I. T. class lectures (Fall 1975), Paul Kiparsky presented a good deal of evidence of a phonological nature that the feature complex [+high, +back] is in general appropriate for the retroflex sounds. I will therefore take English /r/ to include the feature specifications shown in (d):⁷³

- d. $\left[\begin{array}{l} \text{-syllabic} \\ \text{-consonantal} \\ \text{+sonorant} \\ \text{+high} \\ \text{+back} \\ \text{+coronal} \end{array} \right]$

In the literature on the dialectal treatment of "post-vocalic /r/" (cf. Section 2), the distinction between the "/r/-ful" and "/r/-less" pronunciations of a word like course, [kors] and [koəs], respectively, is often described by saying that /r/ is consonantal in the first pronunciation but has reduced to a glide in the second. (One also sees references to the "vocalization" of /r/; this misleading term is used to mean that /r/ has become /ə/.) The claim I wish to make is that both pronunciations involve glides between the [o] and the [s], and that what is lost in the "/r/-less" pronunciation are certain feature specifications relevant to the shape of the tongue, [+high] and [+coronal] if the suggestions of the preceding paragraph are correct, /r/ and /ə/ otherwise having feature compositions which are nearly or exactly identical; in particular, /r/ and /ə/ are both [-syllabic] and [-consonantal], i.e., glides.

Additional justification for regarding English /r/ as a glide will be found elsewhere in this dissertation. I mention here two patterning arguments.

The other English glides, /y/ and /w/, may be viewed as occurring in

three forms phonetically. They are pre-vocalic glides in yet, wet, stressed syllabics (i.e., [ɪ, u]) in beat, boot, and form the second element of a diphthong in toy, toe. /r/ and no other segment in English shows these three variants: red, burn, far. (Note that burn must be transcribed [br̩n], not [bVrn], where V is some non-retroflex vowel, for there is no portion of the syllabic nucleus that is not retroflex in standard American speech (see, for ex., Heffner, 1950:108). The conventional symbol for the syllabic equivalent of the glide [r] is [ɹ̩] when stressed and [ɹ̥] when not.)

In addition, note that in monosyllables the glides [y, w] are found after the tense vowels, say, so [sey], [sow], but not after the lax vowels *[sey, sew; sæy, saw; etc.] in the standard dialects. /r/ is the only other non-syllabic following this pattern: [ker, kor] but *[kɛr, kær, etc.].

In summary, there is good reason for viewing English /r/ as a [-consonantal] segment in the feature system outlined above, and for regarding /r, w, y/ as a natural class of English non-syllabics.

Appendix 2 - A Note on the Phonetics of "Flapped" /t/

In studying the properties of "flapped" /t/, a good starting point is the observation that /d/ is subject to flapping as well. If one compares the pronunciations of ebbing, heading, and egging with each other and with the pronunciation of /b, d, g/ in other contexts, one finds a distinct manner of articulation in the case of the /d/ of heading. The tip of the tongue is raised toward the alveolar ridge, but rather than being placed in position, held, and released, as is normal with stops, the tenseness of the tip is adjusted so that the egressive airstream will

set the tip of the tongue into oscillation by the Bernoulli effect, as in the case of a trill. However, for "flapped" /t, d/, the tongue drops away after the first tap of the trill. Thus a better description of the /d/ of heading would be "one-tap trill," reserving the term "flap" for the ballistic movement of the tongue against the roof of the mouth described for many languages of India (see Abercrombie, 1967:49-50).

The crucial role of the airstream in producing the tap of heading can be appreciated by attempting to mouth silently the words heading, head, and din with no airstream passing through the vocal tract. (This manner of articulation differs from a whisper in that the latter involves air flow.) The absence of airstream in no way impedes production of the /d/ of head and din, for these articulations are achieved by use of the tongue muscles alone, whereas under these conditions it becomes impossible to articulate the /d/ of heading in the way it is normally done.

As pronounced by most Americans, heading is probably exactly equivalent to the pronunciation of herring by Englishmen who have a "trilled" /r/ in \acute{r} — \check{r} . "Flapped" /d/ is also very similar to the single-tap /r/ of Spanish miro, although the latter may involve some additional shaping of the tongue. Certainly the American who attempts to approach the Spanish pronunciation of miro by concentrating on saying "meedo" will be coming very close.

One result of the way in which /d/ is articulated in heading is that the consonant is very short. In some informal instrumental measurements I made, the /d/ of heading had less than one third the duration of the /b, g/ of ebbing, egging.

In view of the above observations, the /t/ of a word like heating,

which is homophonous with heeding in my speech, cannot be viewed as merely a voiced [t], i.e., a [d]. Although tapped /t, d/ is voiced, its oral articulation is quite different from that of [d], as we have seen.

The description of tapped /t/ is additionally complicated by the fact that while many Americans pronounce pairs like heating/heeding identically, others claim to maintain a distinction in the intervocalic consonant. Identity has been reported for a (geographically) wide range of dialects, and I would claim that the following pronouncement of Kenyon's (1966:126) is simply inaccurate.

In American English [t] is often voiced between voiced sounds, as in better [bɛt̚ɾ], battle. Yet voiced [t] is not the same as [d], and does not belong to the [d] phoneme, since Americans do not confuse such words as latter [læt̚ɾ] -- ladder [lædɾ], or putting [pʊt̚ɪŋ] -- pudding [pʊdɪŋ].

In Kenyon's speech,

the chief difference between voiced [t] and [d] is that [t̚] is less than half as long as [d] in a given utterance and the tongue contact for [t̚] is much less firm than for [d]. (p. 127)

Judging by this description, it may be the case that Kenyon simply does not flap /d/, while his [t] is equivalent to my tapped /t, d/.

It is probably significant that although the above quotes are from the 1966 edition of Kenyon's American Pronunciation, the book was written in 1924. Although Kenyon's description is undoubtedly correct for his speech, and while the distinction he describes may be quite widespread even in 1975, it is certainly not universal in current American speech.⁷⁴

It is somewhat difficult to design an experiment to determine whether

tapped /t/ and /d/ are identical in a given dialect. This is so because vowels are shorter before voiceless consonants, and in some cases have different quality, and thus may prevent homophony in pairs of words in which /t/ and /d/ are pronounced identically. (Cf. Chomsky, 1964.) For example, although I am convinced that my flapped /t/ and /d/ are identical, plotter and plodder are not homophonous, the latter word having a distinctly longer vowel, perhaps with slightly different quality. Recognizing that the longer vowel of plodder is a direct consequence of the longer vowel in plod vis-a-vis plot, one might try to eliminate this problem by limiting one's attention to pairs of underived words like latter/ladder, where the length difference is not observed. But exactly because these words are underived, we cannot be sure that they have different consonants underlyingly. Thus the discovery that they are homophonous would be inconclusive.

The literature contains a few very limited attempts at experimental determination of the homophony of tapped /t/ and /d/. Oswald (1943) found listeners in general unable to distinguish between American pronunciations of bleeting/bleeding and similar pairs. Sharf's (1960) results are ambiguous. (One of his two speakers produced voiceless unflapped /t/s in words with orthographic t, like matter, probably under the influence of the microphone and the experimental setting.) I am sure that a careful study, involving speakers of many different backgrounds, would show that for many American dialects /t/ and /d/ undergo merger in the tapping environments, while for others they do not.

In the text I describe my own speech, in which tapped /t/ and /d/ are identical. I believe that the claims made regarding the environment

of /t/-tapping hold as well for speakers who never merge /t/ and /d/.

Comments on the feature specification of tapped /t/ are to be found in the text. It is not at all clear, however, how Kenyon's latter, his ladder, Spanish miro, and Spanish perro (multiple-tap trill) are to be distinguished in terms of distinctive features.

Appendix 3 - More on pre-/r/ Vowel Quality

A. Sections 3.2, 3.3, and 3.4 were concerned with the phonetic changes induced in the reflexes of the Middle English (M.E.) short vowels by a following fully-tautosyllabic /r/. In the absence of further changes, one would expect to find, in current dialects, identical vowels in the environments — rV and — \bar{r} , where \bar{r} = segment other than /r/. While this situation is observed for some dialects and some vowels, further changes have complicated the pattern in many cases, giving rise to vowel-quality distinctions in the environments just mentioned. Furthermore, mergers have taken place between the reflexes of M.E. long and short vowels in — r. I mention here some of the major patterns observed in the United States.

B. As a result of Rule (49), which took /æ/ to /ɑ/ in — r {C, #}, [æɹ] occurred only in —V, as in carry. In some American dialects, typically found in the West and Midwest, a much more recent rule has raised the /æ/ of carry to [e], thereby giving rise to a merger of M.E. /æ/ and / $\bar{\text{æ}}$ / in — rV. (M.E. / $\bar{\text{æ}}$ / became modern /e/ in all environments by means of the Great Vowel Shift.) A well-known example of the homophony resulting from these changes is that of marry, Mary (M.E. / $\text{mæ}r\text{i}$ /, / $\text{m}\bar{\text{æ}}r\text{i}$ /, respectively.)

The raising rule affecting carry, marry can be stated as (e):

$$(e) \quad \text{æ} \rightarrow \begin{bmatrix} -\text{low} \\ +\text{tense} \end{bmatrix} / \text{--- r}$$

Although (e) always applies in the environment --- rV, the rule need not be made conditional on the presence of V, since all /æ/ is in --- V, as we have seen.

It might also be mentioned at this point that the dialects which underwent (e) are a subset of a set of dialects which show a loss of the tense/lax distinction in certain pre-/r/ vowels:

$$(f) \quad \begin{bmatrix} \text{v} \\ -\text{bk} \\ -\text{low} \end{bmatrix} \rightarrow [\alpha\text{tense}] / \text{--- r}$$

where $\alpha = +$ in some dialects, $-$ in others. For example, while more conservative dialects have mirror [ɪ] (<M.E. /mir.../) contrasting with hearer [i] (< M.E. /hēr.../ via Vowel Shift), in other dialects the words rhyme. Similarly, merry (conservative [ɛ] < M.E. /meri/) and Mary (conservative [e] < M.E. /māri/ by Vowel Shift) fall together. As was the case with (e), (f) had the opportunity of affecting vowels only in --- rV, the hypothetical input {i, e} r {C, #} no longer existing because of the rule discussed in Section 3.3.

Note that in dialects affected by both (e) and (f), triplets like merry/Mary/marry will be indistinguishable. (The varying homophony across dialects of the latter set of words is too well-known for it to serve as a reliable shibboleth in investigations of Rules (e)-(f); some speakers have apparently adopted non-systematic pronunciations for one or more of

these words. Better test triplets include parry, peary 'like a pear,' Perry; Harry, hairry, herring; bury is a good test item because its spelling disguises its class membership: bury = berry, not Barry or beary 'like a bear,' in the conservative dialects.)

C. There is a similarity in the development of front and back vowels in pre-/r/ position. Two facts, however, prevent full parallelism in the front and back series. First of all, at the time the pre-/r/ vowel-mutation rules came into the language, English had two front non-high short vowels, but only one back non-high short vowel, /ǣ, ɛ/ vs. /ɔ/. Thus there is no possibility of a merger, among the back vowels, corresponding to the one that gave rise to homophony between marry and merry in some dialects. In this respect, the back-vowel developments are somewhat simpler. A second difference, however, increases the complexity of the back-vowel facts. The front low short vowel, /ǣ/, was backed under the influence of a following fully tautosyllabic /r/ (mar(k) [a]), preventing /ǣ/ in this environment from merging with any other front vowel. In the back series, on the other hand, the low short vowel, /ɔ/, remains back in all environments, even before tautosyllabic /r/, and in fact merges with the reflex of earlier /ɔ/ in certain dialects.

In the most conservative American dialects, spoken in various parts of the Eastern United States, we find the reflexes of earlier /ɔr/ and /ɔr/ distinct in all environments: for [ɔ] or [ɒ] (</ɔ/) vs. fore, four [o] (</ɔ/ via Vowel Shift); forest [a] or [ɒ] (< /ɔ/) vs. forum [o] (< /ɔ/ via Vowel Shift). I will refer to dialects showing these contrasts as E₁ dialects.

Other Eastern U. S. dialects (E₂ dialects), as well as standard Bri-

tish English, retain the distinction between / \check{r} / and / $\bar{o}r$ / only when /r/ is followed by a vowel, i.e., is not fully tautosyllabic with the vowel in question. In such dialects then, for and four are homophonous [o]⁷⁵ while forest, [a] or [ɒ], and forum [o]⁷⁵ remain distinct.

The rule accounting for the merger of / \check{r} / and / $\bar{o}r$ / in E_2 , referred to in Section 3.4, apparently applied in the environment $\left[\begin{smallmatrix} r \\ -S.I. \end{smallmatrix} \right]$, and in this respect parallels the front-vowel rule of Sec 3.2, (49).

Dialects E_1 and E_2 agree in distinguishing the words in (g) from those in (h):

(g) [a] or [ɒ] < / $\check{r}V$ /

Doris	horrible
foreign	Morris
forest	orange
historic	Oregon

(h) [o] < / $\bar{o}rV$ /

boron	orient
forum	story
glory	torus

There are other American dialects ("W dialects") in which all the words of (g)-(h) have a mid vowel, approximately [o].⁷⁶ The W dialects are spoken west "of a continuous line on the map from central Vermont to western Texas" (Thomas, 1958:200).⁷⁷ The rule that gave rise to the W dialects can be written as (i), added as an innovation to an E_2 dialect:

$$(1) \quad /o/ \rightarrow \begin{bmatrix} -\text{low} \\ +\text{tense} \end{bmatrix} \quad / \text{ --- } r$$

This rule parallels Rule (e), the innovation that merged marry and Mary, in several respects: (a) both are conditioned by a following /r/; (b) both apply only in --- rV but need not have V stated explicitly, for other inputs (mar(k), for(k)) have been bled by previous rules applying before non-syllable-initial /r/; (c) both rules raise low vowels to mid position; (d) both rules applied in approximately the same geographic area, west of the line mentioned above. It seems clear, then, that (e) and (1) are special cases of a general pre-/r/ raising rule which affected Midwestern and Western speech.⁷⁸

Footnotes to Chapter II

1. occasionally voiceless; see Appendix 2
2. These allophones are sometimes described as being the affricate /č/. This may be an inaccurate description traceable to the fact that /č/ is the closest freely-occurring phone in English to /c/, or it may actually occur in some dialects.
3. In the experiments described in Lisker and Abramson (1964), most occurrences of initial /b, d, g/ in English were articulated as voiceless unaspirates.
4. I will also, where convenient, treat the conditions "syllable-initial" and "syllable-final" as though they were features on a segment; thus (6) might be rewritten as

$$\left[\begin{array}{l} \text{-continuant} \\ \text{+ stiff v.c.} \\ \text{+S.I.} \\ \text{-S.F.} \end{array} \right] \longrightarrow \text{[+spread glottis]}$$

It should be clear, however, that [S.I.] and [S.F.] are not distinctive features, but rather structural conditions that may be imposed on segment classes in rules.

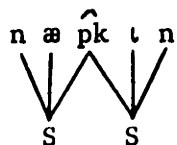
On the use of the feature specifications [-continuant, +stiff v.c.] to capture the set of English voiceless stops, see Halle & Stevens (1971).

5. Words like bodkin thus provide another type of example illustrating the incorrectness of (2a).
6. There is another possible source for the unaspirated articulation of

/k/ in these words.

Consider first how a simple intervocalic stop is articulated. Stoppage of the vocal tract is made at some point, held for a short interval, and then released from that same position. Thus Abercrombie (1967:140) refers to the "three phases of a stop," the shutting phase," "the closure phase," and "the opening phase." Now when there is a two stop intervocalic cluster, one does not observe two-times-three or six phases in ordinary speech, but again only three. First there is the bringing together of the articulators at the point of articulation of the first stop, followed by a closure phase during which there is no escape of air or sound, followed by an opening at the point of articulation of the second stop. During the closure phase, the point of stricture moves silently from that corresponding to the first stop to that corresponding to the second. Acoustically, a medial stop cluster looks like a single stop, except that its silence interval is somewhat longer and its opening and closing formant transitions do not correspond to the same point of stricture.

Now if for the purposes of establishing syllabic structure the sequence closure-holding-release is interpreted as a single segment, whether or not closure and release involve the same point of articulation, the structure of napkin would be,



with the original lines of association between /p/ and S_1 and /k/ and S_2 joining to form ambisyllabic /p̂k/ and giving napkin a syllabic structure

identical to that of happy. At present I know of no further evidence for or against this proposal.

7. I believe the description in this paragraph in fact holds for most American speech, but I have not investigated the matter.

8. In many English and Scottish dialects, /t/ is replaced with a pure glottal stop not involving alveolar closure. Such stops are perceptually very different from the glottalized /t/ described here, presumably for the reasons outlined in the text.

In addition, it should be mentioned that there are several perceptually distinct sounds for which one might use the symbol [tʔ], differing perhaps in the forcefulness of the glottal stoppage and the relative timing of the oral and laryngeal closures. In the /t/ described in the text, the glottalization is not particularly prominent.

9. As is well known, in many dialects orthographic r is not pronounced, or is only optionally pronounced, in this position (cf. Section 2). The observation being made here, of course, is that even where /r/ is pronounced, /p, t, k/ take the V — Pause allophone.

10. In some dialects, words like belt seem to be consistently pronounced with [tʔ], and, as implied in my description, such a pronunciation is an option for me. I have not tried to pass over this fact as possible counterevidence to my claim that /r/ is [-consonantal] in English while /l/ is [+consonantal]. On the contrary, it is my own very clear intuition that release of /t/ is far more acceptable in colt than in court, for example (as well as the differential behavior of /l/ and /r/ with respect

to "flapping" of a following /t/; see Section 1.4) that led me to investigate the articulation of /l/ and /r/ and observe that only /r/ is obligatorily a glide in the way that this term is usually understood (Appendix 1).

I would relate the variability in release of /t/ following /l/ to the observation that in many dialects (optionally in most?) contact is not established between tongue-tip and palate in articulating /l/ in post-vocalic position (see, for ex., Bronstein, 1960:128). In extreme form, this tendency gives rise to pronunciations like [mɪwk] for milk, quite common in some parts of the United States. However, it is possible to attain "/l/ quality" (even as judged by speakers who tend towards consonantal /l/) with no contact between tongue and roof of mouth, as a simple experiment clearly illustrates. Now once contact is lost, we have a [-consonantal] articulation, as discussed in Appendix 1, and we expect the unreleased pronunciation of /t/ and /p/. It thus seems to me that the suggested analysis fits the observed facts quite satisfactorily.

11. In cases like casts and asks, a fast-speech option for many speakers, including myself, is elision of the stop. However the resulting geminate [ss] does not seem to simplify, except perhaps in extremely hurried speech. Thus cast~~s~~ ≠ Cass, ask~~s~~ ≠ ass.

12. Regarding the statement of (17), which is equivalent to (15), note that S may link segments to the right of /t/ and of course segments to the left of the [-consonantal] segment. It need not be stated explicitly that S's vowel is to the left of /t/, since were it to the right, the [-consonantal] segment would necessarily be [-syllabic], giving rise to

an initial cluster of the shape C_1 -glide-/t/, which is of course non-occurring.

13. It is sometimes suggested that "fast-speech" processes be accounted for in terms of a rule which weakens or deletes boundaries at above-normal speech rates. There are two indications that such an account, if ever correct, is not behind the phenomena described here.

First of all, the usually-described "fast-speech" phenomena come into play only in greatly accelerated rates of articulation. If boundary-weakening is to account for these phenomena, it must occur only in truly hurried speech, with normal speech retaining the boundaries assigned by the syntax (subject to the conditions outlined in SPE and in the Introduction to Selkirk, 1972). But the distinction between glottalized and unglottalized (actually "flapped") /t/ in hit Ann corresponds to artificially-distinct speech and normal speech, not normal speech and fast speech; by hypothesis normal speech has maximal boundaries, so differences between slow speech and normal speech cannot be related to boundary differences.

Secondly, if it were assumed that the words of the phrase hit Ann are separated by ## only in slow speech and by # or by no boundary at all in normal speech (an assumption that would give rise to problems elsewhere), we could not account for the glottalized /t/ of slow-speech hit a ball, in which /t/ is followed by single #, or of atlas, which involves no boundary at all.

14. In the dialect I describe, /t/ is never fully replaced by [ʔ]. In comparing Selkirk's statements regarding the general process of glottalization and my own, one should keep in mind that her sources of phonetic

data on glottalization are largely British, whereas I attempt to describe my observations of American speech.

15. Recall that I have attempted to demonstrate that the "liquids and nasals" after which glottalization occurs are illusory. On the other hand, Selkirk omits glides from the enumeration of possible leftward environments, presumably an oversight.

16. There is however a point of contact between syntactic structure and syllabic structure, Rules II-IV, which apply to words and to which certain generalizations concerning words and aspiration/glottalization can be traced (for example, the fact that word-initial /p, t, k/ is always aspirated.) Such generalizations must not be allowed to obscure the fact that considerations of syllabic structure, not syntactic structure, condition proper statements of the aspiration and glottalization rules.

17. In some words which appear to be entirely on a par structurally with words like capital, failure to flap is not quite so serious an affront to the American ear as the absence of flap usually is. Compare better, capital with marital. Even in the case of the latter word, however, /D/ is preferred greatly.

18. Another inaccuracy in Selkirk's rule is found in her attempt to collapse the environments for the flapping of /t/ and /d/. Although I agree with her that latter and ladder are homophonous for most Americans, center and sender are not, at least in normal-rate speech. That is, a preceding /n/ hinders /d/-flapping but not /t/-flapping, a fact which is surely related to the elision of nasal consonants (after vowel-nasalization) before

voiceless stops only (cf. Malécot). See discussion below.

19. For me, there is a third option in the pronunciation of words like winter, possible only in decidedly hurried speech, [wĩnər] = winner. Some speakers appear to have homophony in winter and winner even in normal speech. I cannot relate this loss of /t/ to the other rules discussed in this chapter in an illuminating way.

20. Assuming of course that the expression "pressure build-up in the vocal tract" mentioned in the definition of sonorant is taken to mean "pressure build-up in the vocal tract proper, i.e., not including the region below the glottis." I take this to be the way in which the definition should be understood. Note for example that SPE (p. 354) classifies glottal stop as a sonorant.

21. Note that although in all cases in which Sonorization applies there will exist the syllabic linking shown in (32), this structure can be eliminated from the rule by ordering the rule after Aspiration and including [-spread glottis], i.e., unaspirated, in the structural description of Sonorization. For then inputs in which [-cons] and /t/ are not tautosyllabic will have been aspirated by the Aspiration rule. I don't know of any fact which chooses between this analysis and (32).

22. The appearance of underlying /t/ as an alveopalatal before /r/ is surely an assimilation. /c/ differs from /t/ in being [-anterior] (cf. SPE:304), a specification which /r/, as a retroflex segment, can be taken to share. /t/ does not take on /r/'s [+back] specification in words like train, although it appears to be [+high] under the influence of /r/ (cf.

Appendix 1), and may in this respect differ from alveopalatal stops found in other languages.

Thus the structural change of the /t/ → /c/ rule, to be given below, can be taken as [-anterior, +high].

For its part, /r/ is affected by a preceding /c/, becoming consonantal and fricative.

23. Glottalization (28) requires a [-S.I.] stop preceded by a [-cons] segment. As we have seen, /c/ is either [+S.I.] (in {V, #} — rV) or else preceded by a [+cons] segment, namely /s/. As for Flap (29), it has the rightward environment [+syllabic], while /c/ is always found before /r/.

24. In addition to my own observations, I offer the following comment from Kenyon (1964:164-5):

...intrusive /r/ is the use of an /r/ sound that is not spelled and was originally not sounded. It is a very common practice among cultivated speakers in England and eastern America...The evidence in these regions is so overwhelming that it is mere ignorance of the facts of cultivated usage to deny it.

Gimson (1962:204), discussing R. P. (standard British English) describes "intrusive /r/" as being pervasive.

25. The discussion in the text would be incomplete without reference to the fact that even within /r/-retaining dialects, the structural description of rule (42) is significant. In most of these dialects, post-vocalic /r/ is articulated differently from /r/ in environments in which it is universally retained. (See Kurath and McDavid, 1961:115, for a descrip-

tion of the difference in some American dialects; see also fn. 73.) Thus it is possible that the correct historical solution is a universal rule of the form $/r_1/ \rightarrow /r_2/$, followed by the context-free innovation $/r_2/ \rightarrow \emptyset$ in the "r-less" dialects. Cf. Gimson (1962:205).

26. Gimson (1962:204) on R. P.: "...the comparative rarity of the cases of such possible intrusive /r/s [after low vowels not followed by orthographic r -DK] tends to make speakers more aware of the "correct" form; thus I saw it [...r...], drawing [...r...], are generally disapproved of, though it is likely that many RP speakers have to make a conscious effort to avoid the use of such forms."

27. This fact quickly becomes obvious when an English speaker attempts to produce sonograms illustrating pure vowels, i.e., vowels with steady formants.

28. If (46) is correct, the intrusive /r/ following the word eh, 'lax mid front vowel,' which I observed on the part of a Boston-bred linguist ("the vowels [ɛ] and [ɪ]," phonetically [...ɛrənɪ̯ə]) is to be traced to the fact that English speakers, even with phonetic training, produce [ɛ̯] when attempting to articulate [ɛ] in isolation.

29. I have observed, but will not discuss here, Southern dialects in which post-vocalic pre-consonantal /r/ tends to be retained, final /r/ dropped: force the Senato^r...

30. Dialects without [r] in staring and structural probably also occur in the southern United States.

Note that in the British and New England dialects discussed above,

where such alternations are also observed, epenthesis rule (45), which applies on all domains, would introduce an /r/ in the inflected forms.

31. See SPE and Selkirk (1972·Introduction).

32. I include this qualification to exclude possible hypercorrection effects due to conscious or unconscious imitation of other dialects on the part of speakers who have close contact with natives of other regions.

33. This sort of phonological situation is not at all uncommon. Again in New York speech, then is sometimes [ð], sometimes [d], while den is always [d], never [ð]. Or to give a more universal example, in spite of the fact that several is almost always pronounced [...vr...], the fact that it is occasionally pronounced [...vər...] implies that it is distinct underlyingly from Chevron, which is never [...vər...].

34. In New York speech at least, derived final /ə/ does not allow "epenthetic" /r/: in the phrases a lotta·apples, you shoulda·eaten, I'm gonna·ask 'im, /r/ in the positions indicated by dots is not observed and is felt to be severely deviant, in spite of the fact that the final segments of tuna and of lotta, etc. are phonetically identical.

A possible way of accounting for this phenomenon is to order rule (47) before the various rules which generate final /ə/, of → /ə/, to → /tə/, etc. (Note that these rules must be distinguished from the general SPE rule which takes unstressed lax vowels to /ə/: ✓algebra-r-is.)

There is at least one indication that this solution is not correct, however. When the rightward environment of the epenthesis rule is derived, /r/ appears normally: give Linda-r-~~historical~~ information,

let's subpoena-r-'em. Thus all rules (the sample is admittedly small) that create a rightward environment for epenthesis would precede the latter rule, while leftward-environment producing rules would follow it.

These facts suggest that words with "lexical" /ə/, like Linda, tuna, (and, contra SPE, algebra) are somehow marked as alternating with /ər/, while lotta, shoulda, being derived, lack this specification. Note that this marking could not be the inclusion of a final /r/ which is deleted before consonant and pause by (42), for such deletion would have to be absolutely obligatory (recall that tuna is never [-r] before consonant or pause), while (42) is normally optional in New York: Peter, tuner are sometimes [-r], sometimes [-ə] before consonant and pause; cf. discussion in the text. I have no satisfactory solution to offer.

35. In addition to the specific references found in this section, the following works served as general sources of information: Bloomfield (1935), Bronstein (1960), Kenyon (1966), Kenyon & Knott (1953), Kurath (1964), Kurath & McDavid (1961), Thomas (1958), Trager & Bloch (1941), Trager & Smith (1951).

36. In some common American dialects a much more recent rule has raised the unaffected /ə/ of carry to /e/; see Appendix 3 for further discussion.

37. A historically more accurate account might have to break (48) down into a lengthening rule in the environment of (48) and a context-free / \bar{a} / → / \bar{a} / rule. (See Kenyon, 1966:178 fn 94.)

38. Certain other non-syllabics, /f, θ, s, m, n/, induced the /ə/ → /a/ change, but only in a limited set of words (about 150); in contrast, the

backing of /æ/ was exceptionless before non-syllable-initial /r/). [ɑ] is found in place of [æ] in these words in England and, in an even more restricted set of words, in Eastern New England (where the vowel tends to be [a:]), but not in the rest of the United States. Examples for both England and New England include bath and can't. Although there is no general rule accounting for which words with /æ/ + /f, θ, s, m, n/ underwent the backing rule, it is significant that in all cases the conditioning consonant is [-S.I.]: no word like asset had its vowel backed.

39. In some American dialects, an independent (chronologically much later) rule took /ʌ/ to /ɹ/ in words like hurry. On the fate of mirror and merry in the U. S., see Appendix 3.

40. If there really is a difference between /fɹrst/ and /frst/, the non-syllabic /r/ may have to be deleted.

Rule (51)'s structural description is such that all short non-low vowels are affected. Due to an asymmetry in the M. E. short vowel system, two front vowels but only one back vowel undergo the rule.

41. See Appendix 3 for further discussion of the development of /ɔr/.

42. With regard to these transcriptions and those in (55), I do not mean to imply that the syllabic segments of pairs like core and code, care and cage are identical, but merely that they are both typically mid.

43. Words like what, whether (where contrasting with watt, weather) might be viewed as requiring the weakening of the claim in the text to "sequences of voiced glides are not found in monosyllables," in view of the standard transcription [hw...] for such words. However [hw] for wh is simply in-

accurate, at least for the types of American speech I have come in contact with. what is not pronounced with [h] followed by (voiced) [w], but rather with a voiceless [w]-glide, [w̥at], or with a voiceless fricative (velar?) with labialization [x̥w̥at]. I can see no justification for regarding wh as consisting of a sequence of segments.

44. Haj Ross has pointed out to me that the analysis of this section draws additional support from two further observations: (a) even those dialects which retain pre-[u] [y] after [l] (lure, lute) fail to show [y] after [r]: ruin *[ryuwn], a consequence of the restriction against GG sequences and the major-class distinction between /r/ and /l/; (b) as a syllable terminus in English, we find /rl/ (Carl) but not /lr/; this is seen to be related to the hypothesis that /r/ is a glide while /l/ is a sonorant when it is observed that it is true in general in English that syllables may end in glide+sonorant but not sonorant+glide.

45. Often, /æ/ is raised before /m/ and /n/ but not before /ŋ/, or else is raised to /E/ (see below) before /m, n/ and to /ɛ/ or /e/ before /ŋ/.

46. See, for example, Trager (1930), who claims that this situation holds for most American speech. I have observed tensed and raised /æ/ in words like mad, mass in the speech of many Easterners, Southerners, and Midwesterners.

47. Although the distinction seems to be mainly one of tenseness, [E] tends to be longer and end in a more pronounced centralizing glide. One can see that these latter differences are secondary in nature by conscious-

ly lengthening and diphthongizing the vowel of men and noting that it still maintains a quality distinct from that of man.

48. This situation obtains in New York City and elsewhere in the U. S.

49. The crucial difference between new and annual is their respective syllable structures, not the fact that [nyu] is the first syllable of new and the second of annual: compare Agnew, which is like annual in this regard but in which the /n/ cannot be associated with S_1 due to the presence of the /g/; in Agnew, /y/ is deleted.

50. Of course, the reason why the rule can be lost and replaced with a syllable structure constraint is that adoption of the rule did not give rise to large-scale alternations between [n] and [ny]. If this were the case, /y/ and Rule (63) might have been preserved.

51. In trisyllabic words with main stress on the penult, secondary stress on the final syllable is not the usual case. Thus continue is universally interpreted as having contour 010, /n/ is ambisyllabic, and Rule (63) is blocked.

52. In this section, I follow SPE in describing the distribution of [ŋ] as observed only in the most common American dialects. In areas of both the United States and Great Britain, one finds retention or re-introduction of historical [g] in words like hang, hanger.

Furthermore, even in the standard dialects, the facts are not always as stated here and in pronouncing dictionaries. While [ŋg] never replaces [ŋ], in rapid speech words which are cited as having [ŋg] are often ob-

served with [ŋ] alone. The ease with which this simplification can take place shows a certain variability, governed by factors I have not studied. For example, although Kenyon & Knott, AHD, etc., are agreed that English, longer, and prolongation have [g], I find simplification most natural in the case of English and least natural for prolongation, with longer falling somewhere in between.

In the discussion that follows in this section and in Chapter III, the statement that a word has [ŋg] is to be taken to mean that [g] is permissible in the word, while the claim that a word has [ŋ] corresponds to a judgement that [g] is not possible in the word even in careful speech.

53. bomb/bombard is the only possible exception to this claim that I am aware of, and counts as an exception only if the morphemic analysis /bomb+ard/ rather than /bom+bard/ can be justified. The only evidence for /ard/ as a morpheme comes from the words drunkard and dullard, but here the suffix would function to form a noun from an adjective as opposed to a verb from a noun as required in bombard.

As will be pointed out in Chapter III, there are actually very few [ŋ]~[ŋg] alternations.

54. Cf. also Sapir (1925), who considered the "mental" representation of all occurrences of [ŋ] in English to include /g/.

55. The claim about native-speaker competence being made here can be established in several ways. Speakers of the dialect under discussion who have some phonetic training simply report that, for example, [hɪŋgo] is a possible word of English while [hɪŋgso] is not. A more naive speaker

might be asked to repeat words spoken to him; his responding correctly to [hɪŋgo] while distorting [hɪŋgso] to [hɪŋso] (or, if the [g] catches his attention, to [hɪŋgəso]) or reporting that he is unable to repeat [hɪŋgso] exactly as it was spoken to him, would support the hypothesis. So would a subject's reading hingo (presented as a made-up word) with [g] but hingso without.

56. Note that /g/-Deletion is another rule that must be ordered before Rule V: V would cause the /g/ of hɪŋ; it to become [+S.I.] but the /g/ must be deleted.

57. Of course, /l, r, w, y/ is not an unnatural class (= [-syllabic, +sonorant, -nasal] and it might be countered that one should modify (72) so as to apply before #, nasals, and non-sonorants. (73) is preferable because rather than representing the complementarity of /ŋg/-simplification environments and environments in which syllable-initial /g/ is possible as accidental, it relates them in a principled way. Furthermore, (73) allows the elimination of a conjunction of # and classes of segmental units. Finally, since the /g/ of anglicize, etc., is [+S.I.] phonetically, (73) is merely making use of independently motivated phonological machinery.

58. As is well known, at an earlier stage in the history of English, [ŋ] occurred only as the pre-velar allophone of /n/; there were no words like [sɪŋ], and sing was pronounced [sɪŋg]. I would attribute the appearance of free [ŋ] in words like sing, Yngve to the addition of Rule (73) as an (Early Modern English) phonological innovation.

59. By the standard argumentation, character cannot be bisyllabic

/kærVkr/: cf. characteristic *[kærəktrɪstɪk].

60. pronounced [álĭstě] by Alistair Cooke.

61. cf. mĭnistĕrial: minister is underlyingly trisyllabic.

62. For example, SPE (p. 148) argues that underlying geminates and a degemination rule are required for English. If this hypothesis is correct, Mississippi could have /ip/ or /ipp/ as its pre-final cluster, as far as segmental considerations are concerned. The choice of /ipp/ is motivated entirely by the desire to help reduce the stress rules to regularity. On the other hand, simply marking Mississippi for penult stress is equally (though more obviously) ad-hoc.

(Regarding gemination as an account of anomalous penult stress assignment, note that since voiced-obstruent clusters are exceptional in English, one should not expect voiced-obstruent geminates in lexical representations. This prediction is noted in SPE, where it is claimed that in fact the geminate artifice is required only in the case of voiceless obstruents and sonorants. In this regard, consider Aláddin, Armagéddon, Chappaquídk, eléven, Manischéwitz, Nebuchadnézzar, paláver.)

The largely idiosyncratic nature of English stress placement is more explicitly recognized in more recent formulations of the stress rules. For example, in Halle (1973a), it is acknowledged that the contrast between a pair of nouns like Íván, ícòn is a matter for ad-hoc lexical marking (p. 454-5).

63. In the small class of words where even the closed-penult principle fails, an observation made elsewhere in this Chapter is relevant. If words like Jěspěrsěn, Jěffěrsón, ěněrgŷ, Běvěrlŷ, whose penult vowel is phonetically [ɾ], are taken to have underlying /ɾ/, then the penult is open, and the observed antepenult stress is unparadoxical. See also Section 8.3, as well as Section 3 of Chapter III.

64. I mentioned in Chapter I that the only other formal phonological analysis known to me which incorporates the notion of ambisyllabicity is that of Anderson & Jones (1974), and I indicated there why I felt their general approach is wrong.

A&J apply their syllabic formalism to just one phonological problem, that of English stress assignment. It turns out, however, that their treatment, rather than being an improvement over the SPE stress rules, actually fails to work in one of the most straightforward cases.

In A&J's theory, all syllables have maximal initial and final clusters, regardless of the amount of overlapping entailed. Boston, for example, consists of the syllables /bost/ and /ston/.

Like SPE, A&J attempt to define "weak cluster" in such a way that the part of the MSR that assigns non-final stress reads in essence, "assign antepenult stress if the penult is weak, penult stress otherwise." They claim, however, that through the use of syllable structure one can give a simple definition of weak cluster not involving the mention of special consonant classes, as the SPE definition does.

They note that under their syllabication conventions, the penults of cinema, algebra, veranda are /nem/, /geb/, /rand/, respectively. Since

only veranda has penult stress, and only it is closed by more than one consonant, their first approximation to a definition of "weak cluster" is $\check{V} C_0^1$], where brackets enclose syllables.

The above analysis is based on English nouns. In verbs the weak/strong cluster principle finds applicability one syllable further to the right, choosing between final and penult stress. Here also A&J's definition seems workable: edit, final syllable weak /dit/, vs. collapse, final syllable strong /laps/.

A&J then note that a noun like pentáthlon has a weak penult /taθ/ by their definition, yet penult stress is observed and seems generally required. On the basis of this sort of example, they modify their weak-cluster definition. To produce correct results in pentathlon, a convenient definition of weak cluster would be \check{V}], a definition which is also satisfactory for correct assignment of stress in words like veranda. However in verbs the original $\check{V} C_0^1$] is required. Taking advantage of the fact that for verbs the pivotal syllable is final and thus followed by #, they conclude that two subcases are needed to define "weak cluster," \check{V}] and $\check{V} C_0^1 \#$], or in abbreviated form, $\check{V} (C_0^1 \#)$]. This is their final formulation.

What A&J seem to have overlooked is that while the noun expansion \check{V}] gives correct results for pentathlon and veranda, it fails for algebra (penult = /geb/), and more importantly for the whole class of unproblematical antepenult cases, cinema (penult = /nem/), for example.

More than inadvertancy is involved here. From a more general perspective, A&J have chosen a poor example to illustrate the possibility of non-discrete syllabication. As we have seen in this chapter, English stress

assignment differs from many other phonological rules in applying at a level at which ambisyllabicity, necessary for accurate phonetic representations and relevant to the conditioning of certain low-level rules, is not yet appropriate. Note that Rule II-produced penults for antepenult-stressed cinema and algebra are /ne/ and /ge/; for penult-stressed veranda and pentathlon, /ran/ and /taθ/.

65. Penults containing tense vowels are always stressed in English.

It would be desirable to be able to discover a unifying principle linking tense vowels and vowels followed by two or more consonants in their stress-attracting properties. The fact that tense-vowel syllables are always closed by a post-vocalic glide suggests that Rule (79) may represent such a link. However this generalization is not capturable without a major reformulation of the SPE analysis of the deep phonology of English, for in this analysis Diphthongization/Vowel Shift must follow the M.S.R.

66. In Halle's most recent analysis of English stress (class lectures, M. I. T.), the need for an independent rule assigning initial stress is obviated by a reformulation of the Main Stress Rule as a rule schema expanding to assign the feature [+stress] indefinitely many times in indefinitely long words. Since in particular initial stress will always be assigned, the critique of Halle's published formulation of the facts of initial stress I give in this section is not invalidated by his reanalysis.

67. All the words of (82) are exceptions to Destressing. Those in (b) are in addition exceptions to Halle's (1973a) Detail Rule, which chooses one among several [+stress] vowels as the position of main stress.

68. These examples should perhaps be viewed as a challenge to the assumption that "related" forms must have continuous strings of identical underlying segments rather than to the system of stress assignment rules.

In the same way that the word majority has semantic properties beyond those predicted by its components major and -ity, it has phonological properties not predictable from those of major combined with general phonological considerations. Cf. Section 2.2 of Chapter III.

69. Cf. Fidelholtz (nd). Fidelholtz shows that destressing/reduction in $\#C_0 \text{ --- } C_2 \acute{V}$ correlates with frequency of usage of the word under consideration. The fact that an uncommon word like gùstátion fails to undergo destressing cannot be allowed to cast doubt on the correctness of a syllable-based account vis-a-vis Halle's (1973a) treatment however, since even words with a single consonant following the first vowel follow Fidelholtz' generalization (he limits his attention to the C_2 case) rare Négèv, château vs. common těrrífic, Ămérica.

70. I assume that syllabication is discrete in French, as it usually taken to be. If not, read "only if the nasal is fully within the vowel's syllable." The latter condition is appropriate for the English /æ/-raising rule.

71. If the convention suggested in the final paragraph of Halle (1971) is taken at face value, it is in fact (87) and not (85) which is predicted as a proper generalization of (84).

72. There are two types of exception to this statement. Some dialects in Scotland, for example, have trilled and uvular-fricative /r/s. Secondly, within the more widespread dialects, there is an allophone of /r/ involv-

ing frication: compare train with frication vs. rain without.

73. As opposed to "post-vocalic" /r/, syllable-initial /r/ may involve some labialization: cf. bar and rob in most American /r/-retaining dialects.

74. Among U. S. radio and television announcers, who are undoubtedly taught that it is wrong to pronounce words such as latter and ladder alike, a quite different way of distinguishing them is often heard. Unlike Kenyon, who voices both /t/ and /d/ but articulates them differently, these speakers "flap" both but keep flapped /t/ voiceless.

75. I transcribe the vowel in these words as [o] since it is mid. The vowel is not as high, however, as the vowel of four in E₁.

76. Thus it is possible to distinguish three major dialect areas in the U. S., each represented by tens of millions of speakers:

	E ₁	E ₂	W
<u>for</u> = <u>four</u> ?	no	yes	yes
<u>for(est)</u> = <u>for(um)</u> ?	no	no	yes

The fourth possibility, forest = forum but for ≠ four, is not found anywhere in the English-speaking world, as far as I can determine.

The "r-less" vs. "r-ful" split is independent of the classification above. Of the six possible combinations, at least five occur:

<u>r</u> -less E_1 :	eastern New England
<u>r</u> -ful E_1 :	inland southern U. S., Scotland
<u>r</u> -less E_2 :	standard British English
<u>r</u> -ful E_2 :	middle Atlantic coast
<u>r</u> -less W:	?
<u>r</u> -ful W:	midwest and west U. S.

77. There are some exceptions to this geographical generalization. The St. Louis, Mo. area, well to the west of Thomas' isogloss, displays an E_1 dialect.

78. Most of those regions of the U. S. which have undergone rules (e) and (i) in addition have [τ] as the first vowel in words like courage, hurry, while the E_1 - E_2 areas show [\wedge]. This third dialectal split should quite probably be related to the first two, though it differs in showing an assimilation in addition to a raising (and a raising to high rather than mid position, if the remarks of Appendix 1 are correct in general.)

CHAPTER III

ON WORD-BASED GENERALIZATIONS WITH SYLLABIC CONDITIONING

Section 1 - A Hypothesis

Three types of phonological generalization requiring a syllabic treatment were isolated in Chapters I and II:

- (1) a. processes like /t/-Glottalization (Chapter II (28)), which are ordered after Rule V (Chapter I (32)) and apply on all domains without regard to syntactic boundaries
- b. processes like /æx/ → /ɑx/ (Chapter II (49)), which are ordered before Rule V and thus in effect apply only within the word
- c. generalizations like the absence of syllable-final /tk/ (Chapter II (96)), which correspond to simple constraints on possible syllable structure

The reasons for regarding processes like /t/-Glottalization as being ordered after Rule V and as being free of syntactic conditioning are fully discussed in Chapter II. I turn now to a closer look at processes of the types (1b) and (1c).

Recall first the discussion of Section 6.1 of Chapter I, where it was pointed out that under the standard assumptions, there are two sources of general phonetic gaps $*[A] / P \text{ — } Q$: (a) /PAQ/ is absent from lexical representations and ungenerable from allowable sequences by means of rules of the phonology; (b) /PAQ/ is permissible underlyingly but subject

to an obligatory phonological rule R which destroys the underlying configuration, and [PAQ] is not otherwise generable.

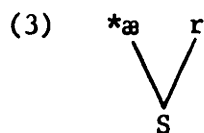
It is generally assumed that analysis (b) is justified as an account of the absence of phonetic [PAQ] only when there is independent evidence for underlying /PAQ/ or for rule R (preferably both). In the case of the absence of [...tk{C, #}],¹ for example, there is nothing in the phonology suggesting that we are dealing with a configuration that needs to be allowed underlyingly, nor is there any independently-motivated rule of English phonology which would prevent the sequence from reaching the surface, were it present in lexical representations. Thus we must view this gap as resulting from a constraint rather than from a rule (a syllable-structure constraint, if the arguments of Chapter I, Section 6 are valid).

Now note that rule (2) (= (49) of Chapter II),

$$(2) \quad \begin{array}{c} \text{æ} \\ \downarrow \\ [+bk] \end{array} \quad \left[\begin{array}{c} r \\ -S.I. \end{array} \right]$$

ordered before Rule V, effectively prevents the occurrence of phonetic [...æ{C, #}], giving rise to a phonetic gap similar to that produced by the underlying constraint which excludes [...tk{C, #}]. Implicit in the discussion of /æ{C, #}/ in Chapter II was the assumption that there is justification for allowing /æ{C, #}/ in lexical representations and including an /æ{C, #}/ → /ar{C, #}/ rule, (2), in the phonology; hence the mention of (2) in (1b). This assumption must be examined. If justification is not forthcoming, we must be prepared to view the absence of [...æ{C, #}] as being on a par with the absence of [...tk{C, #}], the result of a constraint on

possible syllable structure. Such a constraint would be found in Rule IIb and would have the form shown in (3):²

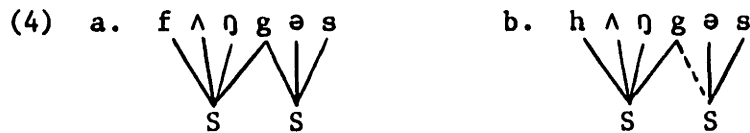


As noted in Chapter II, the [...ær{C, #}] gap and several others like it arose through the introduction into the phonology of a syllable-conditioned rule. A hypothesis that I would like to put forth is that (a) as innovations, syllable-conditioned rules always enter the phonology ordered after Rules I-V, and (b) such rules either remain in this position or else are re-interpreted as syllable-structure constraints,³ but (c) rules cannot be re-ordered so as to follow Rule II but precede Rule V, the reordering mentioned in Chapter II as a possible way of accounting for the [a] of car is vs. the [æ] of carry, the [E] of plan it vs. the [æ] of planet, etc.

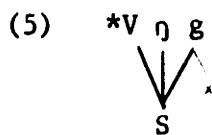
In support of the first part of my hypothesis, I would point out that to my knowledge, it is never necessary to postulate the introduction of a syllable-conditioned rule at a point other than somewhere after Rule V, and that sometimes direct evidence of initial post-V ordering is available in the case of generalizations which are now constraints of type (1c), or, if part (c) of my hypothesis is wrong, perhaps rules of type (1b).

For example, the absence of [ŋ] followed by [-S.I.] [g], discussed in Section 7 of Chapter II, is a syllable-based generalization of type (1b) or (1c), for were the generalization due to a post-Rule V /g/-deletion rule, the distinction between fungus [ŋg] and hung us [ŋ] could not

be accounted for



Rule V would introduce the line of association shown dashed in (4b), destroying the distinction between fungus and hung us. Thus either the /g/-deletion rule is ordered before Rule V, or has been lost from the grammar and replaced with a syllable-structure constraint of the form shown in (5):



However we know that at the time (17th century) that /ŋg/-simplification came into the language, the rule was ordered after Rule V, i.e., that although hung and sing had [ŋ] in isolation and before consonants, phrases like hung us and sing aloud had [ŋg] when spoken without pause. (See Jespersen, 1909:I:217 for documentation.)

As a second example of this type, recall the discussion of /r/-loss (Chapter II, Section 2), which arose as a post-Rule V rule, but survives in standard British English as a constraint against post-vocalic /r/ in syllables.

The part of the hypothesis outlined above that I want to devote most attention to is the suggestion that ordering of rules between syllable-structure assignment rules II and V should not be allowed.

In the sections that follow, I investigate several phonological

generalizations of Chapter II that might be taken, synchronically, to be due to a syllable-structure-conditioned rule of type (1b) and attempt to show for each that there is little or no evidence for the existence of a rule, and, where possible, that there exist facts which argue specifically for a solution in terms of a constraint. Corresponding to each generalization I assume a syllable-conditioned phonological statement (rather than a boundary/segment conditioned one) on the basis of the observations of Chapter II, and limit my attention to the issue of whether a constraint or a rule is involved.

Section 2 - /ær/

In this section I look into some of the pros and cons of deriving words like car, cart [ɑr] from underlying /ær/ by means of Rule (2).

2.1 There is a strong intuition that hypothetical forms like [kær], [kært] could not be words of English. While the rule analysis (2) adequately accounts for this intuition, so does the constraint analysis (3). Thus there is no reason to postulate an /ær/ → /ɑr/ rule on these grounds, just as one could not justify a /t/ → /s/ / — k rule on the basis of the undeniably valid intuition that *retk is not possible, while *resk is.

2.2 The strongest argument for the inclusion of a postulated rule in the phonology is the demonstration that it is needed to account for a general phonological alternation. In the case of (2), no such evidence is available.

SPE, which derives [ɑr] from [ær], offers (p. 216) four pairs of related words showing an [ɑr]/[ær] alternation: bar/barrier, bar/barrister

car/carriage, par/parity. These alternations can hardly be considered convincing (and are not claimed to be in SPE). First of all, there exists only a handful of examples. Secondly, with the possible exception of par/parity, the alternants are not related by general morphological rule.

Thus it is not necessary that the initial underlying segments of barrier, for example, be those of bar, since barrier is not the result of the suffixation of bar. (In contrast, consider bat [tʔ]/batting [D]; unless [tʔ] and [D] are derived from a single underlying segment in these words, it will not be possible to generate batting by means of the general rule Participle = [_v [....] ing].)

Thirdly, when a wider range of facts is considered, the cited examples of alternation appear to be accidental. pair is as closely related to par as parity is, yet under the SPE analysis pair [per] must be from /pār/, while par is /pær/ underlyingly. That is, allomorphy in weakly related forms must in general be tolerated.⁴

Compare also bare (< /bār/) vs. barren (< /bærVn/), which are at least as close semantically as any of the SPE alternants. If barrier must be from /BAR+ier/, where /BAR/ is the lexical representation of bar, why need barren not be representable as /BARE+Vn/?

Fourthly, [ɔr] from derived /ær [C, #]/ fails to be observed where expected. From scarce (< /skārs/) + ity we expect [skɔrsɪDɪ] via Trisyllabic Laxing and /ær/ → /ur/, yet scarcity is [skersɪDɪ].

Similarly, consider bear [ber] vs. birth. Since bear must be /bār/ underlyingly, we expect /bār+θ/ for birth, becoming /bærθ/ by pre-cluster laxing (SPE:172) and finally *[bærθ].

As another example of this sort, note that when Peter [pɪDər] is

abbreviated to Pete, the shortened form is subject to the rules of the phonology: [pitʔ], yet Lar', short for Larry, is [lær],⁵ not [lɑr].

Finally, note that the optional rule that accounts for the alternants [jɛnərəl]/[jɛnrəl] for general produces, with Marilyn as input, [mærlɪn], not [mɑrlɪn].

In any case in which the vowel of derived /ær [C, #]/ fails to become [ɑ] it might be argued that /ær/ → /ɑr/ is ordered before the particular rule creating /ær [C, #]/. While this account is certainly possible, there are some reasons for rejecting it. First of all, such "counter-feeding" order among phonological rules appears to be universally marked (cf. Kiparsky, 1968b). Secondly, the rule shortening Larry to Lar' is presumably a morphological rule; phonological rules would be expected to follow such a rule (cf. Peter/Pete; see Section 4.4 for some additional discussion of this point). But most importantly, note that under an analysis in which there is simply a constraint against tautosyllabic /ær/, there is an immediate explanation to our observation: derived /ær/ remains because there is simply no /ær/ → /ɑr/ rule. More generally, the fact that no rule appears to precede putative /ær/ → /ɑr/ falls out as a direct consequence of the constraint analysis.

In summary the evidence from alternations does not support a synchronic /ær/ → /ɑr/ rule, and in fact may be viewed as favoring a constraint analysis.

2.3 The assumption that symmetry is a desirable property of underlying segmental systems might be used to justify an analysis in which [ɑr] is underlyingly /ær/, for unless /#Xær [C, #]/ is allowed in lexical

representations /r/ will provide an exception to the generalization that /æC#/ is possible underlyingly for all C. However, in the absence of evidence that language learners seek to set up phonological systems with this sort of symmetry, argumentation of this type cannot be considered persuasive. Furthermore, there are other gaps in /Xæ — #/; /ð/, for example, does not occur in this environment.

In addition, as will be seen in Section 3, there must exist gaps of the form / \check{V} r [C, #]/, where V is a non-low vowel. This fact is not only an indication that the kind of asymmetry that would result from the exclusion of tautosyllabic /æ r/ is tolerable, but also that the absence of the latter configuration may be part of a wider generalization.

2.4 In view of the above considerations, it must be concluded that there are no reasons at all compelling for assuming that a word like cart is underlyingly /kært/ and that there exists an /æ r/ → /ɑ r/ rule in the synchronic phonology of English. If these assumptions are dropped, a rule not supported by alternations can be omitted from the phonology, the disparity between phonetic and phonological representations can be lessened, and the fact that all phonological rules appear to follow hypothetical /æ r/ → /ɑ r/ can receive a simple explanation.

Section 3 - Short Non-low Pre-/r/ Vowels

Recall the historical rule, discussed in Section 3.3 of Chapter II, which merged /i, e, u/ in — r [C, #]. For essentially all words with phonetic [ɹ] as a result of this rule (for ex., first, herd, curse), there is no synchronic evidence as to which of the three pre-merger

vowels is the precursor of modern [r̥]. Thus a single vowel, perhaps /r̥/, perhaps /i/, /e/, or /u/, must underly all words of this type. We must countenance, then, at least two systematic gaps of the form "/VC#/ not possible when C = /r/." (Cf. discussion in Section 2.3.)

Let us consider whether there is any evidence that tautosyllabic /ŕr/ must be allowed underlyingly at all, where V = /i/, /e/, or /u/, and that the historical rule is also a synchronic one.

It might be argued that heard [hɹd] is synchronically from /hēr#d/ (hear + past morpheme /d/) via the special #-deletion rule postulated for use where inflected forms unexpectedly undergo pre-cluster laxing (cf. kept; see discussion in SPE, p. 369), pre-cluster laxing, and a synchronic /er/ → /r̥/ rule. There are several reasons for rejecting this analysis.

One is the existence of dialects, like my own, in which erred is only [ɛrd],⁶ while heard is [hɹd], not [hɛrd]. That is, underlying /er/ does not reduce to [r̥] synchronically.

Secondly, observe that since all non-low short vowels merged before tautosyllabic /r/, four of the six underlying "vowel shift" vowels postulated by SPE (i.e., all except /æ, ɔ/) should surface as [r̥] when shortened before tautosyllabic /r/, if the neutralization rule is a part of the synchronic phonology. The absence of additional examples, then, does not speak well for synchronic merger. Furthermore, there is at least one case of [r̥] "derived" from the pre-cluster laxing of one of the two vowels which should not feed the neutralization rule: birth [br̥θ], from bear [ber], lexical /bār/. This sort of example makes it clear that to cite isolated heard as evidence for synchronic /er/ → /r̥/ is totally

unjustified. Cf. fn. 4.

There are some reasons for choosing an analysis with underlying /r/ over one with a $/[i, e, u] r/ \rightarrow /r/$ rule beyond the lack of demonstrated need for the latter rule. Recall the class of words mentioned in fn. 63 of Chapter II (Bévěrlý, Jěspěrsěn, etc.) whose antepenult stress is anomalous if the penult is taken to be /VrC/. Underlying /rC/ would reduce these examples to regularity from the point of view of the stress rules and would capture the phonetic representation directly.

Similarly, it was noted in Section 8.3 of Chapter II that words whose spelling suggests a lexical representation of the form $\#C_0\check{V}rCVX\#$ (Bermuda, Vermont, etc.) are almost always exceptional with respect to the generalization that strong initial syllables retain stress in pre-stress position. Here also the hypothesis that /r/ appears in underlying representations simplifies the stress facts and lessens the disparity between lexical and surface representations.

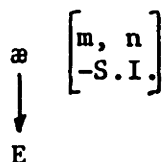
Finally, as an observation paralleling that of Section 2.1, note that allowing underlying /r/ and prohibiting tautosyllabic /ir/, /ur/, and in many dialects, /er/, is as descriptively adequate an account of the intuition that words with $\{[i, \wedge, (\varepsilon)] r \{C, \#\}\}$ are deviant as a rule serving to destroy this configuration.

Summarizing, the lack of evidence for a synchronic /ir, ur, er/ \rightarrow /r/ rule, together with the desirability of phonemic /r/, argue against retaining the historical rule as a synchronic rule of type (1b).

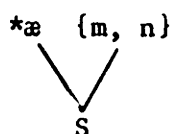
Section 4 - Tensing and Raising of Pre-nasal /æ/

In this section I discuss the possibility that the /æ/ \rightarrow /E/ rule of Chapter II, Section 5,

(6) (= Chapter II (61))



which accounts for the contrast mat, manage [æ] vs. man, mandible [E], has been lost from synchronic grammars and replaced by a syllable-structure constraint of the form⁷



4.1 As in the case of the generalizations discussed in Sections 2 and 3, strong intuitions about /æ/ and /E/ are observed, but do not call for a rule analysis rather than a constraint analysis: either is fully capable of accounting for the fact hypothetical *zan, *zanda, have /E/, not /æ/, *zana /æ/, not /E/.

4.2 Nor can one argue for the existence of an /æ/ → /E/ rule on the basis of [æ]/[E] alternations, of which there is a general absence. Even where alternations are expected, they are not observed. tanner 'more tan' has [E], just as tan does. Jan', short for Janice, has the full name's [æ] (cf. lexical Jan, with [E]).

4.3 In the case of the /æ/ → /E/ rule a further demonstration that lexicalization and rule-loss have taken place is possible. I noted above that an occurrence of /æ/ which is in the environment of the puta-

tive tensing/raising rule by virtue of what appears to be morphological derivation (Janice → Jan') remains low and lax, suggesting that the phonological component, acting on the output of the morphological rules, contains no /æ/ → /E/ rule.

Another process, even more clearly morphological, serves to create instances of /æ/ followed by tautosyllabic /m, n/, and here too /æ/ remains. The process is the rule which phonologically interprets the past-tense morpheme, when attached to a member of a certain class of verbs, as ablaut of a [+high] stem vowel to /æ/, as in sit~sat. The crucial examples, began, ran, swam, have /æ/, not /E/,⁸ suggesting that there is no /æ/ → /E/ rule.

4.4 It is instructive to consider the sequence of grammar changes which served to create the contrast between, for example, Japan [E] and began [æ].

We can assume that Rule (6) was added to the end of the phonological component at a certain point in the history of the dialects under consideration, given the prevalence of this sort of sound change (cf. King, 1969, 1973). Such a change would give rise to [E] in both Japan and began. We must then account for the "re-appearance" of [æ] in began.

We cannot hypothesize that Rule (6) was simply lost from the grammar at some subsequent point in time, for we would then be unable to account for the retention of /E/ in Japan, and more importantly, for the intuition that a hypothetical form like zan has /E/.

The problem under discussion has the appearance of one in which rule-reordering would offer a solution. In fact if one postulates that the

tensing/raising rule was reordered so as to precede the ablaut rule, the Japan/began contrast can be accounted for:

(7)	/j̥ æ p æ n/	/b ə g ɪ n/	
	E	-----	æ → E
	-----	æ	Ablaut
	[E]	[æ]	Output

However, in spite of the fact that the derivation in (7) gives observationally-correct results, there are two general theoretical considerations which suggest that the hypothesis that Ablaut and Tensing were reordered must be rejected.

First of all, in the original order, Tensing is fed by Ablaut and is a perfectly transparent rule, for there are no occurrences of [æ] followed by [-S.I.] [m, n], the structural description of Tensing, on the phonetic surface, or of phonetic [E] from other sources.⁹ One would not expect a new ordering to arise in which the two rules are in a counter-feeding relationship and Tensing has become opaque, as is the case in the ordering illustrated in (7).

Secondly, the ordering of (7) represents an interspersing of morphological and phonological rules. It is in general theoretically preferable to have two rule-components, each with strong restrictions on rule-types, rather than a single component with restrictions weak enough to accommodate rules of both types (cf. Chomsky, 1972:Sec. 2.2), and in fact a segregation of morphological and phonological rules nearly always seems possible (see Aronoff, 1974). On these grounds too, then, the reordering analysis of (7) seems poorly motivated.

On the other hand, suppose a constraint analysis of the [æ]/[E] facts is correct. As suggested in Section 4.3, such an account offers an explanation of the [æ] of began, etc., since these preterites, as derived forms rather than lexical items, would not necessarily be in conformance with constraints on underlying representations.

Under the constraint analysis, the generation of language learners following the one in which the /æ/ → /E/ rule was added as an innovation lexicalizes /E/ wherever possible, for example in Japan, and sets up a syllable-structure constraint to account for the distribution of /æ/ and /E/.

The [E] of began, observed by the language-learners in the speech of their parents' generation, will be a special case, since began is the result of a morphological operation on the lexical item begin rather than a lexical item in its own right and its [E] cannot be "lexicalized." Since the Ablaut rule which produces /æ/ is needed for a class of verbs in which /E/ is not involved (sit, etc.) it will continue to operate in the grammar; if begin is taken to belong to this class of verbs by the new generation,¹⁰ Ablaut will produce /æ/ in begin + Past.

The reversion of /E/ to /æ/ might occur at just this point, as a result of imperfect learning, i.e., the result of the toleration, for the sake of overall simplicity, of [æ] in began where the older generation has [E].

However, we need not make the assumption that the replacement of the rule by a constraint will have as an immediate consequence the reversion of [E] to [æ] in began. Suppose the /æ/ to /E/ rule, though not used in the derivation of Japan and thousands of similar words, is preserved to

take the /æ/ of preterites like began to /E/ so that the grammar of the new generation can produce the parents' output:

(8)	/j æ p E n/	/b æ g i n/	_{PAIT}
	-----	æ	Ablaut
	-----	E	æ → E
	[E]	[E]	Output

Now in the analysis summarized in (8), the /æ/ → /E/ rule, though not requiring any special restrictions, is a very minor rule in that it is used in the derivation of only a handful of forms. The loss from the grammar of such a rule would be a natural type of phonological change.¹¹ With the rule gone, the ablaut-generated /æ/ of began will surface. I would suggest that such a loss has in fact taken place in the dialects in which Japan has [E], began [æ].

If this analysis, which seems to be the most reasonable account of the exceptional [æ] in words like began,¹² is correct, the distributional facts and native-speaker intuitions discussed above are due to a syllable-structure constraint against tautosyllabic /æm/ and /æn/, and there is no synchronic /æ/ → /E/ rule.

Section 5 - The Velar Nasal

As a final example of a phonological generalization which might be taken to be due to a rule of type (1b) but which upon closer examination appears to be better described as a constraint of type (1c), I discuss in this section the absence of [ŋ] in position before non-syllable-initial [g].

5.1 Any analysis of the velar nasal in English must account for the fact that hypothetical words like [hæŋg], [æŋgmə] are not observed, and, more importantly, for the strong intuition that there could exist no such words. As detailed in Chapter II, Section 7, the SPE analysis, buttressed by a syllable-structure condition on the /g/-deletion rule, accounts for these facts. On the other hand, if there is no /g/-deletion rule, the distributional and intuitional facts just mentioned are due to a constraint against syllables having the shape /C₀Vŋg/. There is thus no reason for preferring a rule analysis to a constraint analysis on these grounds.

5.2 The rule analysis, which derives all [ŋ] from /ŋg/ in — [C, #], has no way of accounting for phonetic [VŋV] in those cases in which it is not possible to motivate # between /ŋ/ and the following vowel. As it stands, the constraint analysis, which allows syllable final /ŋ/ (hang would be from /hæŋ/, for example), predicts that morpheme-internal [VŋV] should be possible. As is well known, there do exist occurrences of this sequence, as in hangar [hæŋər]. In what follows I argue (a) that the general system of rules and constraints in the phonology should not exclude all instances of [VŋV] and (b) that the necessity of allowing [VŋV] weakens the rule analysis vis-a-vis the constraint analysis.

The words in (9) display the sequence [VŋV]:¹³

(9) dingaling 'fool',¹⁴

dinghy

hangar

dingus

humdinger

orangutan

Ringling (Bros.)

Schlesinger¹⁵

Singapore

Singer (Sewing Machine Co.)

One might challenge the significance of these examples by pointing out, correctly, that they are limited in number. It must be kept in mind, however, that the status of this observation is quite different from the status of the fact that there are no words with syllable final [ŋg]. The conclusion that there are very few words with [VŋV] is the result of the study of a large number of English words, a statistical fact not directly testable for psychological significance.¹⁶ That the absence of words with syllable-final [ŋg], on the other hand, is a reflection of native speaker competence is directly confirmable.

In support of the claim that there is no direct evidence that the paucity of [VŋV] words is more than accidental, note that words like hangar are in no way sensed as deviant or as somehow different from the vast majority of other common English words.¹⁷ Nor is it clear whether a hypothetical word like zanger should be pronounced with [g].¹⁸ (Of course, in some intervocalic environments, [ŋg] seems decidedly better than [ŋ]: consider, for example, hypothetical Zingóma. I do not mean to imply that [ŋ] is freely occurring in $V_1 \text{ --- } V_2$ for all V_1 , V_2 and all stress patterns; certain specific constraints against the occurrence of [VŋV] undoubtedly have demonstrable psychological reality. I am arguing in this section against a phonological analysis in which all instances of [VŋV] are exceptional.)

Consider next a somewhat indirect piece of evidence regarding the status of the sequence [VŋV], an observation which again suggests that the rarity of this string is, at least in certain environments, accidental rather than systematic. The word hangar is a direct borrowing from French (first attested for English in 1852, in the meaning 'large shed')

and in French the g is pronounced. For some time the g was pronounced in English as well. The 1933 edition of O. E. D. gives only the hybrid pronunciation [hãgər].¹⁹ [hæŋgər] was at one time standard in the U. S., with [hæŋər] becoming the norm in this country only in the last generation or two (cf. Thomas 1958:82; Bronstein 1960:222). Thus unless one accepts [VŋV] as a phonetically well-formed sequence of English, one must claim that the borrowed word hangar drifted from a natural (cf. anger) to an unnatural pronunciation from the point of view of the phonology of the borrowing language, an unacceptable result. This observation supports the suggestion that in a theoretical framework that aims at psychological accuracy, the generalization that words with [VŋV] are rare may be better left uncaptured.

Modern lexicography apparently also recognizes that there is no longer a systematic gap in English with respect to [VŋV] in certain environments. For example, in the entry for Engels, RHD gives [ɛŋəlz] as the pronunciation of the name of the German socialist leader and [ɛŋgəlz] as the pronunciation of the name of a Russian city, corresponding to the absence and presence, respectively, of [g] in the German and Russian pronunciations of this word. These transcriptions do not, however, represent an attempt to describe the pronunciation of Engels in these foreign languages - non-English pronunciations are always noted as such (cf. "Friedrich [fridrɪk], Ger. [fRɪdRɪx]"). Note also the [ɛŋgəlz], the pronunciation given for the Russian city, incorporates an anglicization: there is no [ŋ] in Russian, even before velars, but [ɛŋgəls], the actual Russian pronunciation, would be unnatural for English. Thus we may conclude that these entries have been modified as much as necessary to make

them conform to the general principles of English phonology, as perceived by the panel of native speakers who prepared RHD's transcriptions, and that in the case of [ɛŋəlɪz], no anglicization was felt to be necessary.²⁰

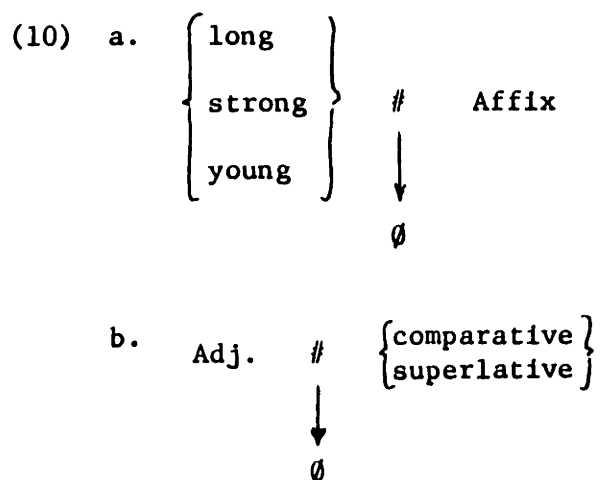
In summary, if words like hangar are not deviant from the point of view of English phonology, then even a rule analysis of the deviance of tautosyllabic [ŋg] must allow underlying /ŋ/. But if /ŋ/ is a phoneme, there is no barrier to its use in the lexical representation of a word like hang and in the vast majority of words with phonetic [ŋ].

5.3 A remaining obstacle to the dropping of the /g/-deletion rule from the grammar might be the desire to account for [ŋ]/[ŋg] alternations in a way not involving allomorphy. In this regard it is essential to note that here, as in the case of the putative rules discussed in Sections 2, 3 and 4, the evidence from alternations is almost vanishingly small.

I am aware of only three words with [ŋ] that alternate with forms with [ŋg]: long, strong, and young. ([ŋg] is found in the comparative and superlative of each of these, as well as in elongate (-ion) and prolongate (-ion); length has an optional [k] which can be taken to be from /g/ by assimilation to /θ/.) Thus whatever the source of [g] in these few examples, they can hardly be viewed as evidence for analyzing all occurrences of free [ŋ] as surface manifestations of underlying /ng/.

Furthermore, it is not clear how an alternation such as long/longer would be handled even in an analysis with a /g/-deletion rule. It is suggested in SPE (p. 369-70) that a special rule deletes the internal # in comparatives and superlatives, which have the form [##[#...#]er/est#;
A A

at the input to the phonological component, allowing final underlying /g/ in longer to surface, since /g/ is deleted only before #. However the applicability of the #-deletion rule cannot be stated in general terms. It could not be conditioned by the morphemes long, strong, young, since it does not apply in strongly, longish, etc., *[ŋg]. Nor could the more likely possibility, that the comparative and superlative suffixes are general conditioning factors for #-deletion, be true. First of all, the comparatives of adjectives which are not normally compared, for example, hung, wrong, as well as actually occurring forms like lovingest, swing^{ing}est, must retain # since they have no [g]. Secondly, retention of # in forms like soberer, soberest²¹ is required under the standard assumptions, either to allow syllabication of the sonorant /r/ (if the underlying form of sober is /sɔ̃br/), or to prevent Tri-syllabic Laxing of the initial vowel (if /sɔ̃bVr/). In summary, then, neither of the somewhat general rules in (10) can be correct.



Rather, the ad-hoc (11) would be required:

$$(11) \quad \left\{ \begin{array}{l} \text{long} \\ \text{strong} \\ \text{young} \end{array} \right\} \xrightarrow{\#} \left\{ \begin{array}{l} \text{comparative} \\ \text{superlative} \end{array} \right\}$$

↓
∅

In view of this result, which is equivalent to marking these three lexical items for insertion of /g/ in the comparative and superlative, it must be conceded that the evidence from alternations does not support a synchronic analysis in which all free [ŋ] is from underlying /ng/.

5.4 Finally, let us consider whether the fact that tense vowels appear to be absent before /ŋ/ (cf. (69d) of Chapter II) in any way militates against a constraint analysis.

I point out first that the attempt to identify the class of vowels occurring before /ŋ/ with the class of lax vowels fails in both directions.

First of all, in many American dialects, words like hang are pronounced [heŋ]. There is no evidence that this [e] is derived from a lax V.

Secondly, one of the vowels that universally appears before /ŋ/ phonetically is [ɔ] (long, song). This vowel is described as phonetically tense in SPE and furthermore corresponds in general to underlying tense [ā] in monosyllables in the SPE analysis (cf. SPE Section 4.3.7). Thus in the most obvious analyses, the generalization that tense vowels are not found before /ŋ/ is falsified.

There are three obvious possibilities for dealing with the occurrence of [ɔŋ]. One could conclude (a) that [ŋ] does not correspond to an underlying cluster, or (b) that pre-cluster laxing does not hold in general, or (c) that [ŋ] derives from some lax vowel in the case of the environment —ŋ. In SPE (p. 209) the derivation of [ŋ] from /ng/ and

the correctness of the laxing rule are taken to be beyond question.²² Thus SPE concludes that a solution to the problem must be sought in (c), and the suggestion is made that long has underlying lax /o/. But obviously if one presupposes that no tense vowels occur before /ŋ/ and uses this assumption to argue that some lax vowel must occur underlyingly in this position, even when general considerations suggest that a tense vowel is required, it becomes impossible to argue that [ŋ] must correspond to an underlying cluster on the basis of the fact that only lax vowels occur before it underlyingly.

Furthermore, there are several lax vowels that fail to occur before [ŋ], strongly suggesting that deriving [ŋ] from /ng/ is not the right way of dealing with /ŋ/'s distributional peculiarities. First of all, there are no words of the form [Xɛŋ].²³ ^{Arnold / Mary} Secondly, the sequence [uŋ] is completely absent in English. Finally, note that unstressed vowels before [ŋ] are always [ɪ]; [ə] is prohibited in this position, even in dialects which have (or allow) [ə] in all other unstressed positions.²⁴

In addition, it must be noted that the pre-cluster laxing rule is itself suspect as a living phonological process: note coax, Colgate, James, traipse, etc. Without such a rule, the absence of tense vowels before /ŋ/, to the extent that it constitutes a correct generalization, is irrelevant to the hypothesis that all [ŋ] is from /ɪg/.²⁵

5.5 In summary, there seems to be no valid evidence favoring a rule-based analysis of the facts of /ŋ/-distribution over the more straightforward constraint analysis.

Section 6 - Summary

The generalizations discussed in this chapter are alike in that

- (a) for each generalization a rule-based analysis seems possible and has been suggested
- (b) each generalization is syllable-based, as demonstrated in Chapter II
- (c) the rule that would account for each generalization under a rule analysis would have to be ordered prior to the final syllable-structure assignment rule, Rule V

I have attempted to show that in the case of each generalization a syllable-structure constraint provides at least as satisfactory an account as a phonological rule. In view of this result and the fact that the need for syllable-conditioned rules ordered after Rule V (for ex., /t/-Glottalization) and for syllable-based constraints (for ex., the one against tautosyllabic /Vtk/) seems beyond question, the hypothesis of Section 1, repeated here as (12), seems justified in the interest of formulating the strongest possible theory.

- (12) Syllable-conditioned rules enter the phonology ordered after the block of syllable-structure assignment rules I-V, and retain this post-V ordering unless replaced with syllable-structure constraints.

Footnotes to Chapter III

1. where C is such that /kC/ is not a permissible initial cluster
2. For example, since the configuration of (3) would be found in /kær/, /kært/, such inputs to Rule II would be excluded. (3), if correct, is likely to be part of a more general constraint; see Section 3.
3. It is beyond the scope of this dissertation to attempt to set down the conditions under which re-interpretation rather than rule-retention takes place, a problem of great theoretical interest.
4. In fact, pairs of words which are even more obviously from the same stem than the ones discussed in the text but which require allomorphy (or, equivalently, ad-hoc phonological rules) are extremely common in English, a fact often overlooked. As a result, it is possible to find a few examples of alternations supporting virtually any phonological analysis. Some illustrations:

- a) giant/gigantic "evidence" for a /g/-deletion (or -epenthesis)
rule
- b) ego/egotism: /t/-deletion
- c) grammar/grammatical: /r/ → /t/
- d) Peru/Peruvian: /v/-deletion
- e) ghost/ghastly: /ɔ̄/ → /ǣ/
- f) will/won't: /ɪ/ → /ɔ̄/; /l/-deletion
- g) money/monetary: /u/ → /ɔ/ and /t/-deletion

h) appear/apparent: /ē/ → /æ/

i) dynamite (cf. dynamic)/dyn-o-mite: /ǣ/ → /ō/

5. in /r/-retaining dialects which have not undergone rule (e) of Chapter II, Appendix 3.

6. err [ɛr] contrasts with air [er], and our [æɹ] ([ɑɹ] and [awɹ] also possible for our) in my dialect.

[ɛr], while not a universal pronunciation of err ([ɹ] is probably more widespread), is not uncommon and is cited in many current dictionaries (AHD and Webster, for ex., give [ɛr] as first choice).

7. On the basis of my own observations and those of William Labov, I can state with certainty that the particular phenomena discussed in this section are commonly observed in the speech of New York City and Philadelphia; I believe they are more widespread.

8. ran may also occur with /E/

9. For general discussion of feeding and counter-feeding rule order, rule opacity, and the significance of these concepts to the theory of language change, see Kiparsky (1968b, 1971).

10. Not an unlikely choice, since /æ/ and /E/ are phonetically close and since there may be more conservative speakers among the older generation who have [æ] in began, Japan, etc.

11. Note that rule loss, as opposed to re-ordering, is a type of change which results in a formal simplification of the grammar. For additional

discussion of this point, see Kiparsky (1974).

12. There is another often-observed exception to the general appearance of [E] before tautosyllabic [m, n]: can 'be able' [kæn] (cf. can 'container' and the related verb, [kEn]). To be covered by the above account of the appearance of [æ] in began, etc., can, though at one time [kEn], would have to have failed to be relexicalized as such, so that [kæn] could resurface upon rule loss. As a somewhat remote possibility as to why can failed to relexicalize, note that only if can retains /æ/ lexically can its past-tense form could be generated by the rule that takes fellow modal shall to should. However it is quite likely that some other mechanism is behind the [æ] of modal can.

13. In Ringling, [ŋ] is followed not by a vowel but by a non-syllabic which follows /g/ in initial clusters. Since under the hypothesis being examined only tautosyllabic /ŋg/ simplifies and since /ŋg/, if present underlyingly, would not be tautosyllabic in this word, it is as relevant as the other words in (9) to the investigation of this section. Cf. tingling [ŋgl].

14. The relevance of this example must not be underestimated. The fact that dingaling is not part of the formal vocabulary, with an "official" pronunciation, is if anything an advantage in an investigation of this sort.

15. and similar names, when not [...j^vər].

16. The paucity of words with [VŋV] is of course historically due to the

fact that there is no source of such words in earlier stages of English. What is at issue is whether synchronic phonologies contain a formal restriction against words of this type, as implied by the SPE analysis.

17. It should be kept in mind that there do exist common words which are immediately sensed to be outside the normal range of English phonology, for example, uh-huh 'yes' [$\tilde{\lambda}h\tilde{\lambda}$], uh-uh 'no' [$\tilde{\lambda}^{\circ}\tilde{\lambda}$]. Cf. also Bach, commonly pronounced [bax].

18. Unfamiliar names in -nger tend to be pronounced without [g]. Note also that a speaker unfamiliar with a name like Plomber or Abercrombie would probably not be sure whether to pronounce the b. Just as both [m] and [mb] are permissible in V — V and both can be spelled mb, so [ŋ] and [ŋg] seem both permissible in V — V in many cases, both corresponding to the spelling ng.

19. I have translated all dictionary transcriptions into IPA notation.

20. The fact that some speakers of English have [g] in (Friedrich) Engels is irrelevant to the argument made in the text.

RHD's pronunciation possibilities for Engels can be compared to the two common pronunciations of the name Wagner. Speakers of English are free to use initial [w] when referring to former New York City mayor Robert Wagner and [v] in the case of composer Richard Wagner since [w] and [v] are both phonetically permissible in initial position. Wagner with final uvular /r/ in English or with initial /w/ in German, on the other hand, is possible only as a conscious and obvious imitation of another language's sound pattern.

(cont'd)

In addition to Engels, note the near-minimal pairs hangar/anger, Singer/finger, dingus/cunnilingus.

21. Although more, most sober may also be acceptable, there is little doubt as to the acceptability of the cited forms. AHD, for example, gives only soberer, -est. Cf. also "...the soberest and most respected [emphasis mine -DK] of astronomers..." (Pirsig 1974:261).

22. "The other alternative [for phonetic [ɔ̄] in long, soft, etc.] is underlying /ā/, as in lawn, fraud. This is ruled out in such words as long and soft, however, since tense vowels do not occur before such clusters..." (SPE:209)

23. In some American dialects, words like hang, anger are pronounced with [ɛ], in which case /æ/ rather than /ɛ/ provides an example of a lax vowel not found before /ŋ/. In still other forms of American speech, hang and anger have [e], as mentioned above; for these dialects we have two lax-vowel gaps, in addition to the ones to be mentioned below.

The preferred pronunciation (Kenyon & Knott, AHD, RHD) of words like penguin, Bengali is [ŋg], although [ŋg] is also cited.

24. Compare: Rosa's [ə], roses [ɪ] or [ə], dozin' [ɪ] or [ə], vs. dozing [ɪ], *[ə].

25. Since [...iŋ], [...uŋ], as well as [...ʊŋ], etc. seem clearly, deviant, we presumably need constraints against these configurations.

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