THE SOUND PATTERN OF ENGLISH I.

NOAM CHOMSKY

MORRIS HALLE

Harper & Row, Publishers

New York, Evanston, and London

THE SOUND PATTERN OF ENGLISH

Library of Congress Catalog Card Number: 67-23446

To Roman Jakobson

PREFACE

This study of English sound structure is an interim report on work in progress rather than an attempt to present a definitive and exhaustive study of phonological processes in English. We feel that our work in this area has reached a point where the general outlines and major theoretical principles are fairly clear and where we can identify the areas requiring additional intensive study with a reasonable expectation that further investigation within the same general framework will not significantly alter the overall picture we have presented, although it may well be that new and different insights—perhaps along the lines discussed in Chapter Nine—will lead to significant modifications. We have decided to publish this study in its present intermediate stage in the hope that it will stimulate criticism and discussion of basic issues and perhaps involve other investigators in the immense task of extending this sketch to the whole of English, providing the same sort of description for other languages, and enriching and sharpening (and, no doubt, revising in many ways) the phonological theory on which it is based.

This book is organized in the following way. Part I opens with an introductory chapter, Chapter One, in which background assumptions are briefly sketched. In Chapter Two of Part I our major conclusions with respect to phonological theory and the phonology of English are outlined. Also discussed are the possible implications of this work with regard to perceptual processes and the conditions under which knowledge of a language (and, presumably, knowledge of other sorts) can be acquired. We have tried in Part I to present an informal account of the main conclusions that we reach and to illustrate the kinds of data that support them. Thus, readers interested only in general conclusions may wish to read no further.

Part II of the book is an elaboration of the topics treated in Chapter Two of Part I. Chapters Three and Four examine in considerable detail two aspects of English sound structure which were only sketched in Chapter Two. In the course of this detailed investigation of English sound patterns and their underlying structure, certain rules of English phonology are developed. These rules are restated in Chapter Five, which concludes Part Two. The primary emphasis in Part II is on the phonology of English; theory is developed informally as needed for the exposition and analysis.

Part III deals with certain aspects of the historical evolution of the sound patterns revealed in the synchronic study in Part II.

Part IV is devoted to phonological theory. The informal discussion in Part I is expanded upon, and the theory presented in an ad hoc manner in Part II is systematically

developed. The first chapter of Part IV—Chapter Seven—is concerned with universal phonetics, that is, with the general theory of linguistic representation of speech signals. Chapter Eight deals with the principles of organization of the phonological component of the grammar, that is, with the rules that relate syntactic structures to phonetically represented speech signals. In the ninth and concluding chapter, a proposal is presented for an extension of phonological theory that takes into account the intrinsic content of features. Part IV is not concerned with the structure of English but is intended rather as a contribution to universal grammar.

We have made no attempt to avoid redundancy or repetitiousness where we felt that this would assist the reader in following the analysis or argument. Thus, much of the discussion in Part I is repeated in Part II, with additional detail and analysis, and Part IV recapitulates, more systematically, much of the contents of Parts I and II. Each of the four parts of the book is very nearly self-contained. In particular, readers familiar with the general background of this work and its major conclusions as outlined in lectures and publications during the last few years might prefer to skip Part I altogether.

In writing the book we have had two classes of potential readers in mind: first, readers who are concerned only with the general properties of English sound structure, with the consequences of these properties for general linguistic theory, and with the implications of general linguistic theory for other fields; second, readers who are concerned with the detailed development of phonological theory and the theory of English, that is, English grammar. Part I of the book is directed to the first class of readers; Parts II, III, and IV, to the second.

One other point of clarification is needed. We have investigated certain topics in considerable detail and have neglected certain others in what might appear to be a rather idiosyncratic and unmotivated pattern. For example, we have studied the stress contours of English in some detail, but we say nothing about the gradations of aspiration that can easily be observed for English stop consonants. For one concerned solely with the facts of English, the gradations of stress may not seem more important than the gradations of aspiration. Our reason for concentrating on the former and neglecting the latter is that we are not, in this work, concerned exclusively or even primarily with the facts of English as such. We are interested in these facts for the light they shed on linguistic theory (on what, in an earlier period, would have been called "universal grammar") and for what they suggest about the nature of mental processes in general. It seems to us that the gradations of stress in English can be explained on the basis of very deep-seated and nontrivial assumptions about universal grammar and that this conclusion is highly suggestive for psychology, in many ways that we will sketch. On the other hand, gradations of aspiration seem to shed no light on these questions, and we therefore devote no attention to them. We intend no value judgment here; we are not asserting that one *should* be primarily concerned with universal grammar and take an interest in the particular grammar of English only insofar as it provides insight into universal grammar and psychological theory. We merely want to make it clear that this is our point of departure in the present work; these are the considerations that have determined our choice of topics and the relative importance given to various phenomena.

This general aim of our book also explains why we have not included a full discussion of exceptions and irregularities. Had our primary concern been the grammar of English, we would have said very little about the principle of the "transformational cycle" (see Chapters Two and Three) and its consequences (in particular, the properties of English stress contours), but we would have provided a complete account of irregular verbs, irregular plurals, exceptions to rules of stress placement and vowel alternation, etc. Since our main interest is, rather, in universal grammar, we have followed exactly the opposite course. We discuss the transformational cycle and its consequences in detail and we do not include an account of irregularities and exceptions, except insofar as these phenomena seem relevant

to the formulation of general principles of English phonology. Given the goals of the research reported on here, exceptions to rules are of interest only if they suggest a different general framework or the formulation of deeper rules. In themselves they are of no interest.

We do not doubt that the segment of English phonology that we develop in detail is inaccurate in certain respects, perhaps in fundamental respects; and it is a near certainty that the phonological theory we propose will be shown to require substantial revision as research progresses. We mention many difficulties, inadequacies, and exceptions as we proceed. It would be a time-consuming but straightforward task to compile a complete list of exceptions, at least for the rules of word-level phonology. Given the purpose of this study such an effort would be beside the point unless it were to lead to the formulation of new and deeper rules that explained the exceptions or to a different theory that accounted both for the regularities that our rules express and for some of their defects and limitations. 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. For this reason, citation of exceptions is in itself of very little interest. Counterexamples to a grammatical rule are of interest only if they lead to the construction of a new grammar of even greater generality or if they show some underlying principle is fallacious or misformulated. Otherwise, citation of counterexamples is beside the point.

We stress this point because of what seems to us a persistent misinterpretation, in linguistic discussion, of the significance of exceptions to rules—a misinterpretation which in part reflects a deeper misunderstanding as to the status of grammars or of linguistic theory. A grammar is a theory of a language. It is obvious that any theory of a particular language or any general theory of language that can be proposed today will be far from adequate, in scope and in depth. One of the best reasons for presenting a theory of a particular language in the precise form of a generative grammar, or for presenting a hypothesis concerning general linguistic theory in very explicit terms, is that only such precise and explicit formulation can lead to the discovery of serious inadequacies and to an understanding of how they can be remedied. In contrast, a system of transcription or terminology, a list of examples, or a rearrangement of the data in a corpus is not "refutable" by evidence (apart from inadvertence—errors that are on the level of proofreading mistakes). It is for just this reason that such exercises are of very limited interest for linguistics as a field of rational inquiry.

In addition to features of English phonology which seem of no general systematic importance, we have omitted from our discussion many topics about which we have not been able to learn enough, though they may very well be of considerable importance. For example, we have omitted pitch from consideration because we have nothing to add to the study of the phonetics of intonation and have not yet attempted to deal with the still quite open question of the systematic role of pitch contours or levels within the general framework of syntactic and phonological theory as we so far understand it. (See Stockwell (1960), Bierwisch (1966), Lieberman (1966) for discussion of these topics.) Thus pitch and terminal juncture will never be marked in the examples we present. As far as we have been able to determine, the various omissions and gaps have no serious bearing on the questions that we have dealt with, although, clearly, one must keep an open mind on this matter.

The dialect of English that we study is essentially that described by Kenyon and Knott (1944). We depart from their transcriptions occasionally, in ways that will be noted, and we also discuss some matters (e.g., stress contours beyond the word level) not included in their transcriptions. For the most part, however, we have used very familiar data of the sort presented in Kenyon and Knott. In fact, their transcriptions are very close to our own speech, apart from certain dialectal idiosyncrasies of no general interest, which we omit. It seems to

us that the rules we propose carry over, without major modification, to many other dialects of English, though it goes without saying that we have not undertaken the vast and intricate study of dialectal variation. For reasons that we will discuss in detail, it seems to us very likely that the underlying lexical (or phonological) representations must be common to all English dialects, with rare exceptions, and that much of the basic framework of rules must be common as well. Of course, this is an empirical question, which must be left to future research. We will make only a few remarks about dialectal variation, where this seems to have some bearing on the problems we discuss.

The general point of view that underlies this descriptive study is one that several of us have been developing for more than fifteen years, at M.I.T. and elsewhere, at first independently, but increasingly as a joint effort. It is represented in such publications as Chomsky, *Syntactic Structures* (1957a); Halle, *The Sound Pattern of Russian* (1959); Chomsky, *Current Issues in Linguistic Theory* (1964); Katz and Postal, *An Integrated Theory of Linguistic Descriptions* (1964); Chomsky, *Aspects of the Theory of Syntax* (1965); Matthews, *Hidatsa Syntax* (1965); Katz, *The Philosophy of Language* (1966); Postal, *Aspects of Phonological Theory* (1968); and in many articles, reports, and dissertations. Much of the apparent novelty of this point of view is the result of historical accident. Although it naturally owes very much to the important studies, both of general linguistics and of English, that have been carried on during the past thirty or forty years, the approach that is developed in the works cited and that we follow here has much deeper roots in an older, largely forgotten, and widely disparaged tradition. (See Chomsky (1964, 1966a) and Postal (1964b) for discussion.) It seems to us accurate to describe the study of generative grammar, as it has developed during recent years, as fundamentally a continuation of this very rich tradition, rather than as an entirely novel departure.

We have been working on this book, with varying degrees of intensity, for about ten years, and have discussed and presented various aspects of this work at several stages of development. One or the other of us has lectured on this material at M.I.T. for the past seven years. No system of rules that we have proposed has survived a course of lectures unchanged, and we do not doubt that the same fate awaits the grammatical sketch that we develop here.

The research for this book was conducted largely at the Research Laboratory of Electronics, M.I.T., and has been partly assisted by grants from the National Science Foundation and, more recently, from the National Institute of Health (Grant 1 PO1 MH 13390–01).

It would be impossible for us, at this point, to acknowledge in detail the contribution that our students and colleagues have made to the clarification and modification of our ideas. We would like to thank Robert Lees and Paul Postal for their many invaluable comments and suggestions; Paul Kiparsky, Theodore Lightner, and John Ross for the questions they have raised and the answers they have supplied or forced us to find; Richard Carter, S. Jay Keyser, S. Y. Kuroda, James Sledd, Richard Stanley, and Robert Stockwell for reading and criticizing various parts of the book in different stages of its evolution. We owe thanks to Patricia Wanner, who has been in charge of typing the numerous versions of the manuscript, to Karen Ostapenko, Deborah MacPhail, and Michael Brame, who have prepared the Bibliography and Indexes, and to Florence Warshawsky Harris, our editor and former student, who has devoted a major part of her life during these last two years to seeing our difficult and forever unfinished manuscript through the press.

We dedicate the book to Roman Jakobson to mark, albeit belatedly, his seventieth birthday and to express our admiration and gratitude for his inspired teaching and his warm friendship which for so many years have enriched our lives.

NOAM CHOMSKY
MORRIS HALLE

CONTENTS

PART I
GENERAL SURVEY

Chapter one

SETTING

1. Grammar

The goal of the descriptive study of a language is the construction of a grammar. We may think of a language as a set of sentences, each with an ideal phonetic form and an associated intrinsic semantic interpretation. The grammar of the language is the system of rules that specifies this sound-meaning correspondence.

The speaker produces a signal with a certain intended meaning; the hearer receives a signal and attempts to determine what was said and what was intended. The performance of the speaker or hearer is a complex matter that involves many factors. One fundamental factor involved in the speaker-hearer's performance is his knowledge of the grammar that determines an intrinsic connection of sound and meaning for each sentence. We refer to this knowledge—for the most part, obviously, unconscious knowledge—as the speaker-hearer's "competence." Competence, in this sense, is not to be confused with performance. Performance, that is, what the speaker-hearer actually does, is based not only on his knowledge of the language, but on many other factors as well—factors such as memory restrictions, inattention, distraction, nonlinguistic knowledge and beliefs, and so on. We may, if we like, think of the study of competence as the study of the potential performance of an idealized speaker-hearer who is unaffected by such grammatically irrelevant factors.

We use the term "grammar" with a systematic ambiguity. On the one hand, the term refers to the explicit theory constructed by the linguist and proposed as a description of the speaker's competence. On the other hand, we use the term to refer to this competence itself. The former usage is familiar; the latter, though perhaps less familiar, is equally appropriate. The person who has acquired knowledge of a language has internalized a system of rules that determines sound-meaning connections for indefinitely many sentences. Of course, the person who knows a language perfectly has little or no conscious knowledge of the rules that he uses constantly in speaking or hearing, writing or reading, or internal monologue. It is this system of rules that enables him to produce and interpret sentences that he has never before encountered. It is an important fact, too often overlooked, that in normal, everyday discourse one understands and produces new utterances with no awareness of novelty or innovation, although these normal utterances are similar to those previously produced or encountered only in that they are formed and interpreted by the same grammar, the same internalized system of rules. It is important to emphasize that

there is no significant sense of "generalization" in which these new utterances can be described as generalizations from earlier experience, and no sense of the term "habit" in which the normal use of language can be described as some kind of "habit system" or as "habitual behavior." We cannot, in other words, characterize the internalized, mentally represented system of rules that we call the "grammar" in terms of any other significant concept of psychology.

To summarize, then, 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. No confusion should result from this standard usage if the distinction is kept in mind.

2. *Linguistic universals*

General linguistics attempts to develop a theory of natural language as such, a system of hypotheses concerning the essential properties of any human language. These properties determine the class of possible natural languages and the class of potential grammars for some human language. The essential properties of natural language are often referred to as "linguistic universals." Certain apparent linguistic universals may be the result merely of historical accident. For example, if only inhabitants of Tasmania survive a future war, it might be a property of all then existing languages that pitch is not used to differentiate lexical items. Accidental universals of this sort are of no importance for general linguistics, which attempts rather to characterize the range of possible human languages. The significant linguistic universals are those that must be assumed to be available to the child learning a language as an a priori, innate endowment. That there must be a rich system of a priori properties—of essential linguistic universals—is fairly obvious from the following empirical observations. Every normal child acquires an extremely intricate and abstract grammar, the properties of which are much underdetermined by the available data. This takes place with great speed, under conditions that are far from ideal, and there is little significant variation among children who may differ greatly in intelligence and experience. The search for essential linguistic universals is, in effect, the study of the a priori *faculté de langage* that makes language acquisition possible under the given conditions of time and access to data.

It is useful to divide linguistic universals roughly into two categories. There are, first of all, certain "formal universals" that determine the structure of grammars and the form and organization of rules. In addition, there are "substantive universals" that define the sets of elements that may figure in particular grammars. For example, the theory of transformational generative grammar proposes certain formal universals regarding the kinds of rules that can appear in a grammar, the kinds of structures on which they may operate, and the ordering conditions under which these rules may apply. We shall study these questions in detail, in connection with the phonological component of a generative grammar. Similarly, general linguistic theory might propose, as substantive universals, that the lexical items of any language are assigned to fixed categories such as noun, verb, and adjective, and that phonetic transcriptions must make use of a particular, fixed set of phonetic features. The latter topic, once again, will occupy us in this book. We will be concerned with the theory of "universal phonetics," that part of general linguistics that specifies the class of "possible phonetic representations" of sentences by determining the universal set of pho-

netic features and the conditions on their possible combinations. The phonetic form of each sentence in each language is drawn from this class of possible phonetic representations.

3. *Phonetic representations*

What exactly is a phonetic representation? Suppose that universal phonetics establishes that utterances are sequences of discrete segments, that segments are complexes of a particular set of phonetic features, and that the simultaneous and sequential combinations of these features are subject to a set of specific constraints. For example, universal phonetics may provide us with the feature "consonantal," which distinguishes [+consonantal] phonetic segments such as [p], [t], [θ], [s], [š] from [−consonantal] phonetic segments such as [u], [i], [a]; and the feature "strident," which distinguishes [+strident] segments such as [s] and [š] from [−strident] segments such as [p], [t], and [θ]. Among the "simultaneous constraints" of universal phonetics would be the condition that no phonetic segment can be both [−consonantal] and [+strident]; the feature "strident" does not provide a further classification of the category of [−consonantal] segments. Among the "sequential constraints" might be certain conditions that assign a maximal length to a sequence of [+consonantal] phonetic segments, that is, to a consonant cluster. There will be many other constraints of both sorts, and they must be met by each phonetic representation in each language.

More specifically, a phonetic representation has the form of a two-dimensional matrix in which the rows stand for particular phonetic features; the columns stand for the consecutive segments of the utterance generated; and the entries in the matrix determine the status of each segment with respect to the features. In a full phonetic representation, an entry might represent the degree of intensity with which a given feature is present in a particular segment; thus, instead of simply subdividing segments into [+strident] and [−strident], as in the example just given, the entries in the row corresponding to the feature "strident" might indicate degrees along a differentiated scale of "stridency." The phonetic symbols [p], [t], [θ], [i], [u], etc., are simply informal abbreviations for certain feature complexes; each such symbol, then, stands for a column of a matrix of the sort just described.

To recapitulate, the phonetic representation of an utterance in a given language is a matrix with rows labeled by features of universal phonetics. The grammar of the language assigns to this phonetic representation a "structural description" that indicates how it is to be interpreted, ideally, in this language. More generally, we may say that the grammar of each language assigns a structural description to each member of the universal class of possible phonetic representations. For example, the grammar of every language will assign structural descriptions to phonetic representations such as (1) and (2):[1]

(1) ilvyɛ̆dradəmɛ̃ ("il viendra demain")

(2) hiylkʌm+təmarə ("he'll come tomorrow")

[1] We omit much phonetic detail that should be specified in universal representations but that is irrelevant to the exposition here. This is the course we will generally follow in discussing particular examples. In the representation (2), and in other representations in this chapter, we include the "boundary symbol" +, which can be taken as specifying a certain type of transition between phonetic elements. Actually, however, we will suggest later that boundary symbols do not appear in phonetic representations.

The grammar of English will assign to (1) a structural description indicating that it is not a sentence of English at all, and to (2) a structural description that specifies the elements of which it is composed on the various linguistic levels, the manner of their organization, the interrelations of these abstract representations, and so on. The grammar of French will supply this information for (1), and will designate (2) as a nonsentence. Many elements of the class of possible phonetic representations will be designated as "semi-grammatical sentences," not well-formed but nevertheless interpretable by analogy to well-formed sentences in ways that are, for the moment, not well understood.[2]

4. *Components of a grammar*

The class of possible phonetic representations is of course infinite. Similarly, the class of phonetic representations designated as well-formed sentences in each human language is infinite. No human language has a limit on the number of sentences that are properly formed and that receive a semantic interpretation in accordance with the rules of this language. However, the grammar of each language must obviously be a finite object, realized physically in a finite human brain. Therefore, one component of the grammar must have a recursive property; it must contain certain rules that can be applied indefinitely often, in new arrangements and combinations, in the generation (specification) of structural descriptions of sentences. Every language, in particular, contains processes that permit a sentence to be embedded within another sentence, as the English sentence *John left* is embedded in the sentence *I was surprised that John left*. These processes can apply indefinitely often to form sentences of arbitrary complexity. For example, the sentence *I was surprised that John left* can itself be embedded in the context *Bill expected* ——, giving, finally, *Bill expected me to be surprised that John left*, after various obligatory modifications have taken place. There is no limit to the number of applications of such processes; with each further application, we derive a well-formed sentence with a definite phonetic and semantic interpretation.

The part of a grammar which has this recursive property is the "syntactic component," the exact form of which will not concern us here.[3] We will, however, make certain assumptions about the abstract objects generated by the syntactic component, that is, about the "syntactic descriptions" that can be formed by the application of its rules.

The syntactic component of a grammar assigns to each sentence a "surface structure" that fully determines the phonetic form of the sentence. It also assigns a far more abstract "deep structure" which underlies and partially determines the surface structure but is otherwise irrelevant to phonetic interpretation, though it is of fundamental significance for semantic interpretation. It is important to bear in mind that deep structures are very different from the surface structures to which we will restrict our attention and that they provide a great deal of information not represented in surface structures.

To recapitulate, a grammar contains a syntactic component which is a finite system of rules generating an infinite number of syntactic descriptions of sentences. Each such syntactic description contains a deep structure and a surface structure that is partially determined by the deep structure that underlies it. The semantic component of the grammar

[2] For discussion of this matter, which we will exclude from consideration henceforth, see Section IV of Fodor and Katz (1964), and pages 148 ff. of Chomsky (1965), as well as many other references.

[3] For recent discussion, see Katz and Postal (1964) and Chomsky (1965).

is a system of rules that assigns a semantic interpretation to each syntactic description, making essential reference to the deep structure and possibly taking into account certain aspects of surface structure as well. The phonological component of the grammar assigns a phonetic interpretation to the syntactic description, making reference only to properties of the surface structure, so far as we know. The structural description assigned to a sentence by the grammar consists of its full syntactic description, as well as the associated semantic and phonetic representations. Thus the grammar generates an infinite number of sentences, each of which has a phonetic and semantic representation; it defines an infinite sound-meaning correspondence, this correspondence being mediated by the abstract syntactic component and the structures it generates.

We are not concerned here with deep structures and the rules that generate them, the rules that relate them to surface structures, or the rules that assign semantic interpretations to syntactic descriptions. We are limiting our attention to surface structures, phonetic representations, and the rules that assign a phonetic representation (possibly several phonetic representations, in the case of free variation) to each surface structure.

5. *Surface structures*

The surface structures generated by the syntactic component have the following characteristics. Each consists of a string of minimal elements that we will call "formatives." Each formative is assigned to various categories that determine its abstract underlying form, the syntactic functions it can fulfill, and its semantic properties. For example, the formative *boy* will belong to the category of elements with initial voiced stops,[4] to the category "noun," to the category "animate," to the category "male," etc. This information about formatives will be presented in a "lexicon," which forms part of the syntactic component of the grammar. The organization of the lexicon will not concern us here; we simply assume that the full categorization of each formative is represented in the surface structure. In fact, we may think of the lexical entry of a formative as nothing other than a list of the categories to which it belongs. The categories are sometimes called "features." We will refer, as we proceed, to phonological, syntactic, and semantic features.

The surface structure must indicate how the string of formatives it contains is subdivided into "phrases," each phrase being a certain continuous substring of the string of formatives. The analysis of strings into phrases is a "proper bracketing" in the sense that phrases can overlap only if one is contained in the other. Thus, if *A*, *B*, *C* are formatives, the surface structure of the string *ABC* cannot specify *AB* as a phrase and *BC* as a phrase, for the string may be bracketed either as ((*AB*)*C*) or as (*A*(*BC*)) but not in both ways simultaneously.

The phrases furthermore are assigned to certain categories, and this information may be represented by putting labels on the brackets. Take, for example, the sentence (3):

(3) *we established telegraphic communication*

In (3), the string underlying *we* is assigned to the same category as the string underlying

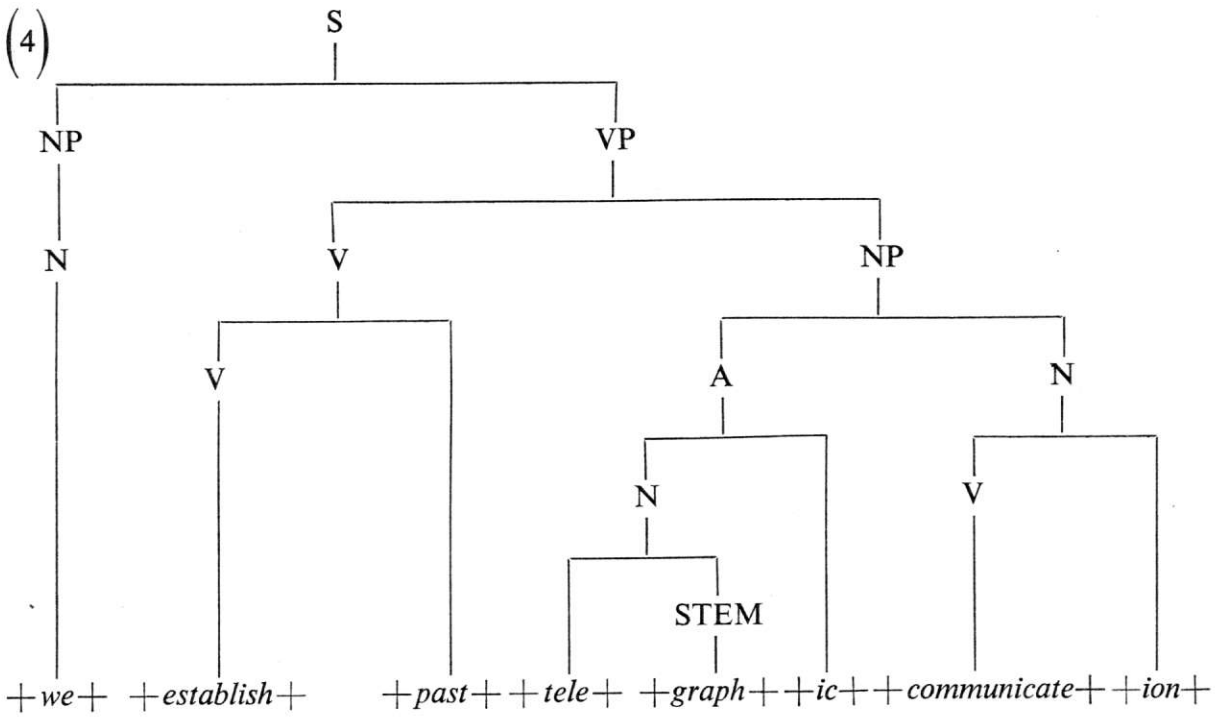
[4] This underlying representation will be abstract in a sense that we will later describe in detail. For example, although the formative *boy* is always represented phonetically with a back vowel, we will present evidence showing that it should be represented in surface structure—that is, before the phonological rules apply—with a front vowel.

telegraphic communication, namely, to the category "noun phrase." Similarly, the other phrases are assigned to certain universal categories.

We will make the empirical assumption that the surface structure of a sentence is precisely a proper bracketing of a string of formatives, with the bracketed substrings (the phrases) assigned to categories selected from a certain fixed universal set of categories. The complete string is assigned to the category "sentence"(S); the other phrases are also assigned to categories that are provided by general linguistic theory, such as the categories "noun phrase" (NP) and "verb phrase" (VP). These universal categories are on a par with the phonetic categories (bilabial closure, frontness, etc.) provided by universal phonetic theory. As we noted earlier, the categories of universal phonetic theory determine a certain infinite class of possible phonetic representations from which the phonetic forms of sentences of any human language are drawn. Similarly, the universal set of phrase categories (NP, VP, etc.), together with the universal lexical categories (noun, verb, adjective) and the universal lexical features that define the class of "possible formatives," provides us with an infinite class of possible surface structures, from which the surface structures of sentences of any particular language are drawn. In other words, general linguistics should provide definitions, in terms independent of any particular language, for the notions "possible phonetic representation" and "possible surface structure." The grammar of each language relates phonetic representations to surface structures in a specific way; and, furthermore, it relates surface structures to deep structures, and, indirectly, to semantic interpretations, in ways that are beyond the scope of our present study.

To give a concrete example, the grammar of English might assign to the sentence (3) a surface structure which can be represented in the equivalent forms (4) and (5):[5]

(4)



(5) $[_{S}\ [_{NP}\ [_{N}+we+]_{N}\ ]_{NP}\ [_{VP}\ [_{V}\ [_{V}+establish+]_{V}\ +past+]_{V}\ [_{NP}\ [_{A}\ [_{N}+tele+$
$[_{STEM}+graph+]_{STEM}\ ]_{N}\ +ic+]_{A}\ [_{N}\ [_{V}+communicate+]_{V}\ +ion+]_{N}\ ]_{NP}\ ]_{VP}\ ]_{S}$

[5] Once again (see note 1), we omit details which are irrelevant here. We assume, for the purposes of this example, that the formatives are *we*, *establish*, *past*, *tele*, *graph*, *ic*, *communicate*, *ion*. The node labeled A represents the lexical category "adjective"; the other labels have been mentioned previously.

The interpretation of the notational devices used in (4) and (5) should be obvious. We intend these representations to indicate that the formative *we* is both an N and an NP, the formative *establish* a V, the formative string *tele graph* an N, the formative string *tele graph ic communicate ion* an NP, the full string an S, etc.[6] Furthermore, each formative has an analysis as a set of intersecting categories, in a way that we shall specify in more detail below. The + symbols represent formative boundaries which, by convention, automatically mark the beginning and end of each formative.

5.1. LEXICAL AND PHONOLOGICAL REPRESENTATIONS

To recapitulate, we presuppose, for our description of English sound patterns, a grammar with a syntactic component that assigns to each sentence a surface structure such as (4)-(5), that is, a proper labeled bracketing of a string of formatives. Our main concern here will be the "phonological component," that is, the system of rules that applies to a surface structure and assigns to it a certain phonetic representation drawn from the universal class provided by general linguistic theory. In particular, the phonological rules of English must assign to the surface structure (4)-(5) a phonetic representation much like (6):

(6) wīyəstæ̂blišt+tèləgrǽfik+kəmyûwnəkéyšən

The phonetic representation (6), corresponding to the underlying surface structure (4)-(5), is a feature matrix of the sort described earlier. In the surface structure, the individual formatives (for example, the lexical formatives *we*, *establish*, *tele*, *graph*, *communicate*, and the grammatical formatives *past*, *ic*, *ion*) will themselves be represented as feature matrices of an abstract sort, and we must now say a few words about this kind of representation. We shall distinguish between "lexical representations" and "phonological representations." We shall use the term "lexical representation" in reference to formatives which are provided directly by the lexicon, i.e., the lexical formatives as well as certain grammatical formatives which happen to appear in lexical entries. There may be other grammatical formatives introduced directly by the syntactic rules themselves. Thus the syntactic rules and the lexicon, applied in a manner that does not concern us here, provide for each utterance a representation as a string of formatives with surface structure.

Notice, however, that the surface structure must meet two independent conditions: first, it must be appropriate for the rules of phonological interpretation; second, it must be "syntactically motivated," that is, it must result from the application of independently motivated syntactic rules. Thus we have two concepts of surface structure: input to the phonological component and output of the syntactic component. It is an empirical question whether these two concepts coincide. In fact, they do coincide to a very significant degree, but there are also certain discrepancies. These discrepancies, some of which we discuss as we proceed, indicate that the grammar must contain certain rules converting the surface structures generated by the syntactic component into a form appropriate for use by the phonological component. In particular, if a linguistic expression reaches a certain level of complexity, it will be divided into successive parts that we will call "phonological phrases," each of which is a maximal domain for phonological processes. In simple cases the whole sentence is a single phonological phrase; in more complex cases the sentence may be reanalyzed as a sequence of phonological phrases. The analysis into phonological phrases

[6] Since in representations such as (4) the category labels are placed above the elements in the string that belong to these categories, one frequently speaks of the category as "dominating" a string or a part of a string. Thus, with respect to (4), we will say both that *we* "is an" N and that *we* "is dominated by" N.

depends in part on syntactic structure, but it is not always syntactically motivated in the sense just mentioned. If the syntactic component were to be connected to an orthographic rather than a phonetic output system, the reanalysis into phonological phrases would be unnecessary. Writers, unlike speakers, do not run out of breath, and are not subject to other physiological constraints on output that require an analysis into phonological phrases.

In addition to a reanalysis into phonological phrases in complex cases, the "readjustment rules" relating syntax to phonology make various other modifications in surface structures. It seems that in general these modifications involve elimination of structure, that is, deletion of nodes in representations such as (4) or of paired brackets in representations such as (5). One can easily imagine why this should be so. Reasoning along lines suggested in Miller and Chomsky (1963, Part 2), let us suppose that perception involves a two-stage memory. The first stage is a short-term system quite limited in capacity and operating in real time in the sense that it must remain available for receiving the incoming signal, and the second stage is a very large system that operates on information supplied to it by the short-term real-time system. The short-term first stage must provide an initial analysis of the signal that is just sufficient in detail to permit the second-stage system to derive the deep structure and semantic interpretation. We might expect a language to be so designed that a very superficial analysis into phrases can be performed by a system with limited memory and heavy restrictions on access. To relate this speculation to the discussion of surface structure, it appears that the syntactic component of the grammar generates a surface structure Σ which is converted, by readjustment rules that mark phonological phrases and delete structure, to a still more superficial structure Σ'. The latter then enters the phonological component of the grammar. We might speculate, then, that a first stage of perceptual processing involves the recovery of Σ' from the signal using only the restricted short-term memory, and that a second stage provides the analysis into Σ and the deep structure that underlies it. From this point of view, it would be natural to suppose that the readjustment rules that form Σ' from Σ will have the effect of reducing structure. It is, incidentally, worthy of note that the transformations that form surface structures from deep structures also characteristically have the effect of reducing structure, in a sense which can be made precise.[7]

Let us return now to our discussion of lexical and phonological representations. We have used the term "lexical representation" to refer to the representation of formatives provided by the lexicon. As we have stated, however, the structures generated through the interaction of syntactic and lexical rules are not quite appropriate, in certain cases, for the application of the rules of the phonological component. They must be modified by certain readjustment rules (of a sort to which we will return in Chapter Eight, Section 6.5, noting, however, that our investigation of the effects of surface structure on phonetic representation has not yet reached a level of depth and complexity that requires a detailed, formal analysis of these processes).[8] These readjustment rules may somewhat modify the labeled bracketing of surface structure. They may also construct new feature matrices for certain strings of lexical and grammatical formatives. To take an obvious example, the verb *sing* will appear in the lexicon as a certain feature matrix, as will the verb *mend*. Using letters of the alphabet as informal abbreviations for certain complexes of features, i.e., certain columns of a feature matrix, we can represent the syntactically generated surface structure underlying the

[7] See Miller and Chomsky (1963). See also Ross (1967) for further relevant observations of a different sort on reduction of structure under transformations.

[8] See Bierwisch (1966) for a very interesting study of readjustment rules of the sort mentioned here.

forms *sang* and *mended* as $[_V\ [_V sing]_V\ past]_V$ and $[_V\ [_V mend]_V\ past]_V$, respectively, where *past* is a formative with an abstract feature structure introduced by syntactic rules. The readjustment rules would replace *past* by *d*, as a general rule; but, in the case of *sang*, would delete the item *past* with the associated labeled brackets, and would add to the *i* of *sing* a feature specification indicating that it is subject to a later phonological rule which, among other things, happens to convert *i* to æ. Designating this new column as *, the readjustment rules would therefore give the forms $[_V s*ng]_V$ and $[_V\ [_V mend]_V\ d]_V$, respectively. We shall refer to this representation—and in general to the representation given by the application of all readjustment rules—as the "phonological representation."

Other terms that might have been used in place of the terms just proposed are "morphophonemic representation" or "systematic phonemic representation." We have avoided these terms, however, because of the technical meaning they have been given in various theories of sound structure developed in modern linguistics. The term "morphophonemic representation" seems to us appropriate only if there is another linguistically significant level of representation, intermediate in "abstractness" between lexical (phonological) and phonetic and meeting the conditions placed on "phonemic representation" in modern structural linguistics. We feel, however, that the existence of such a level has not been demonstrated and that there are strong reasons to doubt its existence.[9] We will make no further mention of "phonemic analysis" or "phonemes" in this study and will also avoid terms such as "morphophonemic" which imply the existence of a phonemic level. Notice that the issue in this case is not terminological but rather substantive; the issue is whether the rules of a grammar must be so constrained as to provide, at a certain stage of generation, a system of representation meeting various proposed conditions. The references in note 9 explain our position, and we will say no more about the matter here.

5.2. *ON THE ABSTRACTNESS OF LEXICAL REPRESENTATIONS*

We have said that the underlying representations, lexical as well as phonological, are abstract as compared with phonetic representations, although both are given in terms of phonetic features. The meaning of this remark will become clearer as we proceed. There is, however, one very obvious sense in which the underlying representations are more abstract than the phonetic representations. Consider, for example, the word *telegraph*. This has several different variants in actual phonetic representations:[10]

(7) $\text{tel}\overset{1}{\text{ə}}\text{gr}\overset{3}{\text{æ}}\text{f}$[11] (in isolation)

(8) $\text{tel}\overset{3}{\text{ə}}\text{gr}\overset{1}{\text{æ}}\text{f}$ (in the context —— *ic*; i.e., *telegraphic*)

(9) $\text{t}\overset{1}{\text{ə}}\text{l}\overset{1}{\text{e}}\text{grəf}$ (in the context ——*y*; i.e., *telegraphy*)

It is quite obvious, however, that this phonetic variation is not fortuitous—it is not of the

[9] We have presented our reasons for doubting the existence of a phonemic level, in the sense of modern linguistics, in various places. See Halle (1959), Chomsky (1964, 1966b), and Chomsky and Halle (1965), as well as Postal (1962, 1968), for arguments that seem to us fully convincing.

[10] Notice that in the sentence (6) it has still another representation because of the stress modifications that take place in that context.

[11] Stress levels are indicated here and throughout by numerals, with "1" representing primary stress, "2" representing secondary stress, etc. (See also note 3 in Chapter Two on this subject.)

same type as the variation between *I* and *we*, which depends on specific assignment of the latter to the category of plurality. Given the grammar of English, if we delete specific reference to the item *we*, there is no way to predict the phonetic form of the plural variant of *I*. On the other hand, the rules for English grammar certainly do suffice to determine the phonetic variation of *telegraph* without specific mention of this lexical item, just as they suffice to predict the regular variation between *cat* and *cats* without specifically mentioning the plural form. It is quite obvious that English grammar is complicated by the fortuitous variation between *I* and *we* but not by the totally predictable variation between *cat* and *cats*. Similarly, the grammar would be more complicated if *telegraph* did *not* undergo precisely the variation in (7)–(9): if, for example, it had one phonetic form in all contexts, or if it had the form (7) in the context ——*ic*, (8) in the context ——*y*, and (9) in isolation.

In short, the phonetic variation of *telegraph* in certain contexts is not an idiosyncratic property of this particular lexical item but is rather a matter of general rule, applying to many other lexical items as well. Regular variations such as this are not matters for the lexicon, which should contain only idiosyncratic properties of items, properties not predictable by general rule. The lexical entry for *telegraph* must contain just enough information for the rules of English phonology to determine its phonetic form in each context; since the variation is fully determined, the lexical entry must contain no indication of the effect of context on the phonetic form. In fact, as we shall see, the lexical representation for the word *telegraph* should be (10), where each of the symbols *t*, *e*, ... is to be understood as an informal abbreviation for a certain set of phonological categories (distinctive features):[12]

(10) +tele+græf+

Thus the lexical representation is abstract in a very clear sense; it relates to the signal only indirectly, through the medium of the rules of phonological interpretation that apply to it as determined by its intrinsic abstract representation and the surface structures in which it appears.

An analogous argument can readily be constructed for the abstract nature of the phonological representations, i.e., those representations that are determined from lexical representations by application of certain readjustment rules (and which, for the most part, are in fact identical with lexical representations).

5.3. *ANALYSIS INTO WORDS*

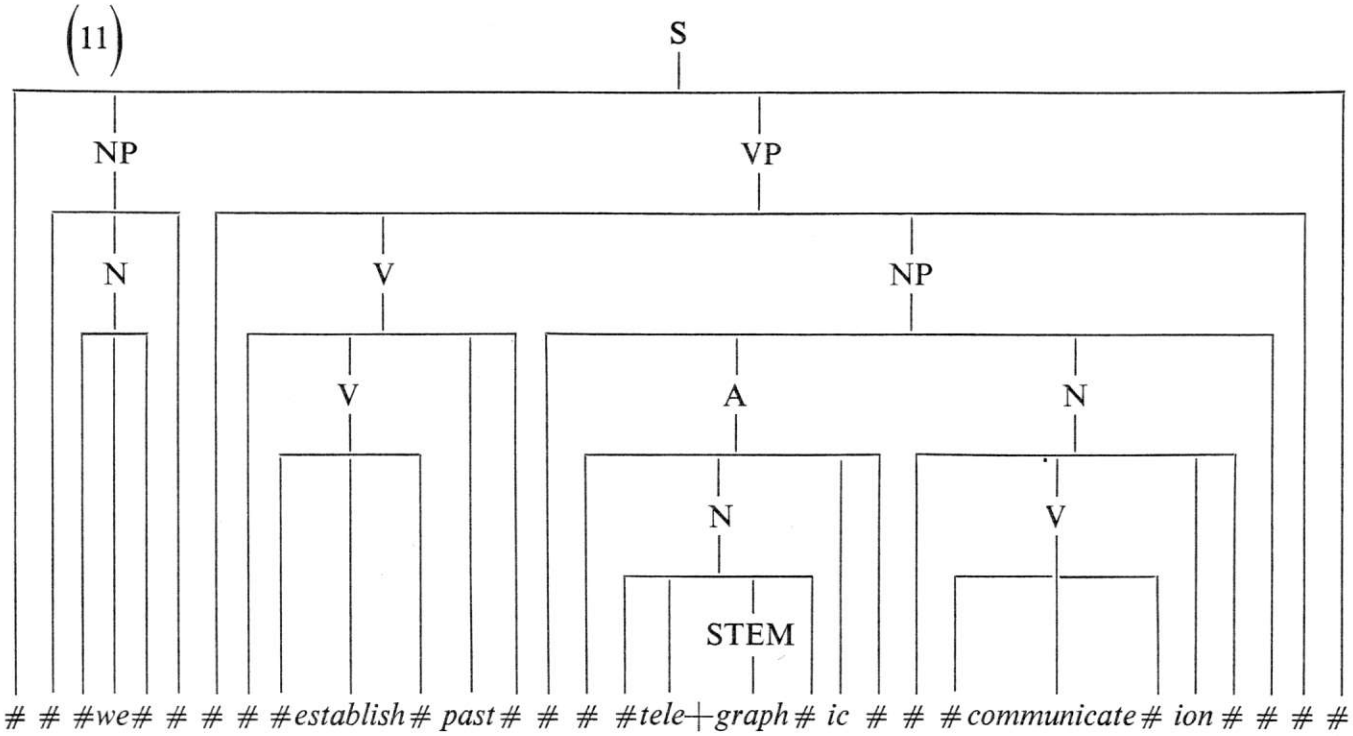
One additional aspect of surface structure is crucial for our discussion. We will see that the phonological rules fall into two very different classes. Certain of these rules apply freely to phrases of any size, up to the level of the phonological phrase; others apply only to words. We must therefore assume that the surface structure of an utterance provides an analysis into a sequence of words. For example, the sentence (3), *we established telegraphic communication*, will be analyzed by its surface structure into the four successive words *we*, *establish+past*, *tele+graph+ic*, *communicate+ion*. The rules that form surface structure (or, perhaps, the readjustment rules discussed above) must provide this information, since it is required for the correct application of the rules of the phonological component of the grammar.

As a first approximation to the problem of analysis into words, let us assume that each lexical category (e.g., noun, verb, adjective) and each category that dominates a lexical

[12] In addition, the lexical entry will provide the other idiosyncratic syntactic information represented in (4)-(5), namely, the information that *graph* is a stem and *telegraph* is a noun.

category (e.g., sentence, noun phrase, verb phrase) automatically carries a boundary symbol # to the left and to the right of the string that belongs to it (i.e., that it dominates, in tree representations such as (4), or that it brackets, in bracket representations such as (5)). Under this assumption, we replace the representation (4) by (11) and modify (5) in a corresponding way:

(11)



Let us tentatively define a word as a string of formatives (one or more) contained in the context # # —— # # and containing no occurrences of # #.[13] Thus the words in (11) are *we*, *establish#past*, *tele+graph#ic*, and *communicate#ion*, as required. The principle just stated can be regarded, tentatively, as a universal principle for the interpretation of surface structures, and, as a first approximation, it works quite well. Among the readjustment rules discussed above, there will be some that modify the representation provided by this interpretive principle in ad hoc ways. For example, we shall see that although the boundary # is appropriate in *establish#ed*, as distinct from ordinary formative boundary (which we have been representing as +), it must be replaced by ordinary formative boundary in *tele+graph#ic* and *communicate#ion*, for reasons having to do with the applicability of certain phonetic rules.

To recapitulate, the rules of syntax will generate surface structures and a universal principle of interpretation will assign the boundary symbol # in certain places. The readjustment rules will modify the surface structure in various ad hoc ways, demarcating it into phonological phrases, eliminating some structure, and replacing some occurrences of # by +. The abstract object thus constructed (which we will also refer to as a "surface structure," or, if more explicitness is necessary, a "phonological surface structure," to contrast it with the syntactic surface structure generated by the syntactic component) enters the phonological component of the grammar and is converted by the phonological rules into a phonetic representation, in ways that we will specify in detail as we proceed. Certain of the phonological rules will apply only to words; others will apply freely to strings of formatives which may be words or subparts of words, or phrases that include words.

[13] See Chapter Eight, Section 6.2, for a more careful analysis of the notion "word."

We will find it convenient to use labeled bracketing such as (5) rather than tree diagrams such as (4) and (11) for the representation of surface structure in the presentation of phonological rules. Since, by convention, every lexical category or category dominating a lexical category has # boundaries associated with it on the left and right, we will sometimes omit reference to these boundaries in the statement of rules. For example, a rule of the form (12) is to be understood as applying to the string (13):

(12) $$A \rightarrow B \;/\; X \text{——} Y]_{\mathbf{V}}$$

(13) $$XAY\#]_{\mathbf{V}}$$

Rule (12) states that an element of the type A is rewritten as a corresponding element of the type B when A appears in the context X —— Y (that is, with X to its left and Y to its right) and when the item in question is a verb, i.e., is dominated by V or, equivalently, is bracketed by $[_{\mathbf{V}}\ ]_{\mathbf{V}}$. We will make these informal specifications more precise as we proceed.

6. Summary

The phonological component is a system of rules such as (12) that relates surface structures such as (11) to phonetic representations such as (6). As we proceed in our discussion, we will propose various specific hypotheses regarding the detailed form of representations such as (11) and (6), and we will also make specific proposals concerning the system of phonological rules that assign a phonetic interpretation to each surface structure.

We have already suggested that a phonetic representation such as (6) is actually a feature matrix in which the rows correspond to a restricted set of universal phonetic categories or features (voicing, nasality, etc.) and the columns to successive segments. We will propose further that such representations are mentally constructed by the speaker and the hearer and underlie their actual performance in speaking and "understanding." We will consider the question of the relation between such phonetic representations and actual speech signals, and the steps by which such representations might be constructed by the hearer on the occasion of reception of a speech signal. We have suggested, moreover, that each formative of the surface structure can also be represented as a feature matrix interpreted in a rather similar way, with rows corresponding to the universal phonetic and grammatical categories. The formative structure is much more abstract, however; its relation to the speech signal is not as direct as that of the phonetic representation.

We will propose that the rules of the phonological component have a fixed form and a specific organization, that they apply in a fixed manner determined by the labeled bracketing of the surface structure, and that they meet various additional conditions depending on their formal relations. These we propose as universal conditions, as aspects of general linguistic theory. We will try to show how, on the basis of these assumptions, many particular phenomena of English sound structure can be explained.

With these remarks on background assumptions, we can proceed to the analysis of English sound structure and of general phonological theory.

Chapter two

A SKETCH OF ENGLISH PHONOLOGY AND PHONOLOGICAL THEORY

1. The principle of the transformational cycle and its application to English stress contours

We turn here to the problem of how a surface structure of the sort described in the preceding chapter determines a phonetic representation.

It is well known that English has complex prosodic contours involving many levels of stress and pitch[1] and intricate processes of vowel reduction. It is clear even from a superficial examination that these contours are determined in some manner by the surface structure of the utterance. Furthermore, it is natural to suppose that in general the phonetic shape of a complex unit (a phrase) will be determined by the inherent properties of its parts and the manner in which these parts are combined, and that similar rules will apply to units of different levels of complexity. These observations suggest a general principle for the application of rules of the phonological component, namely, what we shall call the principle of the "transformational cycle."[2] Regarding a surface structure as a labeled bracketing (see representation (5) in Chapter One), we assume as a general principle that the phonological rules first apply to the maximal strings that contain no brackets, and that after all relevant rules have applied, the innermost brackets are erased; the rules then reapply to maximal strings containing no brackets, and again innermost brackets are erased after this application; and so on, until the maximal domain of phonological processes is reached. In terms of the tree representation of a surface structure (see representation (4) in Chapter One), the rules apply to a string dominated by a particular node *A* only after they have already applied to the strings dominated by each of the nodes dominated by *A*.

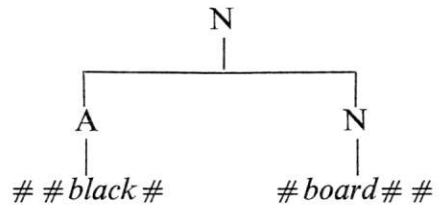
The actual operation of the transformational cycle can now be illustrated with some simple examples. It is clear, first of all, that there are at least two processes of stress

[1] As we explained in the Preface, we will have nothing to say about pitch in this study.

[2] This principle was first formulated in Chomsky, Halle, Lukoff (1956) in a slightly different but equivalent terminology. It has since been applied to phonetic study of a variety of different languages: French (Schane, 1965), Russian (Halle, 1963, Lightner, 1965a), Japanese (McCawley, 1965).

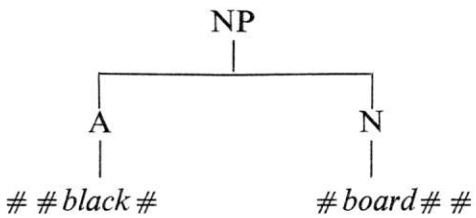
assignment in English. Thus *blackboard*,[3] with a falling stress contour, must be distinguished from *black board*, with a rising contour. The elementary constituents, *black*, an adjective, and *board*, a noun, are the same in both cases; the difference lies in the way these constituents are combined, as reflected in their different surface structures, shown here in the two notations of the preceding chapter:

(1) (a)



$[_{N}\#\ [_{A}\#black\#]_{A}\ [_{N}\#board\#]_{N}\ \#]_{N}$

(b)



$[_{NP}\#\ [_{A}\#black\#]_{A}\ [_{N}\#board\#]_{N}\ \#]_{NP}$

In case (1a), where the entire phrase belongs to the category "noun," the phonological rules must give the contour 13; in case (1b), where it belongs to the category "noun phrase," the rules must give the contour 21. According to the principle of the transformational cycle, the phonological rules apply first to the strings dominated by A and by N, the lowest-level categorial nodes of (1); in other words, the rules apply first to *black* and to *board*. In isolation, each of these would receive primary stress. We therefore might propose the rule:

(2) In monosyllables, the vowel receives primary stress.

Applying this rule to the structures of (1) and then erasing innermost brackets in accordance with the principle of the transformational cycle, we have, in the bracket notation, the representations (3a) and (3b):

(3) (a) $[_{N}\#\ \#\acute{b}lack\#\ \#\acute{b}oard\#\ \#]_{N}$ (b) $[_{NP}\#\ \#\acute{b}lack\#\ \#\acute{b}oard\#\ \#]_{NP}$

We must now apply rules that weaken the rightmost primary stress in case (3a) and that weaken the leftmost primary stress in case (3b). For many reasons, it is necessary to state the rules that determine stress contours as rules of placement of primary stress, rather than as rules of stress weakening. We will therefore formulate the rules that apply to (3) as processes that place primary stress on the leftmost and the rightmost syllables, respectively, and we will adopt the following convention: *when primary stress is placed in a certain*

[3] There are various conventions in use for marking stress, which, at least in part, appear to differ in factual content. We return to this matter later. Here, as mentioned in Chapter One, note 11, in place of the conventional symbols ´, ˆ, `, ˘ for primary, secondary, tertiary, and quaternary (zero) stress, respectively, we will simply use numerals, starting with 1 for primary stress. It should be kept in mind that the numbers go down as the stress goes up, admittedly a disadvantage of this notation. To minimize confusion, we will speak of strengthening and weakening stress, rather than of increasing and decreasing it.

position, then all other stresses in the string under consideration at that point are automatically weakened by one. We can now state the following two rules:

(4) Assign primary stress to a primary-stressed vowel in the context

$$\text{——} \ldots \overset{1}{\text{V}} \ldots]_{\text{N}}$$

(5) Assign primary stress to a primary-stressed vowel in the context

$$\overset{1}{\text{V}} \ldots \text{——} \ldots]_{\text{NP}}$$

In rules (4) and (5), the symbol V stands for "vowel," and $\overset{1}{\text{V}}$ stands for a vowel with primary stress. The dash indicates the position of the segment to which the rule applies. Thus rule (4) assigns primary stress to a primary-stressed vowel which is *followed* by another primary-stressed vowel in a noun, and rule (5) assigns primary stress to a primary-stressed vowel which is *preceded* by another primary-stressed vowel in a noun phrase. By the convention stated above, the actual effect of these rules is to weaken the other stresses in the string to which the rule applies. Thus, applying rule (4) to (3a), we derive the representation (6a); applying rule (5) to (3b), we derive the representation (6b).

(6) (a) $\#\#\overset{1}{black}\#\#\overset{2}{board}\#\#$ (b) $\#\#\overset{2}{black}\#\#\overset{1}{board}\#\#$

We will refer to (4) as the Compound Rule and to (5) as the Nuclear Stress Rule.

It is important to observe that rules (4) and (5) make use of the bracketing given in the surface structure for their proper cyclic operation, and that the labels on the brackets, that is, the syntactic categories indicated in the surface structure, are necessary for determining the correct application of the rules.

To derive the stress contour for *blackboard*, we must apply still another rule, weakening the secondary stress on the second syllable to tertiary. This process can be formulated in the following way (with C_0 standing for a string of zero or more consonants):

(7) Assign primary stress to a primary-stressed vowel in the context

$$\text{——} \ldots \#\#C_0\overset{2}{V}C_0\#]_{\text{N}}$$

Application of rule (7) to (6a) gives the desired stress pattern 13 by the conventions established above; primary stress is placed on the first syllable, and the stress on the second syllable is automatically weakened to tertiary.

Clearly, both the Compound Rule and the Nuclear Stress Rule are of much greater generality than is indicated by the formulation we have given. Thus, rule (4) actually applies not only to compound nouns such as *blackboard*, but also to compound adjectives (*$\overset{1}{\text{heart}}$-$\overset{3}{\text{broken}}$*) and compound verbs (*$\overset{1}{\text{air}}$-$\overset{3}{\text{condition}}$*). It must therefore be extended to lexical categories in general. Similarly, the Nuclear Stress Rule applies not only to noun phrases, but to any phrase which is not a lexical category—for example, to verb phrases (*$\overset{2}{\text{read}}$ the $\overset{1}{\text{book}}$*), to adjective phrases (*$\overset{2}{\text{eager}}$ to $\overset{1}{\text{please}}$*), and to whole sentences (*$\overset{2}{\text{John}}$ $\overset{1}{\text{left}}$*). We therefore replace rules (4) and (5) by the formulations (8) and (9):

(8) Assign primary stress to a primary-stressed vowel in the context

$$\text{——} \ldots \overset{1}{\text{V}} \ldots]_{\text{NAV}}$$

(9) Assign primary stress to a primary-stressed vowel in the context

$$\overset{1}{\text{V}} \ldots \text{——} \ldots]_{\alpha}$$

where $]_\alpha$ stands for a bracket with any label except N, A, or V. We can make the notion "except" precise in a very simple way, namely, by requiring that the rules (8) and (9) apply in the order given. We can then take α in (9) to be simply a variable ranging over all categories. If rule (8) has applied, the resulting string will contain just one primary stress and thus will not fit the required context for (9). Therefore (9) will never apply when α = N, A, or V.

Using familiar notations, we can now formulate the Compound and Nuclear Stress Rules in the following way:

$$(10) \quad \begin{bmatrix} 1 \text{ stress} \\ V \end{bmatrix} \rightarrow [1 \text{ stress}] \; / \; \begin{cases} \text{——} \ldots \overset{1}{V} \ldots]_{NAV} \\ \overset{1}{V} \ldots \text{——} \ldots] \end{cases} \quad \begin{matrix} \text{(a) COMPOUND RULE} \\ \text{(b) NUCLEAR STRESS RULE} \end{matrix}$$

In rule (10), we suppress the variable α. We interpret the rule as a sequence of two rules in accordance with the following quite general convention: a rule of the form (11) is an abbreviation for a sequence of rules of the form (12).

$$(11) \quad X \rightarrow Y \; / \; \begin{Bmatrix} Z_1 \\ Z_2 \\ \vdots \\ Z_n \end{Bmatrix}$$

$$(12) \quad \begin{array}{l} X \rightarrow Y \; / \; Z_1 \\ X \rightarrow Y \; / \; Z_2 \\ \qquad \vdots \\ X \rightarrow Y \; / \; Z_n \end{array}$$

The i^{th} rule of (12) is interpreted as stating that any symbol meeting the condition X acquires the features listed as Y when it is in a context meeting the condition Z_i. In accordance with these conventions, which will be generalized as we proceed, the rules (10a)-(10b) have precisely the same content as the sequence (8)-(9).

The rules so far discussed illustrate two general observations that have proven valid in every careful study of phonological processes that has so far been undertaken within the framework of generative grammar, namely, the following:

(13) It is always possible to order the rules in a sequence and to adhere strictly to this ordering in constructing derivations without any loss of generality as compared to an unordered set of rules or a set ordered on a different principle.

(14) Such linear ordering makes it possible to formulate grammatical processes that would otherwise not be expressible with comparable generality.[4]

[4] We shall see later that certain qualifications are necessary in the formulation of (13) and (14).

The observations (13), (14) are implicit in Bloomfield's "Menomini Morphophonemics" (1939). In Bever (1967), it is shown that the depth of ordering of Bloomfield's grammatical description is at least eleven; that is, from the linear sequence of rules constituting this grammar, a subsequence of eleven rules can be extracted with the property that the grammar becomes more complex if any two successive rules of this subsequence are interchanged in the ordering. In this same sense of depth of ordering, a depth of at least twenty-five is demonstrated in Chomsky (1951).

Neither of these statements is a necessary truth;[5] each represents an interesting and, for the present, reasonably well-confirmed empirical hypothesis. With the modification already stated as the principle of the transformational cycle, we will accept the empirical hypothesis

[5] This fact is sometimes overlooked in the case of (13). To illustrate the empirical character of (13), consider three hypothetical languages L_1, L_2, L_3, each containing the phonological segments *A*, *B*, *X*, *Y* and the lexical entries *ABY*, *BAX*. Suppose, furthermore, that in each of these languages it is a fact that *B* is realized as *X* before *Y* and that *A* is realized as *Y* before *X*. Thus the grammars contain the rules (α) and (β) as the most general statement of the facts:

$$(\alpha)\ B \rightarrow X \ / \ \text{——}\ Y$$

$$(\beta)\ A \rightarrow Y \ / \ \text{——}\ X$$

Suppose now that the lexical entries *ABY* and *BAX* are realized phonetically in the following ways in L_1, L_2, L_3:

In L_1	*ABY* is realized as *YXY*	*BAX* is realized as *BYX*
In L_2	*ABY* is realized as *AXY*	*BAX* is realized as *XYX*
In L_3	*ABY* is realized as *AXY*	*BAX* is realized as *BYX*

The facts of L_1 and L_2 can be accounted for by letting the rules (α) and (β) apply in different orders: in L_1 (α) precedes (β); in L_2 (β) precedes (α). Then in L_1 we will have the derivations of (I) for the lexical entries *ABY* and *BAX*, and in L_2 we will have the derivations of (II) for the same lexical entries:

(I)	*ABY*	*BAX*	
	AXY		BY RULE (α)
	YXY	*BYX*	BY RULE (β)
(II)	*ABY*	*BAX*	
		BYX	BY RULE (β)
	AXY	*XYX*	BY RULE (α)

Hence the hypothetical languages L_1 and L_2 support the empirical generalizations (13) and (14). However, the facts of L_3 cannot be accounted for in this fashion. As we have just seen, neither the ordering (α), (β) nor the ordering (β), (α) will give the result required, namely, that *ABY* is realized as *AXY* and that *BAX* is realized as *BYX*. Nevertheless, rules (α) and (β) state the facts in the simplest and most general way. Therefore the hypothetical language L_3 refutes the empirical hypothesis (13). In fact, L_3 supports a different empirical hypothesis concerning rule ordering, namely, that rules be unordered and that they apply simultaneously, so that each derivation has only two steps. With this convention (call it the "simultaneous application" convention), we have the derivations (III), as required for L_3:

(III)	*ABY*		*BAX*	
	AXY	BY RULE (α)	*BYX*	BY RULE (β)

The simultaneous application hypothesis was first made explicit by Z. S. Harris (1951, Appendix to §14.32), in a discussion of an example from Bloomfield (1939) in which statement (13) was explicitly assumed. It has since been restated several times by Lamb (1964 and elsewhere), who, however, introduced a new element into the discussion by his assumption that the simultaneous application hypothesis is simpler, in some absolute sense, than the hypothesis that rules apply in sequence, in a fixed order. We see no justification for such assumptions about an absolute sense of "simplicity," in this case, nor any relevance to such assumptions if they can be given sense. The issue seems to us an empirical one; that is, the issue is whether the case posited in the hypothetical language L_3 actually is representative of natural language. So far as we know, it is not. On the contrary, the empirical evidence in natural language rules against the hypothetical situation of L_3, and therefore against the simultaneous application hypothesis and in favor of the hypotheses (13), (14). We shall have more to say about this matter as we proceed. In fact, we shall note that there are situations, formally well defined, in which something like the simultaneous application hypothesis is correct, e.g., in the case of rules that switch values of a feature. (See Chapter Eight, Sections 3, 4.) Thus the situation is complex, but, we think, quite clear.

For further discussion, see Chomsky (1964, §4.2; 1967) and Chomsky and Halle (1965).

that the rules are linearly ordered as the basis for the work to be presented here, and will give many examples that support this hypothesis. We assume, then, the following principles:

(15) (a) The rules of the phonological component are linearly ordered in a sequence $R_1, \ldots, R_n$.
(b) Each rule applies to a maximal string containing no internal brackets.
(c) After applying the rule R_n, we proceed to the rule R_1.
(d) Unless an application of R_n intervenes, the rule R_j cannot be applied after the rule R_i $(j < i)$ has applied.
(e) R_n is the rule: erase innermost brackets.

The joint effect of these principles is that the rules apply in a linear sequence to a minimal phrase of the surface structure, then reapply in the same sequence to the next larger phrase of the surface structure, and so on. When we speak of the principle of the "transformational cycle," we are referring to the empirical hypothesis (15). The statement of principle (15) is not yet sufficiently precise to resolve all questions as to how rules apply, and we will sharpen and refine it as we proceed.

In the technical terminology of the theory of generative grammar, the term "grammatical transformation" refers to a rule that applies to a string of symbols by virtue of some categorial representation of this string. We use the term "transformational" in referring to the principle just established since the rules in the cycle are transformational in the usual sense; that is, the domain of their applicability and the manner in which they apply is determined by the phrase structure of a string, not just by the sequence of elementary symbols of which the string is constituted.[6] More specifically, the application of the cyclical rules depends not only upon the formatives in the surface structure but also upon the way they are categorized. For example, the specification of N, A, or V is necessary for determining the applicability of the Compound Rule.

Notice, once again, that the principle of the transformational cycle is a very natural one. What it asserts, intuitively, is that the form of a complex expression is determined by a fixed set of processes that take account of the form of its parts. This is precisely what one would expect of an interpretive principle that applies to phrase markers, in this case, surface structures.[7]

Returning now to actual examples, let us consider the more complex phrases *black board-eraser* ("board eraser that is black"), *blackboard eraser* ("eraser for a blackboard"), and *black board eraser* ("eraser of a black board"), with the stress contours 213, 132, and 312, respectively.[8] Application of the rules discussed to the surface structure of these forms

[6] The rules involved here are, however, transformations of a very narrow and restricted class, the class referred to as "local transformations" in Chomsky (1965).

[7] Observe that the interpretive semantic rules must apply in accordance with essentially the same principle as the one stated here for the phonological rules, as has been pointed out by Fodor and Katz (1963) and by Katz and Postal (1964). The basic semantic rules apply to deep structures rather than to surface structures, however. In a sense the transformational syntactic rules also meet a similar cyclic condition. See Chomsky (1965, Chapter 3) for discussion

[8] Phoneticians might vary slightly in their description of the contours for these phrases. Whether these discrepancies are a matter of fact or of convention is a question to which we will return below. In any event, the matter is of little importance for the present. Our rules could be slightly modified to accommodate different decisions. For example, a slight revision of rule (7) would provide the contour 313 instead of 312 for the last example.

gives us the following derivations (with all occurrences of # suppressed):

(16) (a) $[_{NP}\ [_{A}black]_{A}\ [_{N}\ [_{N}board]_{N}\ [_{N}eraser]_{N}\ ]_{N}\ ]_{NP}$

1	1			RULE (2)
		1		
	1	2		RULE (10a)
2	1	3		RULE (10b)

(b) $[_{N}\ [_{N}\ [_{A}black]_{A}\ [_{N}board]_{N}\ ]_{N}\ [_{N}eraser]_{N}\ ]_{N}$

1	1			RULE (2)
		1		
1	2			RULE (10a)
1	3	2		RULE (10a)

(c) $[_{N}\ [_{NP}\ [_{A}black]_{A}\ [_{N}board]_{N}\ ]_{NP}\ [_{N}eraser]_{N}\ ]_{N}$

1	1			RULE (2)
		1		
2	1			RULE (10b)
3	1	2		RULE (10a)

These derivations illustrate the expository conventions that we will use henceforth. Let us now consider them in detail.

In the case of (16a), in the first cycle primary stress is placed on the minimal phrases *black* and *board*, which are monosyllables and therefore subject to rule (2). Also in the first cycle, primary stress is placed on *eraser* by a rule which we have not yet presented. Innermost brackets are then erased, and we return to the first of the linear sequence of transformational rules. The string now under consideration is (17), this being the only maximal string of (16a) which, at this point in the derivation, contains no internal brackets.

(17) $[_{N}\overset{1}{board}\ \overset{1}{eraser}]_{N}$

Rule (10a), the Compound Rule, is applicable to (17), and assigns primary stress on the first word, giving the stress contour 12 for this string by the conventions established previously. Since (10b) is inapplicable, we conclude this cycle, erasing innermost brackets. The string now under consideration is

(18) $[_{NP}\overset{1}{black}\ \overset{1}{board}\ \overset{2}{eraser}]_{NP}$

Rule (10a) is not applicable to this string, so we turn to rule (10b), the Nuclear Stress Rule, which assigns primary stress to *board*, weakening all other stresses in (18) by one. This gives the contour 213 as the final line of derivation (16a).

The derivation (16b) has the same first cycle as (16a), but for the second cycle, the string under consideration is the noun *blackboard* rather than the noun *board-eraser*. The

Compound Rule assigns to this noun the contour 12. Erasing innermost brackets, we proceed to the next cycle, considering now the noun *blackboard eraser* (whereas at the analogous stage of the derivation (16a), we considered the noun phrase *black board-eraser*). Being a noun, this string is subject to the Compound Rule, so that primary stress is placed on the first word, giving the contour 132.

Now consider the derivation (16c). The first cycle is exactly the same as in the other two derivations of (16). But in the second cycle we consider not the noun *board-eraser*, as in (16a), nor the noun *blackboard*, as in (16b), but the noun phrase *black board*, meaning "board that is black." To this, only the Nuclear Stress Rule applies, placing primary stress on the second word. This concludes the second cycle. In the third cycle we consider the noun *black board eraser*, which at this stage has the contour 211. The Compound Rule (10a) applies to this string, assigning primary stress to the leftmost primary-stressed vowel and weakening all the others. This gives the desired contour 312.[9]

To illustrate the transformational cycle with one more example, consider the noun phrase *John's blackboard eraser*, which undergoes the following derivation (where D stands for the category "determiner"):

(19)

$[_{NP}\ [_{D}John's]_{D}\ [_{N}\ [_{N}\ [_{A}black]_{A}\ [_{N}board]_{N}\ ]_{N}\ [_{N}eraser]_{N}\ ]_{N}\ ]_{NP}$					
1		1	1		RULE (2)
				1	
		1	2		RULE (10a)
		1	3	2	RULE (10a)
2		1	4	3	RULE (10b)

The phrase *blackboard eraser* undergoes the three-cycle derivation (16b); the determiner *John's* receives its primary stress on the first cycle. In the fourth cycle, the string under consideration is the noun phrase *John's blackboard eraser*, with the stress contour 1132. The Nuclear Stress Rule assigns primary stress to the rightmost primary-stressed vowel, weakening all others, and giving the stress contour 2143.[10]

Suppose that the phrase *John's blackboard eraser* appears in the context ——*was stolen*. The whole phrase in this case is a sentence, i.e., is bounded by $[_{S}\ \ldots\ ]_{S}$. The word *stolen* will receive primary stress on the first cycle, and *John's blackboard eraser* will have the derivation (19). In the final cycle, at the level of $[_{S}\ \ldots\ ]_{S}$, primary stress will be placed on *stolen* by the Nuclear Stress Rule, giving *John's blackboard eraser was stolen.*[11]

[9] Though examples (16a) and (16c) may appear somewhat artificial, the reality of the syntactic patterns they illustrate can hardly be doubted. They appear, for example, in such phrases as *American history-teacher*, meaning "American teacher of history," which is analogous to (16a) and has the same stress contour 213; and in *American-history teacher* meaning "teacher of American history," which is analogous to (16c) and also has the stress contour 312 (or 313—see note 8). We assume here that the word *American* receives primary stress on the second syllable, although we have not yet given the rules that determine this. Similarly, the phrases *civil rights bill* and *excess profits tax* are of the form illustrated in (16c), whereas *uncivil game warden* or *excessive profits tax* are of the form illustrated in (16a). There are many other exact or near minimal pairs, e.g., *civil engineering student* ("student of civil engineering" or "polite student of engineering"), *small boys school* ("school for small boys" or "boys' school that is small").

[10] See note 8.

[11] See note 8. To prevent *was* from receiving primary stress by rule (2), we restrict this rule, as a first approximation, to the lexical categories, namely, noun, adjective, verb. We assume, on syntactic grounds, that the auxiliary *be* is not introduced as a member of a lexical category.

Suppose that the phrase *John's blackboard eraser* appears in the context *take*——, the whole constituting a sentence (in this case, an imperative). The word *take* receives primary stress and *John's blackboard eraser* receives the contour 2143 by the derivation (19). In the final stage of the cycle, the Nuclear Stress Rule (10b) places primary stress on *black*, giving the final contour 23154.

These examples show how complex and varied phonetic representations are determined by very simple rules when the principle of the transformational cycle is presupposed; in other words, they illustrate the kind of evidence that can be offered in support of the hypothesis that it is the principle of the transformational cycle that underlies the phonetic interpretation of utterances. Observe that no rules at all are needed beyond those required for the most elementary phrases. The interplay of these rules in more complex phrases is determined by the principle of the transformational cycle, which is, it should be noted, not a rule of English grammar but rather a general principle governing the applicability of phonological rules in any grammar.

Notice that the rules, as presented, assign a different internal stress contour to the phrase *John's blackboard eraser* depending upon whether it appears in subject or object position in the surface structure. In subject position, as in the context ——*was stolen*, the contour of the phrase is 3254, with the same internal relations of stress as in the phrase in isolation, though weakened in each case by one degree. In object position, on the other hand, as in the context *take*——, the contour of the phrase is 3154, with internal relations that are different from those of the phrase in isolation. Similarly, a simple adjective-noun construction such as *sad plight* will have the contour 21 in isolation, the contour 32 in the context *his*——*shocked us*, and the contour 31, with different internal relations, in *consider his*——. As the structure of the sentence becomes more complex, the internal relations of stress within a phrase of this sort will continually be modified. Thus in the sentence *my friend can't help being shocked at anyone who would fail to consider his sad plight*, the surface structure might indicate that the word *plight* terminates no less than seven phrases to which the Nuclear Stress Rule applies, so that successive applications of this rule would give the contour $\overset{8}{sad}\ \overset{1}{plight}$. Presumably, the actual internal relations of stress in *sad plight* are the same, in this case, as in *consider his sad plight*, or even in *sad plight* in isolation.

In connection with this problem, several comments are called for. First, it is very likely that certain readjustment rules of the sort mentioned in Chapter One, page 10, must be applied to surface structures before the application of phonological rules, deleting structure and restricting the number of applications of the transformational cycle (and, consequently, the fineness of stress differentiation). Second, it is necessary to formulate a principle for interpretation of phonetic representations that nullifies distinctions that go beyond a certain degree of refinement. Third, there may very well be additional principles that modify the convention weakening stress when primary stress is placed in a complex construction. Finally, it is necessary to take note of the qualifications with respect to phonetic representation in general that we discuss in the next section.

Before leaving the topic of stress contours within phrases, we should make it quite clear that the rules discussed above give accurate results only for very simple constructions. We have not investigated the problem of determining the stress contours of complex phrases of varying syntactic types; our investigation has been limited to the very restricted types of constructions that have been discussed in the literature on English phonetics and phonology of the past several decades. There is, for the moment, little useful data on more complex

constructions. Such observations as have been made suggest that the problem of extending this description to a wider class of cases may be nontrivial. For example, Stanley Newman, in his important article on English intonation (1946), points out that in the sentence *he has plans to leave*, the contour on *plans to leave* is rising if the meaning is, roughly, "he intends to leave," but is falling if the meaning is "he has documents to leave." It is not at all clear what features of syntactic structure determine this difference. Another class of phenomena not accounted for are those involving obligatory contrastive stress (sometimes stress shift) as determined by syntactic parallelism, as in such sentences as *he wanted to study electrical rather than civil engineering*, or *instead of encouraging the teacher to make the work interesting, the school administrators actually* discourage *her*. Many other problems can be cited, all indicating that many questions of fact and, perhaps, of principle still remain unresolved in this area.

2. *On the reality of phonetic representation*

Utilizing the principle of the transformational cycle, the speaker of English can determine the phonetic shape of an utterance on the basis of such rules as the Compound and Nuclear Stress Rules, even though the particular utterance may be quite new to him. He need not deal with the stress contour as a property of the utterance independent, in whole or in part, of its syntactic organization. There is no doubt that stress contours and many other phonetic properties are determined for new utterances with quite a bit of consistency among speakers. This is a fact that must be accounted for by an empirically adequate grammar. In the case of English we can approach an explanation by incorporating in the grammar such rules as the Compound and Nuclear Stress Rules and by postulating the principle of the transformational cycle. Before going on to investigate the rules of English in greater detail, let us briefly consider the question of how these rules and the general principles that govern their applicability relate to psychological processes and to physical fact.

We might suppose, on the basis of what has been suggested so far, that a correct description of perceptual processes would be something like this. The hearer makes use of certain cues and certain expectations to determine the syntactic structure and semantic content of an utterance. Given a hypothesis as to its syntactic structure—in particular its surface structure—he uses the phonological principles that he controls to determine a phonetic shape. The hypothesis will then be accepted if it is not too radically at variance with the acoustic material, where the range of permitted discrepancy may vary widely with conditions and many individual factors. Given acceptance of such a hypothesis, what the hearer "hears" is what is internally generated by the rules. That is, he will "hear" the phonetic shape determined by the postulated syntactic structure and the internalized rules.

Among the internalized rules are some that are particular to the language in question and thus must have been learned; there are others that simply play a role in setting the conditions on the content of linguistic experience. In the present case, it would be reasonable to suggest that the Compound and Nuclear Stress Rules are learned, while the principle of the transformational cycle, being well beyond the bounds of any conceivable method of "learning," is one of the conditions, intrinsic to the language-acquisition system, that determines the form of the language acquired. If this assumption is correct, we would expect the principle of the transformational cycle to be a linguistic universal, that is, to be consistent

with the empirical facts for all human languages;[12] the Compound and Nuclear Stress Rules, on the other hand, might be in part language-specific.

We do not doubt that the stress contours and other phonetic facts that are recorded by careful phoneticians and that we will study here constitute some sort of perceptual reality for those who know the language in question. In fact we are suggesting a principled explanation for this conclusion. A person who knows the language should "hear" the predicted phonetic shapes. In particular, the careful and sophisticated impressionistic phonetician who knows the language should be able to bring this perceptual reality to the level of awareness, and there is ample evidence that phoneticians are capable of doing this. We take for granted, then, that phonetic representations describe a perceptual reality. Our problem is to provide an explanation for this fact. Notice, however, that there is nothing to suggest that these phonetic representations also describe a physical or acoustic reality in any detail. For example, there is little reason to suppose that the perceived stress contour must represent some physical property of the utterance in a point-by-point fashion; a speaker who utilizes the principle of the transformational cycle and the Compound and Nuclear Stress Rules should "hear" the stress contour of the utterance that he perceives and understands, whether or not it is physically present in any detail. In fact, there is no evidence from experimental phonetics to suggest that these contours are actually present as physical properties of utterances in anything like the detail with which they are perceived. Accordingly, there seems to be no reason to suppose that a well-trained phonetician could detect such contours with any reliability or precision in a language that he does not know, a language for which he cannot determine the surface structure of utterances.

Considerations of this sort lead us to suspect that the question of how highly differentiated the stress contours in a representation should be is of little significance. In a complex utterance with a rich surface structure, the rules outlined in the preceding section will lead to a stress contour of many levels. There may be no empirical sense to the question of whether the resulting representation is correct in full detail. Because of the completely impressionistic character of judgments of relative stress, decisions over a broad range are of little value. It is not at all surprising that there should be great difficulty, within impressionistic phonetics, in determining how many stress levels should be marked and how they are distributed in utterances that exceed a certain degree of complexity. The shape and the degree of differentiation of a stress contour are largely determined by obligatory rules and are therefore below the level of systematically significant representation. Once the speaker has selected a sentence with a particular syntactic structure and certain lexical items (largely or completely unmarked for stress, as we shall see), the choice of stress contour is not a matter subject to further independent decision.[13] That is, he need not make a

[12] In one sense, a general principle counts as a linguistic universal if it is compatible with the facts for all human languages. As linguists, of course, we are concerned not with principles that happen by accident to be universal in this sense, but rather with those that are universal in the domain of all possible human languages, that is, those that are in effect preconditions for the acquisition of language. (See the discussion in Chapter One, p. 4.) Such principles, and such alone, can serve to explain and account for the phenomena of particular languages. The distinction in question is not easy to draw, but is no less crucial for this reason.

Notice, incidentally, that the transformational cycle might apply vacuously in a certain language, in particular if the language has very shallow surface structure. Thus a highly agglutinative language might be expected to offer little or no support for the principle of the transformational cycle, at least within the bounds of a word. This, if true, would be entirely irrelevant to the status of this principle as a linguistic universal.

[13] We assume that the position of emphatic stress is marked in the surface structure, and we neglect matters that we have assigned to the theory of performance (see Chapter One, p. 3).

choice among various "stress phonemes" or select one or another "superfix." With marginal exceptions, the choice of these is as completely determined as, for example, the degree of aspiration. Similarly, a hearer who has grasped the structure and morphemic constitution of an utterance from a rough sampling of the physical input need not attend to stress variation, to whatever extent this may actually be a physical property of utterances.

It is to be expected that determined phonetic features should be quite difficult for the user of the language to learn to identify, whether they involve stress or degree of aspiration (where undoubtedly there are many levels, predictable, at least roughly, by general rules).[14] The apparent ease with which phoneticians trained in the same conventions can, to a large extent, agree on the assignment of four or five stresses in utterances may very well be traceable to their ability, as speakers of the language, to grasp the syntactic structure of utterances and to assign to them an "ideal" stress contour by the rules of the transformational cycle. Such an achievement may have little to do with any physical fact. This is, incidentally, a matter which should be subject to experimental investigation.[15]

To summarize this discussion of phonetic representation, we do not doubt that representations of stress contours and similar predictable phenomena correspond, up to a point, to some perceptual reality that can be brought to consciousness with training and care. That this must be true is shown by the fact that phoneticians trained in the same system of conventions can reach considerable agreement in transcribing novel utterances in languages that they know. These perceptual facts may be of interest only to the extent that they provide data for testing empirical hypotheses such as the principle of the transformational cycle. Accordingly, perceived stress contours are of very great linguistic interest since they offer evidence bearing on this hypothesis, whereas degree of aspiration will be of no linguistic interest if, as one might suspect, it is determined by principles of little depth or generality. Furthermore, the representation of the perceptual facts is likely to be governed in part by arbitrary convention or irrelevant cognitive limitations after a certain degree of complexity is reached. Thus, it is impossible to expect (and, for purposes of investigating linguistic structures, unnecessary to attain) a complete correspondence between the records of the impressionistic phonetician and what is predicted by a systematic theory that seeks to account for the perceptual facts that underlie these records.

3. *The transformational cycle within the word*

Let us return now to the problem of how the phonological component of a grammar is organized, and the more specific matter of the rules of English phonology. In the derivations given in Section 1, we did not provide rules for determining stress placement in the word *eraser* or, for that matter, in any word that is not a monosyllable (see rule (2)). In fact, it is evident that *eraser* is itself a complex form based on the verb *erase* and an agentive

[14] As noted, there is no acoustic evidence to support the view that perceived stress contours correspond to a physically definable property of utterances. However, even if such differentiations did exist along a single dimension of the acoustic signal, there would be some reason to doubt that they might be identified by phoneticians. There is evidence that even under experimental conditions, where complex stimuli are to be sorted along several dimensions, more than two or three distinctions along each dimension will overload the perceptual capacity. See Pollack and Ficks (1954) and Miller (1956).

[15] P. Lieberman (1965) has shown that a phonetician who is capable of describing a pitch contour with great accuracy in isolation may represent this very same contour quite differently when it is associated with an utterance of his language. This strongly suggests that what the phonetician "hears" in utterances depends very heavily on internalized rules that predict perceived phonetic shape. Similar results were obtained for stress.

affix. Thus, at the level where phonological rules of the kind we are now considering become applicable, the structure of this item is something like (20):[16]

(20) $$[_{N}\#\ [_{V}\#erase\#]_{V}\ r\#]_{N}$$

If the principle of the transformational cycle is perfectly general, then this word too should have more than one cycle in its derivation. The rules should first apply to the underlying verb *erase* and then, in the next cycle, to the noun *eraser*. The verb *erase* is bisyllabic, and we see that stress is placed on the second syllable. As a first approximation to the rule of stress placement for lexical items, we can formulate the rule (21), which places primary stress on the final vowel of the string under consideration where this item is a noun, adjective, or verb. The symbol C_0, as before, stands for a string of zero or more consonants.

(21) $$V \rightarrow [1\ \text{stress}] \ / \ X \text{ —— } C_0]_{NAV}$$

Notice that rule (21) now includes, as a special case, rule (2), which placed primary stress on the only, hence final, vowel of a monosyllabic item. We can thus dispense with rule (2), and the rules of stress placement become rules (21), (10a) and (10b) (the Compound and Nuclear Stress Rules), and (7), which appears to be quite marginal.

There is a difficulty, however. If these rules apply in a cycle, rule (21) will be applicable to nouns such as *blackboard*, *blackboard eraser*, and so on, incorrectly assigning primary stress to the final vowel. We must therefore place some restriction on rule (21) to eliminate this possibility. The simplest way to do this is to require that the string to which (21) is applied must contain no occurrences of the boundary #. We therefore add to rule (21) the condition (22):

(22) X contains no internal occurrence of #.

With rule (21) replacing rule (2), we have provided sufficient information to complete the derivations that were given as examples of the operation of the transformational cycle. In the first stage, rule (21) applies to assign primary stress to the final vowel of each of the items *black*, *board*, *John*, *erase*. The second cycle will be vacuous in the case of *John's* or *eraser*, stress simply being reassigned to the stressed vowel.[17] Otherwise, the derivations proceed as before.

The transformational cycle operates within word boundaries in a much more far-reaching and extensive way than suggested by examples such as these. In complex derivational forms, for example, it seems quite natural to suppose that the phonetic shape of the full form is determined by general rule from the ideal representation of its parts in much the same way as in syntactic constructions. Investigation of English and other languages confirms this expectation and permits us to formulate the principle of the transformational cycle in full generality, applying to all surface structure whether internal or external to the word. The word is, as we shall see, a significant phonological unit, but its unique properties do not lead to violation of the general principle of the transformational cycle. We assume, then, that the cycle operates from the minimal units included in (or, in special cases, constituting) words up to the maximal domain of phonological processes, with no discontinuity.

[16] On the placement of # boundaries, see Chapter One, pages 12–14.

[17] We shall see that the reason for the inapplicability of any rules in the second cycle of these forms is actually quite different from what is suggested here. In both cases it is the # boundary preceding the affix which blocks all phonological rules that would otherwise be applicable.

4. The segmental phonology of English—a first approximation

We have described the phonological component as a system of rules, organized in accordance with the principle of the transformational cycle, which maps surface structures into phonetic representations, where a surface structure is a labeled bracketing of a string of formatives. Furthermore, we have been assuming that the formatives can themselves be regarded as strings, consisting of consonants and vowels. The lexicon, which is a part of the syntactic component of the grammar, determines the intrinsic structure of a formative in terms of phonological properties: in particular, the lexicon determines how a formative is represented as a string of consonants and vowels. We will refer to the consonants and vowels that constitute a formative as its "segments." The phonological rules modify the segmental structure of a string of formatives in accordance with the specified labeled bracketing. At the termination of the transformational cycle, all labeled bracketing has been erased, and we are left with a string of phonological elements which we will also refer to as segments, in this case "phonetic segments." These segments too can be analyzed as consonants and vowels of various types. We assume that linguistic theory includes a universal phonetic alphabet—of a sort that we will later describe in detail—which provides a uniform, language-independent system for the representation of phonetic segments. In brief, then, the phonological component maps a surface structure into a string of universal phonetic segments.

Let us for the moment assume a standard phonetic system for the representation of consonants and turn our attention to the system of English vowels.

For our immediate purposes, we may regard a formative as a string of consonants and "vocalic nuclei." The vocalic nuclei may be "simple," as in the boldface positions of *pit*, *pet*, *pat*, *put*, *putt*, *analyze*. We will use the phonetic symbols i, e, æ, u, ʌ, ə, respectively, for these simple vocalic nuclei, delaying a more detailed analysis until later. The segment represented as ə will be referred to as the "reduced vowel."

In addition to simple vocalic nuclei, there are "complex vocalic nuclei," such as those that appear in the boldface positions in *confide*, *feed*, *fade*, *feud*, *road*, and others. For the time being, we will use the symbols *I*, *E*, *A*, *U*, *O*, respectively, for the complex nuclei of the cited forms; that is, we use each capital letter with its conventional name as its phonetic value.

Following this convention, we will have quasi-phonetic spellings such as the following:

(23)

erase	$\mathrm{Er\acute{A}s}$
irate	$\mathrm{Ir\acute{A}t}$
mutation	$\mathrm{mUt\acute{A}\check{s}\partial n}$
ecumenical	$\mathrm{\grave{e}kU\acute{m}enik\partial l}$[18]
cupidity	$\mathrm{kU\acute{p}iditE}$
citation	$\mathrm{sIt\acute{A}\check{s}\partial n}$
maintain	$\mathrm{mAnt\acute{A}n}$
collapse	$\mathrm{k\partial l\acute{æ}ps}$

[18] Or, perhaps, [$\mathrm{\grave{e}kU\acute{m}en\partial k\partial l}$]. As indicated in the Preface, we will generally follow the phonetic representations of Kenyon and Knott, which agree quite well with our own normal speech in most respects. Although there are some differences which we will comment on later, none of them are very crucial, and for the moment we can ignore them.

The representation of other vocalic nuclei and a more detailed analysis of all of these elements will concern us in later chapters. We will discover, in fact, that the representations just proposed are somewhat more than a mere notational convenience.

In terms of the above notions, we can distinguish between "weak clusters" and "strong clusters" in the following way. A weak cluster is a string consisting of a simple vocalic nucleus followed by no more than one consonant; a strong cluster is a string consisting of either a vocalic nucleus followed by two or more consonants or a complex vocalic nucleus followed by any number of consonants. In either case, the cluster is assumed to be followed either by a vowel or by the boundary symbol # (with possible intrusions of the + boundary). These definitions will be emended and made more precise later on.

Using the symbol S for a strong cluster and W for a weak cluster, we can see that the items of (23) are phonetically of the following form in terms of clusters (with initial consonants omitted):

(24)

Er$\overset{1}{\text{A}}$s	SS
Ir$\overset{1}{\text{A}}$t	SS
mUt$\overset{1}{\text{A}}$šən	SSW
$\overset{3}{\text{e}}$k$\overset{1}{\text{U}}$menikəl	WSWWW
k$\overset{1}{\text{U}}$piditE	SWWS
sIt$\overset{1}{\text{A}}$šən	SSW
mAnt$\overset{1}{\text{A}}$n	SS
$\overset{1}{\text{k}}$əlæps	WS

5. *More on the transformational cycle within the word*

We can now proceed to deepen the account of stress placement within words. Rule (21), the only rule given so far that places stress within words, assigns primary stress to the final vowel of the string under consideration. Thus it assigns primary stress to the final syllable of words such as *evade*, *supreme*, *exist*, *absurd*. Observe, however, that all these examples have final strong clusters phonetically. In fact, if a verb or adjective has a final weak cluster, then stress is placed on the penultimate rather than the final syllable. Thus we have words such as $\overset{1}{\textit{relish}}$, $\overset{1}{\textit{covet}}$, $\overset{1}{\textit{develop}}$, $\overset{1}{\textit{stolid}}$, $\overset{1}{\textit{common}}$, $\overset{1}{\textit{clandestine}}$, all with penultimate stress and final weak clusters.[19] These observations suggest that rule (21) should be divided into two cases, the first assigning primary stress to the vowel preceding a final weak cluster, the second assigning primary stress to the final vowel of the string under consideration. We can give this rule in the following form:

(25)

$$V \rightarrow [1 \text{ stress}] \; / \; X \text{——} C_0(W)]$$

where X contains no internal occurrences of # (see condition (22)) and W is a weak cluster. We interpret (25) as an abbreviation for two rules, in accordance with the general convention that a rule of the form (26), with a string in parentheses, is an abbreviation for the

[19] Exceptions to the rules we are now sketching will readily come to mind. To a considerable extent they will be taken care of by the more careful formulation given in the next chapter. Exceptions do remain, however. (See the Preface on the subject of exceptions.)

Notice that the rule we are discussing here is, in effect, the familiar Latin stress rule.

sequence of rules (27) (where either Z or Q contains ——):

(26) $$X \rightarrow Y \;/\; Z(P)Q$$

(27) (a) $X \rightarrow Y \;/\; ZPQ$
(b) $X \rightarrow Y \;/\; ZQ$

The order in (27) is crucial: in a sequence of rules abbreviated by the parenthesis notation, as in (26), the case (27a) that includes the string in parentheses is applicable before the case (27b) without the parenthesized string. In accordance with these conventions, rule (25) is an abbreviation for the two rules (28a) and (28b), in that order:

(28) (a) V → [1 stress] / X —— C_0W]
(b) V → [1 stress] / X —— C_0]

Words such as *relish*, *develop*, *common*, with final weak clusters, are subject to (28a) and receive penultimate stress. Words such as *evade*, *supreme*, *exist*, with final strong clusters, are not subject to (28a) and receive stress on the final syllable by (28b).

There is one additional condition to be noted in connection with rule (25). Suppose that we apply this rule to a word with a final weak cluster, such as *edit*. By case (28a), primary stress is placed on the penultimate syllable, giving $\overset{1}{edit}$. But then, by case (28b), primary stress will be shifted to the final syllable and the first syllable will be weakened to [2 stress], resulting in the incorrect form $*\overset{2}{edit}\overset{1}{}$. The simplest and most general way to avoid this is to establish a condition on the parenthesis convention itself. In fact, in all descriptive work in generative grammar with which we are familiar, it has been tacitly assumed that in the case of a rule such as (26), the two subcases (27a) and (27b) are ordered not only as shown, but are "disjunctively ordered," in the sense that if rule (27a) applies, then rule (27b) is not permitted to apply. Thus a sequence of rules abbreviated in terms of the parenthesis notation constitutes a disjunctively ordered block; as soon as one of these rules is applied, the remaining rules are skipped within any one cycle of a derivation. We now establish this as a general convention with regard to the parenthesis notation, to be extended and generalized as we proceed. We thus extend the general theory of the organization of a grammar expressed in the principle of the transformational cycle, by observing that certain subsequences of the linearly ordered rules may be disjunctively ordered. To return to the rules we have been discussing, the two cases (28a) and (28b) abbreviated by (25) will be disjunctively ordered, and the difficulty noted at the beginning of this paragraph will not arise; once case (28a) has applied to give the correct form $\overset{1}{edit}$, then case (28b) is prevented, by the principle of disjunctive ordering, from applying to that form.

Like other general conditions on the organization of a grammar, the convention just proposed constitutes an empirical hypothesis subject to refutation by linguistic fact. The hypothesis is, in this case, that if a sequence of rules is to be abbreviated by the parenthesis convention,[20] then this sequence forms a disjunctively ordered block. Obviously, this is not a necessary truth, by any means.

[20] The question of when a sequence of rules is to be abbreviated by the parenthesis convention is not a matter of choice but rather one of fact. That is, the convention regarding parentheses is just one part of an evaluation procedure to be applied to grammars. This procedure is perfectly general (language-independent) and performs the function of determining which of the grammars consistent with the data is to be selected as the grammar of the language for which the data provide a sample. For discussion, see Chomsky (1965) and many earlier references.

The matter of defining "optimal representation" is nontrivial. In the ensuing discussion we make certain tacit assumptions about "optimality" that will be explored further in Chapter Three, Section 1. See Chomsky (1967) for further discussion.

It is not to be expected that an absolutely crucial test case for this hypothesis will be very easy to come by. In any real case, there will presumably be other aspects of a grammatical description which, if modified, will allow this hypothesis to be retained in the face of superficially disconfirming evidence. This is the usual situation when an empirical hypothesis of such generality is at issue. Still, it is quite clear what sort of evidence is relevant to increasing or diminishing the plausibility of the hypothesis.

Returning now to the problem of stress assignment, we see at once that rule (25) requires refinement and elaboration if it is to account for the facts. Each of the examples given to illustrate the rule contains just a single formative. Where a word has an internal analysis in terms of formatives, rule (25) must apply in a slightly different way. To see this, consider the derived forms *person*+*al*, *theatr*+*ic*+*al*, *anecdot*+*al*, *dialect*+*al*. If rule (25) were to apply directly to these forms, it would assign primary stress to the penultimate syllable (the final cluster *-al* being weak), giving **personal*, **theatrical*, *anecdotal*, *dialectal*, only the last two of which are correct. Notice that all four words would be assigned primary stress in the correct way by rule (25) if the affix *-al* were excluded from consideration at the point when the rule is applied. The residual forms *person-* and *theatric-*, with final weak clusters, would have primary stress assigned to their penultimate syllables by case (28a); the forms *anecdOt-* and *dialect-*, on the other hand, would be exempt from (28a) because of their strong final clusters and would instead have primary stress assigned to the final syllable by case (28b). This observation is in fact quite general for affixes, and we therefore replace rule (25) by the following sequence of rules:

(29)
(a) V → [1 stress] / X —— C_0(W)+affix]
(b) V → [1 stress] / X —— C_0(W)]

Clearly there is a generalization being missed by the formulation (29), for the obvious similarity between the two cases is not expressed. To permit us to capture generalizations of this sort, we extend our notations to permit rules such as (30):

(30) $$X \rightarrow Y \;/\; Z\text{——}R \;/\; P\text{——}Q$$

In general, a rule of the form (31) can be regarded as an abbreviation for the rule (32), where Z and R are strings:[21]

(31) $$X \rightarrow Y \;/\; Z\text{——}R$$

(32) $$ZXR \rightarrow ZYR$$

Following this convention, we interpret (30) as an abbreviation for (33), where Z and R are strings:

(33) $$ZXR \rightarrow ZYR \;/\; P\text{——}Q$$

This is now a rule of a familiar form. Reapplying the convention that defines (31) in terms of (32), we interpret (33) as an abbreviation for (34):

(34) $$PZXRQ \rightarrow PZYRQ$$

[21] We will give more precise definitions of these notions in Chapter Eight. For the present, one can think of rule (31) (equivalently, (32)) as stating that a linguistic element of the form X is extended to contain the features Y (or is modified to contain Y, if Y differs in some respect from X) when this element of the form X appears in a context of the form Z—— R. There are ambiguities in this account; they will be resolved later, and are not of the sort that should lead to misunderstanding in the present context.

Thus, when Z and R are strings, the notation (30) is well-defined. Suppose, however, that Z and R are not strings, but notations of any complexity, including braces, parentheses, and so on. Then it would not do to say that (31) is an abbreviation for (32); rather, (31) is an abbreviation for the sequence of rules (35), determined by the conventions for braces, parentheses, etc. The sequence (35) is then an abbreviation for the sequence (36), by the convention just stated.

(35)
$$\begin{Bmatrix} X \rightarrow Y \;/\; Z_1 \text{——} R_1 \\ X \rightarrow Y \;/\; Z_2 \text{——} R_2 \\ \vdots \\ X \rightarrow Y \;/\; Z_m \text{——} R_m \end{Bmatrix}$$

(36)
$$\begin{Bmatrix} Z_1XR_1 \rightarrow Z_1YR_1 \\ Z_2XR_2 \rightarrow Z_2YR_2 \\ \vdots \\ Z_mXR_m \rightarrow Z_mYR_m \end{Bmatrix}$$

This leaves us with only the problem of explaining the meaning of (30) in the case when Z and R involve notations such as braces and parentheses. Since (31), in this case, is an abbreviation for (35) (ultimately, (36)), the conventions already given will interpret (30) as an abbreviation for (37):

(37)
$$\begin{Bmatrix} X \rightarrow Y \;/\; Z_1 \text{——} R_1 \\ X \rightarrow Y \;/\; Z_2 \text{——} R_2 \\ \vdots \\ X \rightarrow Y \;/\; Z_m \text{——} R_m \end{Bmatrix} \;/\; P \text{——} Q$$

The above can be seen to be (35) (or, equivalently, (36)) in the context P——Q. By the usual brace conventions, we can now interpret (37) as an abbreviation for (38):

(38)
$$\begin{Bmatrix} X \rightarrow Y \;/\; Z_1 \text{——} R_1 \;/\; P \text{——} Q \\ X \rightarrow Y \;/\; Z_2 \text{——} R_2 \;/\; P \text{——} Q \\ \vdots \\ X \rightarrow Y \;/\; Z_m \text{——} R_m \;/\; P \text{——} Q \end{Bmatrix}$$

In (38), each Z_i and R_i is a string of symbols, so that (38) is itself interpretable by the convention that gives (30) as an abbreviation for (33).

We see, then, that there is a very natural way of interpreting familiar conventions so that a rule of the form (30) has, in effect, the following intuitive meaning: first, expand the context P——Q, in accordance with the brace and parenthesis conventions, into the sequence of its special cases P_1——$Q_1, \ldots, P_k$——Q_k; next, apply the rules abbreviated as $X \rightarrow Y \,/\, Z$——R in the usual sequence, under the condition that the element ZXR under consideration is in the context P_1——Q_1; next, apply the same rules under the condition that the element ZXR is in the context P_2——Q_2; etc.

With these notational remarks, we can return to the generalization left unexpressed in rule (29) which can now be captured by the following rule:

(39)
$$\text{V} \rightarrow [1 \text{ stress}] \;/\; X \text{——} \text{C}_0(\text{W}) \;/\; \text{——}(+\text{affix})]$$

where W is a weak cluster, C_0 is a string of zero or more consonants, and X does not contain an internal # boundary.[22] Our conventions interpret (39) as an abbreviation for

[22] Actually, the affix must be restricted to a glide or to a monosyllabic formative with a simple vocalic nucleus, for reasons that will be developed in the next chapter.

the following sequence of rules:

(40)
$$\begin{array}{llll} \text{(a)} & \text{V} \rightarrow & \text{[1 stress]} & / \; X\text{——}\text{C}_0\text{W}+\text{affix}] \\ \text{(b)} & \text{V} \rightarrow & \text{[1 stress]} & / \; X\text{——}\text{C}_0+\text{affix}] \\ \text{(c)} & \text{V} \rightarrow & \text{[1 stress]} & / \; X\text{——}\text{C}_0\text{W}] \\ \text{(d)} & \text{V} \rightarrow & \text{[1 stress]} & / \; X\text{——}\text{C}_0] \end{array}$$

The parenthesis convention proposed earlier imposes the following ordering conditions on (40a–d): (1) the order of application is (a), (b), (c), (d), as given; (2) if case (a) applies, then case (b) is inapplicable; (3) if case (c) applies, then case (d) is inapplicable; (4) if either case (a) or case (b) applies, then cases (c) and (d) are inapplicable. Summarizing, the convention implies that the ordering of (40) is totally disjunctive; if one case applies, then all later cases are skipped.

In forms such as *person+al* and *theatr+ic+al*, case (a) of rule (40) assigns primary stress in the antepenultimate syllable. Case (b) of (40) applies to words such as *dialect+al* and *anecdOt+al*, assigning primary stress in the penultimate position, which contains a strong cluster. Cases (c) and (d) are simply the two cases of rule (25); they apply to such words as *edit* and *develop*, assigning penultimate stress, and to words such as *evade* and *supreme*, assigning primary stress in the final syllable. Rule (39) thus expresses in a precise way the linguistically significant generalization that underlies this class of examples.

Notice that some of these examples involve more than one cycle. The word *theatrical*, for example, is clearly derived from *theater*, which will receive primary stress on the initial syllable in the first cycle (by a rule which will be given in the next chapter); thus, in isolation the stress will be in that position. But in the second cycle, the stress is shifted to the second (antepenultimate) syllable by rule (39). We thus have the derivation (41). (Recall that we assume all formatives to be automatically bounded by +, by convention. We therefore need not indicate all occurrences of this boundary in a derivation.)

(41)
$$[_{\text{A}}\,[_{\text{N}}\textit{theatr}]_{\text{N}}\,\textit{ic}+\textit{al}]_{\text{A}}$$

1	(RULE TO BE GIVEN)
21	RULE (39), CASE (40a)

The stress on the first syllable is then weakened as a special case of rules that we will go into later.

Suppose that we have a still more complex form such as *theatricality*, for example. For this form, the same rules provide the following derivation:[23]

(42)
$$[_{\text{N}}\,[_{\text{A}}\,[_{\text{N}}\textit{theatr}]_{\text{N}}\,\textit{ic}+\textit{al}]_{\text{A}}\,\textit{i}+\textit{ty}]_{\text{N}}$$

1		(RULE TO BE GIVEN)
21		RULE (39), CASE (40a)
32	1	RULE (39), CASE (40a)

[23] The analysis of *-ity* as *i+ty* might be disputed, but it seems well motivated on morphological grounds. There is, first of all, a noun-forming affix *-ty* (*loyalty*, *novelty*, etc.) Furthermore, the forms in *-ity* often have other derived forms with affixes beginning with *-i* (*sanctity–sanctify–sanctitude*, *clarity–clarify*, etc.), which suggests that *-i-* is a stem-forming augment. We shall see, in fact, that there are good reasons to suppose that no affixes are polysyllabic.

As rule (39) is stated, this analysis of *-ity* is necessary. From considerations presented in the next chapter, however, it can be shown that even if *-ity* were to be analyzed as a single formative, the rules would still provide the derivation (42). Therefore, in this instance at least, phonological considerations do not require the analysis into two formatives.

There is a generally accepted convention to the effect that secondary stress appears within a word only if it is the main stress within that word. Accordingly, we add the following rule:

(43) Within a word, all non-main stresses are weakened by one.

The exact status of this rule, which we will call the Stress Adjustment Rule, is a matter to which we will return below. We will see, in fact, that it becomes a special case of the Nuclear Stress Rule (10b), when the latter is properly formulated. The Stress Adjustment Rule (43) converts *theatricality* to *theatricality*, which we can take to be the phonetic representation for this word up to the degree of detail we have discussed so far.

In the same manner, rule (39) assigns stress contours to many complex forms, in accordance with the principle of the transformational cycle. We can thus account for a substantial class of cases in a very simple and general way.

Actually, rule (39) may be extended somewhat further. Consider pairs of words such as:

(44)

phótograph	*photosýnthesis*
mónolith	*monománia*
télescope	*telekinésis*
prótoplasm	*protozóa*

Each of the forms consists of a prefix (*photo-*, *mono-*, *tele-*, *proto-*) followed by a stem (which may, in certain cases, function as an independent word). With minimal assumptions about surface structure, *photograph*, for example, will be represented $[_{N}photo\ [_{STEM}graph]_{STEM}\ ]_{N}$. In a case like *photosynthesis*, the bracketing will be the same, but *synthesis* will be labeled as a noun rather than a stem.

We note that primary stress falls on the prefix if the stem is monosyllabic,[24] and on the stem if the stem is polysyllabic. Though this observation will be modified slightly when a larger class of cases is considered, it can be accepted as a first approximation. We notice further that stress placement on the prefix is in accordance with rule (39); that is, by case (40c) (= (28a)), primary stress is assigned to the syllable preceding the final weak cluster of the prefix. (For reasons which appear below, the final vowel of *photo*, *mono*, etc., is lexically lax though in some positions it is phonetically tense.)

Using these observations and the assumed surface structure, we can account for the forms in (44) with a rule that accomplishes the following. After primary stress has been assigned to the stem (or inner noun) in the first cycle, it will be shifted left to the prefix if the stem (or inner noun) is a monosyllable, that is, if the form has a final stressed syllable when it enters the second cycle. For example, *photograph* will enter the second cycle as *photograph*, with a final stressed syllable, and our new rule will then shift the stress back to give *photograph*. The form *photosynthesis*, on the other hand, will enter the second cycle as *photosynthesis*; since the syllable that is stressed is not final, the new rule will not apply and the stress will remain on the inner noun. We can now proceed to formulate the rule as follows:

(45) $$V \rightarrow [1\ \text{stress}] \ / \ X \text{——} C_0(W) \ / \ \text{——} \acute{\Sigma}]$$

[24] We are using the term "monosyllabic" in a phonological, not a phonetic, sense in this context. Thus *plasm* is phonologically monosyllabic (cf. *plasma*) but phonetically bisyllabic, since postconsonantal nasals become syllabic in final position.

where W is a weak cluster and $\acute{\Sigma}$ a stressed syllable, that is, a string of the form $C_0\overset{1}{V}C_0$. Making minimal assumptions about surface structure, as before, this provides derivations such as (46):

(46)

$[_N photo\ [_{STEM} graph]_{STEM}\ ]_N$		
1		RULE (39), CASE (40d)
1	2	RULE (45)
1	3	RULE (43)

Where the stem (or inner noun) is polysyllabic, the stressed syllable will not be final and rule (45) will not apply. This accounts for the fact that in the examples in the right-hand column of (44), primary stress remains on the stem (or inner noun).[25]

Before proceeding to investigate other applications of rule (45), we can observe that it obviously falls together with rule (39). Combining (39) and (45), then, we have the following rule:

(47) $$V \rightarrow [1\ \text{stress}] \ / \ X\text{——}C_0(W) \ / \ \text{——}(\begin{Bmatrix}+\text{affix}\\ \acute{\Sigma}\end{Bmatrix})]$$

where W is a weak cluster, C_0 is a string of zero or more consonants, $\acute{\Sigma}$ is a syllable of the form $C_0\overset{1}{V}C_0$, and X does not contain # boundary internally. We will henceforth refer to this rule, with its various elaborations, as the Main Stress Rule, since it is the main rule applying to lexical categories. We return to this matter in Chapter Three.

In accordance with our notational conventions, rule (47) is an abbreviation for the sequence of rules:

(48)

(a) $V \rightarrow [1\ \text{stress}] \ / \ X\text{——}C_0W\text{+affix}]$
(b) $V \rightarrow [1\ \text{stress}] \ / \ X\text{——}C_0\text{+affix}]$
(c) $V \rightarrow [1\ \text{stress}] \ / \ X\text{——}C_0W\acute{\Sigma}]$
(d) $V \rightarrow [1\ \text{stress}] \ / \ X\text{——}C_0\acute{\Sigma}]$
(e) $V \rightarrow [1\ \text{stress}] \ / \ X\text{——}C_0W]$
(f) $V \rightarrow [1\ \text{stress}] \ / \ X\text{——}C_0]$

Cases (a), (b), (e), (f) are, respectively, cases (a)–(d) of (40). As before, they constitute a disjunctively ordered block; if one of the four cases of (40) applies, none of the later ones is applicable. Furthermore, the notational conventions that we have given imply that if case (48c) applies, then case (d) is inapplicable, and that if either case (c) or (d) applies, then cases (e) and (f) are inapplicable. There are no further disjunctive constraints. The only permitted sequences of applicable rules, then, are the following:

(49)

(a), (c)
(a), (d)
(b), (c)
(b), (d)

Apart from these possibilities, at most one of the rules of (48) can apply. The order in which they become applicable is, aside from this restriction, the linear order of (48). These empirical assumptions follow from the general hypothesis regarding notations and the fact that (47) is the optimal representation of the processes so far discussed (see note 20).

[25] We have not yet given the rules that assign primary stress to these stems and inner nouns in the first cycle.

Before we continue with the analysis of English stress placement, let us make quite clear the status and character of our assumptions concerning the organization of grammars and the conditions on the applicability of grammatical rules. We have, so far, placed the following conditions on the grammar. The grammar is a linear sequence of rules of the form illustrated in (48), applying in accordance with the principle of the transformational cycle (see (15)). The relation of disjunctive ordering is defined on certain pairs of rules of this sequence by virtue of their formal similarities. To determine disjunctive ordering, we apply to the fullest possible extent the notational conventions involving parenthesization, bracketing, and the slash-dash notation defined as in (30)–(34). In this way we form an underlying schema which represents this sequence of rules and which is expandable into this sequence by the successive application of conventions involving the notations. (When this process is formalized later in our discussion, we will guarantee that the order of expansion is unique.) If at some stage in the expansion we reach a schema of the form $Z(X)Y$, expandable into the sequence of schemata ZXY, ZY, then all rules derived by expanding ZXY (or ZXY itself, if it is a rule) are disjunctively ordered with respect to all rules derived by expanding ZY (or ZY itself, if it is a rule). In this way, disjunctive ordering is defined on the rules of the sequence constituting the grammar. Notice that rules may be disjunctively ordered with respect to one another even if they are not adjacent in the ordering; for example, in (48), rule (a) is disjunctively ordered with respect to rule (f), but not with respect to rule (c).

The conventions associated with disjunctive ordering make use of the notations for stating grammatical schemata in a way that is rather novel within the theory of generative grammar. In earlier work these notations have been regarded solely as part of the system for evaluating grammars. They have been proposed as an explication of the notion "linguistically significant generalization"; the degree of linguistically significant generalization attained by a grammar—its "simplicity," in a technical sense of the term—is measured by the number of symbols appearing in the underlying schema that expands to this grammar by the use of the notations. (See Chomsky (1965) and many earlier references for discussion.) But now we are also making use of the notations to determine how the rules apply, in particular, to determine disjunctive ordering. That is to say, we are proposing that certain formal relations among rules, statable in terms of the notations that are used for the evaluation of grammars, are significant in determining how the grammar generates derivations. If the empirical hypothesis embodied in the definition of "disjunctive ordering" is correct, then this fact offers a powerful argument in support of the empirical reality of the evaluation procedures that have been developed within the theory of generative grammar, as it has evolved in recent years.

We can now return to the role of the Stressed Syllable Rule, as we shall henceforth refer to it—namely, cases (c) and (d) of the Main Stress Rule. We will refer to cases (a) and (b) of (48) as the Affix Rule.

Consider now the following sets of words:

(50)

torment^{1}	*torment*$^{1\ 3}$	*torrent*^{1}
convict^{1}	*convict*$^{1\ 3}$	*verdict*^{1}
export^{1}	*export*$^{1\ 3}$	*effort*^{1}
progress^{1}	*progress*$^{1\ 3}$	*tigress*^{1}

The words in the left-hand column are verbs, with stress on the final syllable; those in the other two columns are nouns, with primary stress on the penultimate syllable. Comparing the words in the middle column with those in the right-hand column, we can see that they

differ in the degree of stress on the final syllable and, concomitantly, in the quality of the final vocalic nucleus, which is reduced to [ə] in the right-hand column but not in the middle column.

We can account for the nouns in the middle column, that is, those with stress contour 1 3, by regarding them as derived from the corresponding verbs. Thus we view the relation between *torment* and *torment* as roughly analogous to the relation between *advertisement* and *advertise* or *impression* and *impress*. We then have derivations such as the following:

(51)

$[_N\,[_V$*torment*$]_V\,]_N$	
1	RULE (47), CASE (48f)
1 2	RULE (47), CASE (48d)
1 3	RULE (43)

In the first cycle, the Main Stress Rule applies to the underlying verb, assigning primary stress in the final strong cluster. Since the verb undergoes no further applications of the Main Stress Rule, in isolation it retains primary stress in this position. But the derived noun must undergo a second application of the Main Stress Rule, in accordance with the principle of the transformational cycle. In this application, the Stressed Syllable Rule applies, shifting primary stress to the left. Secondary stress on the final syllable is then weakened to tertiary by the Stress Adjustment Rule, giving the contour 1 3. The distinction between the elements of the left and middle columns of (50) can thus be attributed to the extra cycle in the derivation of the nouns. The distinction between the elements of the middle and right columns can be attributed to the fact that the right-hand elements are not derived from associated verbs and therefore have never received primary stress on the final syllable.[26] In this way, the Stressed Syllable Rule accounts for a distinction between tertiary and zero stress in the final syllables of pairs such as *torment–torrent*, *export–effort*.[27]

We have not yet explained why stress falls on the final syllable of the verb *progréss* in (50), even though this contains a weak cluster. As we will show in Chapter Three, Section 10, we must assume there to be a special boundary in such verbs—between *pro* and *gress* in this case—which blocks the application of (48e) in the first cycle but not of (48d) in the second cycle. Thus the derivation of the noun *prógress* from the underlying verb *progréss* will be identical to that of *tórment* in (51).

We have now seen two rather different effects of the Stressed Syllable Rule. In the case of *photograph* versus *photosynthesis*, it accounts for the distinction between a falling

[26] We have not yet given the rule that determines stress placement in nouns such as those of the right-hand column of (50). The fact is that in nouns, as distinct from verbs and adjectives, a final syllable with a simple vocalic nucleus is disregarded for purposes of stress placement, and the Main Stress Rule is then applied to the residue in the usual way. Thus, for nouns, a final syllable with a simple vocalic nucleus is treated in the same way as an affix and a stressed syllable by rule (47). We do not give this rule here because it involves certain assumptions with respect to notations and ordering that we prefer, for expository reasons, to leave for the next chapter. The facts are clear, however. By extending the Main Stress Rule in this way, we can account for the fact that primary stress appears in the penultimate syllable in the nouns of the rightmost column of (50), as well as in words such as *phlOgíston* and *horÍzon*, which have a strong medial cluster; that it appears in the antepenultimate syllable in words such as *vénison*, *cánnibal*, *élephant*, with a weak medial cluster and simple vocalic nucleus in the final syllable; and that it falls on the final syllable (by rule (48f)) in words such as *machíne*, *careér*, which have a complex vocalic nucleus in the final syllable.

[27] Observe that in the case of *torrent*, we know that the vowel of the final syllable is *e* (cf. *torrential*). In the case of *effort* there is no way of determining the phonological quality of the underlying vowel, which need not, therefore, be specified in the lexical entry for this formative.

and a rising contour for the prefix-stem combination, exactly as in the case of the noun *export* versus the verb *export*; in the case of *export* versus *effort* or *torment* versus *torrent*, it accounts for the difference between tertiary and zero stress in the final syllables.

Consider now words such as:

(52) (a) *relaxátion, annexátion, emendátion, connectívity, domestícity, authentícity*
(b) *devastátion, demonstrátion, contemplátion, opportúnity*

Observe that in each case the cluster preceding the primary stress is of the form VC_2 and is therefore a strong cluster, and that in each case this syllable has a weak stress.[28] However, the vowel quality is retained in the syllable preceding primary stress in the examples of (52a) but is lost in the same position in the examples of (52b). This distinction is clearly traceable to the fact that the examples of (52a) are derived from underlying forms in which this vowel has primary stress, whereas the examples of (52b) are derived from underlying forms in which this vowel is unstressed. Thus we have derivations such as the following:[29]

(53) (a) $[_N\,[_V relax]_V\ At+ion]_N$

1	RULE (47), CASE (48f)
2 1	(SEE NOTE 29)
2 3 1	(SEE NOTE 29)
3 4 1	RULE (43)

(b) $[_N\,[_V devastAt]_V\ ion]_N$

1 2	(SEE NOTE 29)
2 1	(SEE NOTE 29)
3 1	RULE (43)

Although certain details are not given in these derivations, there is still sufficient information to account for vowel quality in the weak-stressed syllable preceding primary stress. It is clear that the process of vowel reduction depends in a fundamental way on stress; in particular, a vowel that is sufficiently stressed, in some sense that we will make precise later, is protected from vowel reduction. Thus the degree of stress on the final syllable of *torment* (see derivation (51)) is sufficient to prevent vowel reduction, but that on the final syllable of *torrent* is not. Similarly, the second syllable of *relaxation*, having received primary stress in the first cycle, is immune to vowel reduction, but the second syllable of *devastation*, never having received any stress, does undergo the process of vowel reduction. In this way, we can account quite readily for the distinction between the examples of (52a) and (52b).

For some dialects (in particular, our own), we can find near minimal pairs to illustrate these far-reaching phonetic effects of the rules of the transformational cycle. Consider,

[28] Here, as elsewhere, we rely on the phonetic representations in Kenyon and Knott, which agree with our own pronunciation, with the provisos stated elsewhere. The stress on the syllable preceding primary stress cannot be stronger than [4 stress] in any of these cases, since the first syllable in each case has tertiary stress and the second (pre-main-stress) syllable is clearly weaker than the first. We would give the contour 3415 for (52a) and 3515 for (52b).

[29] These derivations involve various principles that will not be discussed until the next chapter. In particular, the affix *-ion* invariably places stress on the syllable immediately preceding it, and there is a rule changing a ˘21 contour to 231, as a special case of more general processes that we will discuss. We also omit here the rules that assign the proper stress contour 1˘2 (which would become 1˘3 by the Stress Adjustment Rule) to *devastAt* in the first cycle. Filling in these omissions will lead to no change in the analysis of the facts under discussion here.

for example, the words *compensation–condensation.*[30] In *condensation*, the vowel in the second syllable has received stress in the first cycle of the derivation because of the underlying verb *condense*: therefore, it does not reduce, and we have the phonetic representation [kandensÁšən]. The corresponding vowel of *compensation*, never having received stress, is subject to vowel reduction, resulting in the phonetic representation [kampənsÁšən].

To conclude this preliminary discussion of the principles that determine stress contours and the related phenomenon of vowel reduction, let us turn to the set of words in English that have the noun-forming affix *-y* (not to be confused with the adjective-forming *-y* of such words as *stringy* and *brawny*, which has very different phonetic effects and a different underlying representation). This is the affix that we find in such words as *aristocrac+y*, *econom+y*, *galax+y*. Before turning to its effect on stress placement, let us consider its phonological representation.

Phonetically, this affix is either [i] or [E], depending on the dialect; that is, it is a high front vowel of dialectally varying degree of tenseness and diphthongization. The tenseness and diphthongization give no information about the underlying phonological representation since there are no relevant contrasts in this position. As we shall see in the next chapter, even phonologically nontense vowels (i.e., simple vocalic nuclei) become tense and diphthongized in final position in the dialects in question. But, in fact, we do know that phonologically the affix cannot consist of a complex vocalic nucleus [E] if it is to be subject to the Main Stress Rule (47), since the cases of this rule that involve affixes, as we shall see, are restricted to affixes with simple vocalic nuclei.

With this possibility eliminated, let us now ask whether the affix *-y* can be phonologically represented as the simple vocalic nucleus *i*. An argument against this analysis is provided by consideration of the stem-forming vowel [i], which, along with the parallel stem-forming vowel [u], appears in the derived forms of pairs such as *proverb–proverbial*, *professor–professorial*, *habit–habitual*, *tempest–tempestuous*. The underlying forms must be represented in the lexicon in such a way as to indicate that they take the stem-forming augment [i] or [u] in their derived forms. A natural, and apparently the simplest, proposal is to enter these words in the lexicon in the form *professor+i*, *habit+u*, etc., with the augment deleted in final position by rule (54):

$$(54) \qquad \begin{Bmatrix} i \\ u \end{Bmatrix} \rightarrow \phi \; / \; + \text{——} \; \#$$

But if this suggestion is followed, then words such as *economy* cannot be entered with the representation *econom+i* for the affix will be incorrectly deleted in final position by rule (54).

These considerations suggest that the representation of the affix *-y* in lexical entries should be *+y*. That is, it should be entered as a high front glide, which later becomes a

[30] The latter is the nominalized verb that means "act of condensing," not the noun that means "a condensed state or form" or "a condensed mass" and that, although in some way related to the verb *condense*, is not derived from it as is *condensation* in the first sense. Kenyon and Knott give only the form with unreduced second syllable for *condensation*, and give both reduced and unreduced variants for *compensation*, as well as for the underlying form *compensate*. There is well-known dialectal divergence in these positions. In general, with respect to phonetic minutiae of this sort, it is impossible to expect complete consistency between speakers or for one speaker at various times. Nor should it necessarily be assumed that the transcriptions suggested by phoneticians, at this level of detail, correspond in any very clear way to an acoustic reality. As pointed out in Section 2 of this chapter, we are concerned here with ideal forms that may undergo various modifications in performance and that may relate more closely to a perceptual than an acoustic reality.

vowel by an extremely simple rule. We shall see, in fact, that the required rule converting *y* to *i* falls together with other rules that are needed on independent grounds. Thus, in terms of its analysis into vowels and consonants, the word *economy* is of the phonological form VCVCVCC, consistent, in fact, with the orthographic representation.

Adopting this quite well-motivated proposal, let us now turn to the effect of the affix *-y* on stress placement. We have already provided one quite general rule describing the effect of an affix on the assignment of primary stress, namely, cases (48a) and (48b) of the Main Stress Rule (47). But the affix *-y* does not seem to fall under this generalization, as we can see by considering data of the sort presented in (55), where the symbols W, S, and A stand for syllables terminating in weak, strong, and arbitrary clusters, respectively, and where the formula to the left of the colon describes the underlying form of the examples to the right:

(55)
(a) ÁW+*y*: *economy*, *policy*, *aristocracy*
(b) #ÁS+*y*: *industry*, *galaxy*, *modesty*
(c) ÁWS+*y*: *orthodoxy*, *testimony*, *rhinoplasty*, *promissory*, *auditory*
(d) AŚS+*y*: *advisory*, *compulsory*, *refractory*, *trajectory*[31]

The examples of case (a) are in fact consistent with the assumption that *-y* is simply a regular affix subject to the Affix Rule that is part of the Main Stress Rule (47). Since the syllable preceding the affix contains a weak cluster, case (48a) of (47) will assign primary stress to the syllable preceding this cluster, in the usual way. The examples of (55b), however, appear to be inconsistent with this assumption. If *-y* were subject to the Affix Rule, then primary stress would be placed on the strong cluster immediately preceding the affix, in accordance with case (48b) of rule (47), whereas in these examples primary stress is actually on the syllable preceding this strong cluster. Examples such as these might lead one to suggest another rule, unique to the suffix *-y*, namely, the rule that this suffix places primary stress on the syllable preceding it by two. Under such a rule, the examples of (55a) and (55b) would be accounted for.

The forms in (55c), however, show at once that this new proposal is incorrect. In these examples, primary stress is three syllables removed from the affix *-y*, and there is an unexplained tertiary stress on the syllable immediately preceding this affix (a syllable which, we observe, contains a strong cluster). We cannot simply add a special case requiring that stress be three syllables removed when *-y* is preceded by a strong cluster, for this possibility is excluded by the examples of (55d).

With no further attempt at patchwork solutions, let us see how close we can come to the facts by making the weakest and most general assumption, namely, that *-y* is simply a regular affix obeying the Main Stress Rule as it now stands.

As we have already noted, the examples of (55a) are consistent with this analysis. That is, the affix *-y* will now, like all affixes, assign stress to the syllable preceding a final weak cluster.

Consider next the examples of (55b). Under the assumption that *-y* is a regular affix, case (48b) of the Main Stress Rule (47) will place primary stress on the final syllable of the string preceding *-y*, since this syllable contains a strong cluster. This gives, for example, the form *industry*. Recall that according to the ordering constraints on the subcases (48a–f)

[31] We assume here that these words have the same affix *-Or+y* as *promissory*, *auditory*. Other analyses might be suggested for many of these words, taken in isolation, but the analyses we are supposing are at least as well motivated, on grounds independent of stress placement, as any others. We shall see directly that considerations of stress placement strongly support the analyses proposed here.

of rule (47), after (48b) has applied, case (c) or (d) may still be applied (see (49)). Case (48d) applies to a string of the form $VC_0\acute{\Sigma}]$, where $\acute{\Sigma}$ is a stressed syllable, assigning primary stress to the vowel. But, as we have noted above, the affix *-y* is a glide in the underlying representation. Hence $\overset{1}{industry}$ is a string of the form $VC_0\overset{1}{V}C_0]$, which is a special case of $VC_0\acute{\Sigma}]$. Case (48d) thus applies to $\overset{1}{industry}$, giving the stress pattern $\overset{1}{ind}\overset{2}{ustry}$, after which the Stress Adjustment Rule applies to give $\overset{1}{ind}\overset{3}{ustry}$. Other rules, to which we return below, determine that a tertiary-stressed vowel in the context of the $\overset{3}{u}$ of $\overset{1}{ind}\overset{3}{ustry}$ loses its stress and reduces. This gives the desired stress pattern. The examples of (55b), then, are quite consistent with the assumption that *-y* is a regular affix.

Consider now the forms of (55c), which, as we have noted, are inconsistent with the assumption that *-y* places primary stress two syllables back. Taking *orthodoxy* as a typical example, the Main Stress Rule, as it stands, provides the following derivation:

(56)

$$[_N\,[_A ortho\,[_{STEM} dox]_{STEM}\,]_A\,y]_N$$

	1	RULE (47), CASE (48f)
1	2	RULE (47), CASE (48c)
2	1	RULE (47), CASE (48b)
1	2	RULE (47), CASE (48c)
1	3	RULE (43)

In the first cycle, primary stress is placed on the monosyllabic stem *dox* (exactly as it is placed on the monosyllabic stem *graph* in the derivation (46) of *photograph*). In the next cycle we consider the adjective $\overset{1}{orthodox}$. The Stressed Syllable Rule (48c) places primary stress on the syllable preceding the weak cluster, again exactly as in the case of *photograph*. Thus, in isolation, the adjective would have the stress contour $\overset{1}{ortho}\overset{3}{dox}$ (the Stress Adjustment Rule weakening the final stress to tertiary). But in (56) there is still another cycle. In this third cycle, primary stress is assigned by the Affix Rule (48b) to the syllable with the strong cluster preceding the affix. The result is a string terminating with the stressed syllable $\overset{1}{doxy}$, a syllable of the form $\overset{1}{C}VCCC$. Hence the Stressed Syllable Rule (48c) applies once again, as it did in the preceding cycle, reassigning primary stress to the first vowel. The Stress Adjustment Rule (43) now applies to give the desired form $\overset{1}{ortho}\overset{3}{doxy}$. The other examples of (55c) are similar. In sum, these forms are consistent with the assumption that *-y* is a regular affix. The examples in (55d) are derived in a manner parallel to that of (55b), with case (48d) of the Stressed Syllable Rule applying on the last pass through the transformational cycle.

We see, then, that by taking the affix *-y* to be nonvocalic phonologically, all of the cases of (55) are explained on the assumption that it is a perfectly regular and unexceptional affix subject to the general Main Stress Rule. This fact alone would motivate the representation of the affix *-y* as a glide in underlying forms, but, as we have seen, there is independent support for this conclusion. The peculiar arrangement of data noted in (55) follows from this assumption, with no modification of the general rules. Here, then, is a striking example of the effectiveness of the principle of the transformational cycle, in conjunction with the principle of disjunctive ordering, in explaining otherwise quite refractory data.

Other forms in *-y* support these conclusions. Before turning to them, however, let us consider the following:

(57) *invéstigative, génerative, illústrative, demónstrative*

Clearly these have the underlying forms:

(58) *invéstigAt, génerAt, íllustrAt, démonstrAt*

But notice that the affix *-ive* should assign primary stress to the final strong syllable *-At*, in each case, giving the incorrect forms **investigátive*, **generátive*, **illustrátive*, **demonstrátive*. What actually happens is that the affix *-ive* assigns primary stress to the syllable immediately preceding *-At* if that syllable has a strong cluster, or one syllable further back if the syllable preceding *-At* has a weak cluster. In other words, primary stress is assigned just as if the affix were not *-ive*, but rather *-Ative*. In fact, we shall see that in general the element *-At* is considered to be a part of the affix for the purposes of stress placement. We can achieve this effect by reformulating the Main Stress Rule (47) as:

(59) $$V \rightarrow [1\ \text{stress}] \ / \ X\text{——}C_0(W) \ / \ \text{——}((At)\begin{Bmatrix}+\text{affix}\\ \acute{\Sigma}\end{Bmatrix})]^{32}$$

To resolve an ambiguity in the expansion of the schema (59), let us assume, as a general principle, that braces are expanded before parentheses. With this assumption, schema (59) expands to (60), which is then expanded to a sequence of rules in the usual way.

(60) $$V \rightarrow [1\ \text{stress}] \ / \ X\text{——}C_0(W) \ / \ \text{——}\begin{pmatrix} At+\text{affix}] & \text{(a)}\\ +\text{affix}] & \text{(b)}\\ At\ \acute{\Sigma}] & \text{(c)}\\ \acute{\Sigma}] & \text{(d)}\\ ] & \text{(e)}\end{pmatrix}$$

Disjunctive ordering holds between (60a) and (60b), between (60c) and (60d), and between each of (60a)–(60d) and (60e).

Let us consider the effect of this slight modification of the rule on examples with the affix *-y*. We will now have typical derivations such as (61) and (62), for *confíscatory* (similarly, *compénsatory*, *refórmatory*, etc.) and *antícipatory* (similarly, *revérberatory*, *concíliatory*, etc.), respectively:

(61) $[_A\ [_V confiscAt]_V\ Or+y]_A$

1	2			(RULES TO BE GIVEN)
2	3		1	AFFIX RULE (60b)
3	1	4	2	STRESSED SYLLABLE RULE (60c)
4	1	5	3	RULE (43)

(62) $[_A\ [_V anticipAt]_V\ Or+y]_A$

1	2			(RULES TO BE GIVEN)
2	3		1	AFFIX RULE (60b)
1	4		2	STRESSED SYLLABLE RULE (60c)
1	5		3	RULE (43)

The two derivations correspond point by point. In both cases the stress contour is assigned to the underlying verb by rules that we will give later on. The verbs, in isolation, would be $\overset{1}{confiscate}$, $\overset{1}{anticipate}$. In the second cycle, the Affix Rule shifts primary stress to the strong

[32] Notice that the ordering implied by the use of parentheses carries over to this case, as we would expect. Thus, if the Affix Rule applies in the context $\text{——}\overset{1}{At+ive}$ (giving, e.g., $\overset{1}{illustrAtive}$), it is not permitted to reapply in the context $\text{——}\overset{2}{ive}$ (giving $*\overset{1}{illustrAtive}$).

syllable immediately preceding the affix *-y*, in the usual way. At this point the Stressed Syllable Rule applies, under the modification (59)-(60)—that is, with the element *-At* regarded as part of the context of application rather than as subject to the application of the rule. Excluding *-AtOry* from consideration in this way, the rule assigns primary stress to the final strong syllable of the residual string *confisc-* in (61), and to the syllable preceding the final weak syllable of the residual string *anticip-* in (62). Stress is then weakened and vowels reduced in accordance with fairly straightforward rules to which we will return. Here, again, the various cases of the Main Stress Rule interact to generate some rather complex phonetic structures, in accordance with the general principle of the transformational cycle and the general empirical assumptions regarding ordering that we have formulated.

6. *Particular and universal grammar*

In Section 2, on the basis of some preliminary observations about stress contours in English, we suggested that certain principles of organization of a grammar might serve as preconditions for language acquisition, and we discussed some questions of psychological and physical fact relating to this assumption. Now, after a more detailed account of English stress contours, the tentative conclusions of Section 2 have been strengthened.

We have seen that simple rules applying under very general conditions can explain data of a rich and varied sort. This fact raises interesting and important questions. To facilitate the discussion of these questions, we can invoke a traditional distinction between "particular grammar" and "universal grammar." A particular grammar for a single language is a compendium of specific and accidental (that is, nonessential) properties of this language. A universal grammar is a system of conditions that characterize any human language, a theory of essential properties of human language. It is reasonable to suppose that the principle of the transformational cycle and the principles of organization of grammar that we have formulated in terms of certain notational conventions are, if correct, a part of universal grammar rather than of the particular grammar of English. Specifically, it is difficult to imagine how such principles could be "learned" or "invented" in some way by each speaker of the language, on the basis of the data available to him.[33] It therefore seems necessary to assume that these principles constitute a part of the schema that serves as a precondition for language acquisition and that determines the general character of what is acquired. While the general principles of organization of a grammar that we have been discussing can most plausibly be regarded as part of universal grammar, it seems that such rules as the Main Stress Rule must, in large part at least, be a part of the particular grammar of English. A reasonable tentative assumption, then, is that the Nuclear Stress Rule, the Compound Rule, and the Main Stress Rule must be learned by the child acquiring the language, whereas the conditions on the form of rules, the principle of the transformational cycle, and the principles of organization embodied in the various notational conventions that we have established are simply a part of the conceptual apparatus that he applies to the data.

[33] Furthermore, insofar as phonetic transcription corresponds to a perceptual rather than an acoustic reality —see Section 2—departures from the rules are undetectable. Quite apart from this, it is difficult to imagine that adults, whose perceptual set is extremely strong and whose phonetic acuity is very limited, could note and correct deviations in low-level phonetic forms even where these do have a direct counterpart in the physical shape of the utterance.

The Nuclear Stress Rule, the Compound Rule, and the Main Stress Rule, in its various cases, assign primary stress in certain positions. A very small body of data concerning the position of primary stress in simple utterances is sufficient to justify these rules. Correspondingly, a small body of data of this sort might be sufficient to enable the language learner to postulate that these rules form part of the grammar of the language to which he is exposed. Having accepted these rules, the language learner can now apply the general principles of universal grammar to determine their effects in a wide variety of cases. As we have seen, very simple rules can have extremely complex effects when applied in accordance with these general principles. The effects in themselves might well be undetectable by the native speaker or the language learner. When they are determined by a framework of internalized general principles, they become quite accessible to him.

Phonetically untrained speakers of a language seem to find it quite easy to determine the position of main stress in simple utterances, but extremely difficult to trace complex stress contours in a detailed and consistent way. There is, furthermore, some doubt as to the physical reality of these contours, although there is no doubt that with phonetic training, a speaker of the language can identify stress contours and other phonetic details with reasonable consistency. These observations are just what we would expect, given the assumptions to which we have tentatively been led about universal and particular grammar. A small body of data relating to the position of main stress can lead to the formulation of the major stress placement rules. Their effects in complex utterances are determined by the universal unlearned principles of organization of a grammar. There is no need for the speaker or hearer to attend to these automatically determined aspects of an utterance, even where they are physically real; but with training, they can be brought to the level of awareness, whether or not they have acoustic reality. In particular, stress contours can be "heard" with a fair degree of consistency even though they may not correspond in detail to any physical property of utterances.

7. *On the abstractness of lexical representation*

The syntactic component of the grammar contains a lexicon which lists lexical items with their inherent properties, in particular, those phonological properties that are not determined by general rule. The considerations of the preceding sections suggest that these underlying forms will in general contain no indication of the stress contour of the items or of the distinction between reduced and unreduced vowels. In these respects the lexical representation of an underlying form will be very different from the phonetic representations of its variants in particular contexts. As we investigate further, we will find many more dramatic examples of this discrepancy between underlying forms and their phonetic realizations.

In note 26, we pointed out that the placement of primary stress in nouns is governed by the following rule (where V_s is a simple vocalic nucleus):

$$(63) \qquad V \rightarrow [1 \text{ stress}] \ / \ X \text{——} C_0(W) \ / \ \text{——} V_s C_0]_N$$

This rule clearly falls together with the general Main Stress Rule, in a way which we will examine in the next chapter. As pointed out in note 26, it accounts for the stress placement in words such as *vénison*, *horÍzon*, *élephant*. To assign primary stress in these words, we

disregard the final simple vocalic nucleus with the consonants following it, and assign primary stress to the penultimate syllable of the residue if its final cluster is weak or to this final cluster itself if it is strong. Thus the rule is of precisely the sort with which we are now familiar. If the final syllable of a noun contains a complex vocalic nucleus, then rule (63) is inapplicable, and case (48f) of the Main Stress Rule applies in the usual way, placing primary stress in the final syllable of such words as *machíne*, *careér*.

Superficially, words ending in vowels seem to contradict this rule. Thus, in words such as *country*, *menu*, *window*, the final vocalic nucleus is complex (namely, *E*, *U*, *O*, respectively) in many dialects. Nevertheless, it does not receive stress. This seems difficult to explain within our present framework until we observe that there is no contrast between simple and complex vocalic nuclei in word-final position (see p. 39). Consequently, there is no barrier to representing words such as *country*, *menu*, *window* in the lexicon with simple vocalic nuclei in final position. This will then make the forms subject to rule (63), which excludes the final syllable from consideration and then assigns primary stress to the residue in the usual way. A later rule will then determine the quality of the word-final vocalic nucleus. This later rule is well motivated, apart from any question of stress placement. Hence these words do not contradict rule (63).

Further investigation of final unstressed vowels reveals that there is a peculiar gap in the pattern. We do not at this point in the exposition have the means to justify this remark, but we will be able to show that of the six simple vocalic nuclei that might appear in final position, only *i*, æ, *u*, *o*, and ɔ do in fact appear. There are no examples with *e* as the final vowel of the lexical representation.

With these observations as background, let us return to the problem of stress placement. Consider the words *ellipse*, *eclipse*. If the lexical representation were *elips*, *eklips*, then rule (63) would apply, eliminating the final syllable from consideration (since it contains a simple vocalic nucleus) and assigning primary stress to the first syllable, giving **Élips*, **Éklips* as the phonetic forms. Recall, now, the remarks of the preceding paragraph. Suppose that we were to assign to these words the lexical representations *elipse*, *eklipse*, respectively. Rule (63) will exclude the final simple vocalic nucleus *e* from consideration and will assign primary stress to the strong cluster that precedes it, giving *elípse*, *eklípse*. To obtain the correct phonetic forms, we now add the *e*-Elision Rule (64) to the grammar:

$$(64) \qquad e \rightarrow \phi \; / \; \text{——} \; \#$$

This rule gives the correct final forms. It also explains the gap noted in the preceding paragraph. We see now that this gap is not in the underlying lexical representations but only in the phonetic output.

Rule (64), as we shall see, has independent motivation apart from the considerations just mentioned. As one further example, consider the word *Neptune* with the phonetic representation [néptUn].[34] The final cluster of the phonetic representation is strong and hence should receive primary stress by the Main Stress Rule. We cannot simply add a final *e* in the lexical representation here, as we did in the preceding examples, for if we were to enter *Neptune* in the lexicon as *neptUne*, primary stress would still be placed on the second syllable, this time by rule (63). The only apparent alternative is to enter *Neptune* with the lexical representation *neptune*, that is, with the simple vocalic nucleus *u* in the second syllable. Rule (63) will now assign primary stress in the first syllable since the

[34] We overlook dialectal variants for the time being.

second syllable contains a weak cluster. We now add the rule (65) (where C is a single consonant):

(65) $$u \rightarrow U \;/\; \text{——}CV$$

We thus have the following derivation:

(66)

neptune	
1	RULE (63)
U	RULE (65)
ϕ	RULE (64)

The final phonetic form is [néptUn], as required.

Rule (65) is, in fact, justified on independent grounds. Thus we find only phonetic [U], and not the other phonetic reflexes of underlying *u*,[35] in the context ——CV (e.g., *music*, *mutiny*, *mural*).

Here, as in the forms discussed previously in this section, we are again led to an underlying representation which is quite abstract (and which, once again, corresponds directly to conventional orthography).

Consider next verbs such as *caréss* and *haráss*.[36] The final syllable of the phonetic representations for these forms has a stressed weak cluster, which is contrary to what is asserted by the Main Stress Rule (47). Suppose, however, that we were to provide these words with the lexical representations *kVress*, *hVræss*, with V here standing for an unspecified simple vocalic nucleus.[37] The two final consonants now make the final cluster strong, and case (48f) of the Main Stress Rule will apply to assign primary stress on this final strong cluster. To obtain the correct forms, we need another rule, which we shall call the Cluster Simplification Rule, to delete one of the *s*'s:

(67) The first of two identical consonants is deleted.[38]

This gives us [kərés], [hərǽs] as the phonetic forms, eliminating another apparent exception to the stress placement rules.

Once again, we find that the rule that we postulate (in this case, rule (67)) is well motivated on independent grounds, as we see from considerations such as the following. Consider first words such as *cunning*, *currency*, and *mussel*, in which the phonetic reflex of underlying *u* in the first syllable is [ʌ] rather than [U] (see note 35). According to rule (65), underlying *u* should give phonetic [U] in the context ——CV, as in *punitive*, *mural*, *music*, and so on. We can prevent the application of this rule to forms like *cunning* by assuming double consonants in the underlying representations. These will then simplify by rule (67). Alternatively, we would have to assume a contrast between *u* and *U* in underlying representations. This is highly implausible, not only because of the examples already noted that motivate rule (65), but also because of the system of vowel alternations that we shall describe.

Observe next that in the near pair *music–mussel*, noted above, the form with phonetic [U] has a voiced medial consonant, whereas the form with phonetic [ʌ] has an unvoiced

[35] The simple vocalic nucleus *u* of underlying lexical representations generally becomes phonetic [ʌ] before consonants by general rules that we will describe later.

[36] The latter, with the phonetic representation [hərǽs]. An alternative form, [hǽrəs], will derive from the lexical representation *hærVs*.

[37] We return later to the precise content of this remark.

[38] Notice that this rule is not, strictly speaking, formulable within the framework that we have established up to this point. We will return to this matter.

medial consonant. Thus the contrast is between [Uz] and [ʌs] in intervocalic position. This correlation is general. We can account for it by postulating a rule that voices [s] medially, this rule applying prior to (67):

(68) $$s \rightarrow [+\text{voice}] \quad / \ V \text{——} V$$

Given the rule (68), which we will make more exact later on, we have the derivations (69):

(69)

musik	*mussel*	
U		RULE (65)
	ʌ	(SEE NOTE 35)
z		RULE (68)
	ϕ	RULE (67)

The rule (68) is independently motivated by many considerations. Compare, for example, pairs such as *resent–consent*, *resist–consist*, in which the initial consonant of each of the stems *-sent* and *-sist* voices intervocalically but not postconsonantally. Such examples give even more direct justification for rule (67)—the rule deleting the first of two identical consonants. Thus consider words such as *dissemble*, *dissent*, with the prefix *dis-* (cf. *distrust*, *disturb*, etc.) and a stem beginning with *s*. Evidently, rule (67) is required to account for the fact that the medial cluster is phonetically a single consonant [s]; it is protected from voicing by (68) because of the final *s* of the prefix, in contrast with *resemble*, *resent*, etc. Similarly, we must rely on rule (67) to account for the fact that the prefix *ex-* is phonetically [ek] when the stem begins with an [s], as in *exceed* versus *extend*. Thus, several considerations converge to support the analysis proposed.

Consider next words such as *radium*, *medial* versus *radical*, *medical*. These examples have the complex nuclei [A], [E] in the context ——C*i*V, and the simple nuclei [æ], [e] in the context ——C*i*C. A great many examples of this sort, which we shall study in detail below, lead us to postulate rules which have the following effect (where C is a single consonant):

(70) $$\begin{Bmatrix} æ \rightarrow A \\ e \rightarrow E \end{Bmatrix} \ / \text{——CiV}$$

Notice that where the vowel in question is followed by a double consonant (*calcium*, *compendium*), it is not subject to rule (70) and therefore remains simple.

We now proceed to words such as *potassium*, *gymnasium*, *magnesium*. As in the case of *music–mussel*, we find that where we have unvoiced [s], here in the context ——*i*V, the vocalic nucleus preceding it is simple, but where we have voiced [z], the vocalic nucleus preceding it is complex. We can now account for this arrangement of data with underlying forms and derivations much like the following:

(71)

potæssium	*gimnæsium*	
	A	RULE (70)
	z	RULE (68)
ϕ		RULE (67)

Once again, we rely on rule (67), among others, in accounting for the relevant data.

Finally, notice that words such as *confetti*, *Mississippi*, *Kentucky* appear to violate rule (63), which assigns stress in the antepenultimate syllable of a noun that ends in a simple vocalic nucleus preceded by a weak cluster. We can avoid this violation of the rule by giving the lexical representations *kVnfetti*, *mississippi*, *kVntukki*, respectively. The penultimate syllable, being strong, will now take primary stress by rule (63). The double consonants

prevent the voicing of [s] by rule (68) and the change of *u* to [U] by rule (65). Rule (67) then simplifies them, as before. In further support of this analysis, we observe that, quite generally, medial obstruent clusters are unvoiced in English; correspondingly, in the positions where a double consonant must be postulated to account for peculiarities in stress placement, consonant quality, and vowel quality, as in the examples of this paragraph, it is with rare exceptions an unvoiced obstruent that appears.

To recapitulate, the *e*-Elision Rule (64), the Cluster Simplification Rule (67), and the others that we have discussed here form a mutually supporting system of rules that can be justified in a variety of independent ways and that account for a fairly extensive array of data. These rules lead us to postulate underlying forms which are quite abstract. Furthermore, these abstract underlying representations are, in general, very close to conventional orthography.

We will conclude with two more examples. Consider the word *giraffe*, phonetically [ǰəræf]. Here we have a stress on the final weak cluster. We can explain this by postulating the underlying lexical representation *giræffe*. The rule (63) of stress placement assigns primary stress to the penultimate syllable. By *e*-Elision and Cluster Simplification (note again that an unvoiced cluster is involved) we derive [giræf]. Clearly we must have a rule that softens *g* to [ǰ] (and *k* to [s]) before nonlow front vowels, with qualifications to be added later.

(72) $$\begin{Bmatrix} g \\ k \end{Bmatrix} \rightarrow \begin{Bmatrix} ǰ \\ s \end{Bmatrix} \; / \; \underline{\quad} \begin{Bmatrix} i \\ e \end{Bmatrix}$$

With rule (72) and the general rule of Vowel Reduction, we derive [ǰəræf], as required. Alternatively, we might take the underlying representation to be *ǰVræffe*; there are other possibilities for deriving the phonetic form by regular processes.

Finally, consider the words *courage* [kʌ́rəǰ] and *courageous* [kə́rʌǰəs]. Superficially, these seem to contradict the rules of stress placement and vowel quality that we have presented in this chapter. Suppose, however, that we were to take the underlying form to be *koræge*.[39] On this assumption, we have the following derivations:

(73)

koræge	*koræge+əs*	
1		RULE (63)
	1	RULE (47), CASE (48a)
	A	RULE (70)[40]
ǰ	ǰ	RULE (72)
ϕ	ϕ	RULE (64)[41]
ʌ		(SEE NOTE 39)
ə ə	ə	(VOWEL REDUCTION)

[39] In our discussion of the Rounding Adjustment Rule in Chapter Four, we shall show that lax back vowels become unrounded under certain conditions. A consequence of this rule is the shift $o \rightarrow ʌ$, where [ʌ] is regarded as a lax unrounded back mid vowel, differing from [o] only in not being rounded.

Incidentally, a better representation would be *coræge*, where *c* stands for a symbol identical in its feature composition to *k* except that it appears in a lexically designated class of forms that undergo certain syntactic and phonological processes (i.e., they take derivational affixes of the Romance and Greek systems and undergo rules such as (72)). We return to this matter at the end of Chapter Four.

[40] Actually, we generalize (70) so that it applies in the context —— CαV, where α is a nonlow front vowel or glide, that is, [i], [e], [ɪ], [ē], or the corresponding glides. This is a simplification of the rule, in our terms, as we shall see.

[41] We generalize rule (64) so that it elides final *e* not only before word boundary, but also before any formative boundary. This, too, is a simplification in our terms, as we shall see.

In the case of *courage*, in isolation, primary stress is placed by the Noun Rule (63); in the case of *courageous*, by the Affix Rule (47), in the familiar way. The second syllable of *courageous* becomes a complex nucleus by rule (70), before the nonlow front vowel followed by another vowel. The consonant *g* then softens to [j] by rule (72), and the final *e* is elided. Vowel Reduction then gives the desired forms. Once again, a quite abstract underlying form, very similar to conventional orthography, accounts for the variant forms by rules of great generality and wide applicability.

There is, incidentally, nothing particularly surprising about the fact that conventional orthography is, as these examples suggest, a near optimal system for the lexical representation of English words. The fundamental principle of orthography is that phonetic variation is not indicated where it is predictable by general rule. Thus, stress placement and regular vowel or consonant alternations are generally not reflected. Orthography is a system designed for readers who know the language, who understand sentences and therefore know the surface structure of sentences. Such readers can produce the correct phonetic forms, given the orthographic representation and the surface structure, by means of the rules that they employ in producing and interpreting speech. It would be quite pointless for the orthography to indicate these predictable variants. Except for unpredictable variants (e.g., *man–men*, *buy–bought*), an optimal orthography would have one representation for each lexical entry. Up to ambiguity, then, such a system would maintain a close correspondence between semantic units and orthographic representations. A system of this sort is of little use for one who wishes to produce tolerable speech without knowing the language—for example, an actor reading lines in a language with which he is unfamiliar. For such purposes a phonetic alphabet, or the regularized phonetic representations called "phonemic" in modern linguistics, would be superior. This, however, is not the function of conventional orthographic systems. They are designed for the use of speakers of the language. It is therefore noteworthy, but not too surprising, that English orthography, despite its often cited inconsistencies, comes remarkably close to being an optimal orthographic system for English. Correspondingly, it would not be surprising to discover that an adequate theory of the production and perception of speech will find a place for a system of representation not unlike orthography, though there is, for the moment, little evidence that phonemic transcription is a "psychologically real" system in this sense.

It should also be observed that very different dialects may have the same or a very similar system of underlying representations. It is a widely confirmed empirical fact that underlying representations are fairly resistant to historical change, which tends, by and large, to involve late phonetic rules.[42] If this is true, then the same system of representation for underlying forms will be found over long stretches of space and time. Thus a conventional orthography may have a very long useful life, for a wide range of phonetically divergent dialects.

These observations suggest a description of the process of reading aloud that might, to first approximation, be described in the following way. We assume a reader who has internalized a grammar G of the language that he speaks natively. The reader is presented with a linear stretch *W* of written symbols, in a conventional orthography. He produces as an internal representation of this linear stretch *W* a string *S* of abstract symbols of the sort that we have been considering. Utilizing the syntactic and semantic information available to him, from a preliminary analysis of *S*, as well as much extra-linguistic information

[42] See Halle (1964), Kiparsky (1965), Postal (1968).

regarding the writer and the context, the reader understands the utterance, and, in particular, assigns to S a surface structure Σ.[43] With Σ available, he can then produce the phonetic representation of S and, finally, the physical signal corresponding to the visual input W. Clearly, reading will be facilitated to the extent that the orthography used for W corresponds to the underlying representations provided by the grammar G. To the extent that these correspond, the reader can rely on the familiar phonological processes to relate the visual input W to an acoustic signal. Thus one would expect that conventional orthography should, by and large, be superior to phonemic transcription, which is in general quite remote from underlying lexical or phonological representation and not related to it by any linguistically significant set of rules. On the other hand, for an actor reading lines in a language that he does not know, phonemic transcription should be much superior to conventional orthography, since it can be read without comprehension, whereas conventional orthography, being close to the linguistically significant system underlying ordinary speech, can be read only when the surface structure (including the internal structure of words) is known, that is, when the utterance is to some degree understood.

There are many interesting questions that can be raised about the development of systems of underlying representation during the period of language acquisition. It is possible that this might be fairly slow. There is, for example, some evidence that children tend to hear much more phonetically than adults. There is no reason to jump to the conclusion that this is simply a matter of training and experience; it may very well have a maturational basis. Furthermore, much of the evidence relevant to the construction of the underlying systems of representation may not be available in early stages of language acquisition. These are open questions, and it is pointless to speculate about them any further. They deserve careful empirical study, not only because of the fundamental importance of the question of "psychological reality" of linguistic constructs, but also for practical reasons; for example, with respect to the problem of the teaching of reading. These further topics, however, lie beyond the scope of this book.

8. *Vowel alternations*

We have already noted that simple and complex vocalic nuclei alternate in some way. Let us now consider these processes in more detail.

A comparison of words such as *profane–profanity*, *compare–comparative*, *grateful–gratitude*, *serene–serenity*, *appeal–appelative*, *plenum–plenitude*, *divine–divinity*, *derive–derivative*, *reconcile–conciliate*, and innumerable others suggests that the grammar must contain rules which have the following effect:

(74)
$$\begin{aligned} A &\rightarrow æ \\ E &\rightarrow e \\ I &\rightarrow i \end{aligned}$$

The vowel in boldface stands for a complex vocalic nucleus in the first member of each pair, and for a simple vocalic nucleus in the second member of each pair. Furthermore, both the vowel quality and the stress placement in the first member of each pair seem to

[43] Obviously, it is an oversimplification to assume that conversion of W to S precedes the interpretive processes that assign Σ to S. There is no reason for this having to be the case, and such commonplace phenomena as proofreading errors suggest that in fact it is not the case.

require that the underlying form have the complex rather than the simple vocalic nucleus, that is, that the rule be (74) rather than (75):

(75)
$$\begin{aligned} æ &\rightarrow A \\ e &\rightarrow E \\ i &\rightarrow I \end{aligned}$$

Thus we postulate underlying forms such as *profAn*, *serEn*, *divIn*,[44] which are stressed on the final complex nucleus by the Main Stress Rule (case (48f)). To account for the second members of the pairs, we apply rule (74) in the context (76) (where $\check{V}$ stands for an unstressed vocalic nucleus):

(76)
$$\text{——}C_0\check{V}C_0V$$

Superficially, the vowel alternations illustrated by (74) appear to be extremely complex and unsystematic. We have disguised this fact by our capitalization notation. Stated in terms of symbols that receive a direct phonetic interpretation, the rules in (74) appear as:

(77)
$$\begin{aligned} \bar{e}y &\rightarrow æ \\ \bar{\imath}y &\rightarrow e \\ \bar{a}y &\rightarrow i \end{aligned}$$

where the symbols $\bar{e}$, $\bar{\imath}$, $\bar{a}$ stand for phonetically tense counterparts to *e*, *i*, æ.[45] These rules are extraordinarily complex in terms of the otherwise well-motivated feature system that we will develop below and in terms of any concept of complexity that seems to have any merit at all.

Compounding the problem is the fact that it is not enough to postulate the rules (74)-(77); it is also necessary to postulate the rules (75), which have precisely the opposite effect. To see this, consider words such as *various–variety*, *German–Germanic–Germanium*, *manager–managerial*. The underlying form for *vary* must be *vAri*, with a final simple vocalic nucleus. Stress placement will then be determined correctly by rule (48e). The final vowel is converted from *i* to [E] finally or before another vowel by the rule discussed on page 45 in connection with words such as *country*, *window*. But notice that under stress, in *variety*, the vowel in question becomes not [E] but [I]. Therefore we must have a rule converting *i* to [I] in this position. Consider next the triple *German–Germanic–Germanium*. The position of stress on the first member of this triple shows that the vocalic nucleus of its final syllable must be weak. The second member shows that it must be æ. The third member shows that this underlying æ becomes [A] by a rule of the form $æ \rightarrow A$ in certain contexts (see rule (70) and the discussion of *courage–courageous* on p. 48). Consider now *manager–*

[44] If we were restricted to lowercase Latin letters and to a principle of absolute linearity of spelling, we could not use this device and would have to find an alternative notation. The proper choice is obvious, in the light of the rules given above. We can represent *profAn*, *serEn*, *divIn* in the form *profæne*, *serene*, *divine*; stress placement will now be determined correctly by the Main Stress Rule (case (48e)); the simple vocalic nuclei will become complex in the context ——C*e* by a rule rather like (65); and the final *e* will be elided by rule (64), giving the correct phonetic forms.

One might inquire whether this proposal is not after all correct, for the underlying representations. We have considered this possibility quite seriously, and it has something to recommend it. We reject it, however, in favor of the analyses with final complex nuclei in the underlying representations, for two reasons which will become clearer later on: first, the solution with final *e* is less highly valued in terms of the general measure of evaluation (complexity measure) that we will develop; second, we have not been able to find a simple system of rules that gives the required results in detail under this assumption.

[45] The phonetics is straightforward except with respect to postulation of the [æ]–[āy] relation, which begs a few questions to which we shall return in Chapter Four.

managerial. Considerations of stress and vowel quality show that the final vowel of *manager* must be a simple vocalic nucleus. This vowel becomes [E] in the context ——CiV; it must therefore be the vowel *e* (since æ becomes [A] and *i* becomes [I]). Many examples of this sort show that we must, in fact, set up rules with the effect of (75), in addition to rules with the effect of (74).

We have now reached a conclusion which is quite unacceptable. The rules (74) (= (77)) and (75) are extremely complex in themselves. It is evident, furthermore, that there must be some underlying generalization that accounts for the fact that the rules (74) and the rules (75) are precisely opposite in their effects. If we give the rules in the form (74), (75), there is no way to express this generalization. In brief, we have two extremely complex processes which are surely related, but related in some way which is not statable if these processes are described in the form (74), (75).

These considerations suggest very strongly that something is seriously amiss in the analysis we have been tacitly assuming, with the symbols A, E, I, O, U taken simply as informal notational abbreviations for complex nuclei of underlying forms.

Notice that the processes (74) and (75) involve alternations of two kinds, from a phonetic point of view. We can see this by considering the formulation (77) of (74). Clearly these rules affect both the complexity and the quality of the vocalic nuclei in question; that is, the complex nuclei become simple, and the vowel of the vocalic nucleus changes in quality as well. Let us consider these processes individually.

To begin with, let us disregard the question of vowel quality and consider the matter of complexity of the vocalic nucleus. We note at once that the presence of the *y*-glide correlates with tenseness of the vowel. We need therefore account only for the tenseness. The presence of the glide will then be determined by the Diphthongization Rule (78):

$$(78) \qquad \phi \rightarrow y \;/\; \bar{V}\text{——}$$

where $\phi \rightarrow y$ stands for "insert *y*" and where $\bar{V}$ is a tense vowel. (We shall see that this rule is, in fact, more general.) We may now assume that there are no postvocalic glides in underlying forms.

The examples that we have already given illustrate fairly adequately the general scope of the rules governing tenseness. Summarizing what we have observed, we can formulate the following rules, as a first approximation:

$$(79) \qquad V \rightarrow [-\text{tense}] \;/\; \text{——}C\check{V}CV$$

$$(80) \qquad V \rightarrow [+\text{tense}] \;/\; \text{——} \begin{cases} \# & \text{(a)} \\ V & \text{(b)} \\ C\begin{Bmatrix} i \\ e \end{Bmatrix} V & \text{(c)} \end{cases}$$

The Laxing Rule (79) converts the tense vowels in the boldface positions of *gratitude* (cf. *grAteful*), *serenity* (cf. *serEn*), *derivative*, (cf. *derIv*) to their lax counterparts. If the underlying forms are *grāt*, *serēn*, *derīv*, respectively, rule (79) will give the forms *græt(itude)*, *seren(ity)*, *deriv(ative)*, as required. On the other hand, the Tensing Rule (80) will apply in the following way: (a) in the context —— #, the final vowels of *country*, *window*, *vary*, etc., will become tense; (b) in the context ——V, the vowels in boldface in *various*, *variety*,

impious, *piety*, etc., will become tense; (c) in the context ——CαV (where α is a nonlow nonback vowel), the vowels in boldface in *managerial*, *courageous*, *Canadian*, etc., become tense. In all three cases, the tense vowel is diphthongized by rule (78).

The rules (78)–(80), which are quite simple and straightforward, account for the complexity of the vocalic nuclei in all of the cases that we have considered. The problem of vowel quality still remains, however, for the tense vowels (the complex vocalic nuclei). At this stage of our analysis, the vowels in boldface in the words *grateful*, *serene*, *derive*, for example, will be [ǣy], [ē̄y], [ī̄y], respectively, from underlying æ, *e*, *i*, by Tensing and Diphthongization. But the vocalic nuclei of these words should be [ē̄y], [ī̄y], [ā̄y], respectively. That is, we must add a Vowel Shift Rule which has the following effect on stressed vowels:

(81)
$$\begin{aligned} \bar{æ} &\rightarrow \bar{e} \\ \bar{e} &\rightarrow \bar{i} \\ \bar{i} &\rightarrow \bar{a}\ (= \bar{æ}\text{—see note 45}) \end{aligned}$$

In other words, the rule (81) effects the shifts:

(82)
$$\bar{æ} \rightarrow \bar{e} \rightarrow \bar{i} \rightarrow \bar{æ}$$

We shall see, in Chapter Four, that the Vowel Shift Rule can be stated in a very simple way, and, in fact, that it can be generalized beyond the class of examples that we have considered. With the Tensing and Laxing Rules, the Diphthongization Rule, and the Vowel Shift Rule, we have now fully accounted for the examples considered so far, as we can see by the following typical derivations:

(83)

profæn (*profane*)	
profǽn	MAIN STRESS RULE (48f)
profǽyn	DIPHTHONGIZATION (78)
profḗyn	VOWEL SHIFT (81)

(84)

profænity (*profanity*)[46]	
profǽnity	MAIN STRESS RULE (48a)
profǽnity	LAXING RULE (79)

(85)

mænVger (*manager*)	
mǽnVger	MAIN STRESS RULE (63)
mǽnV̆er	RULE (72)
mǽnəʳ̆ər	VOWEL REDUCTION

(86)

mænVgeriæl (*managerial*)	
mænVgériæl	MAIN STRESS RULE (48a)
mænV̆ériæl	RULE (72)
mænV̆ḗriæl	TENSING RULE (80c,b)
mænV̆ḗyrīyæl	DIPHTHONGIZATION (78)
mænV̆íyrīyæl	VOWEL SHIFT (81)[47]
mænəʳ̆íyrīyəl	VOWEL REDUCTION

[46] In these derivations, we omit all cycles except the last.

[47] Note that the Vowel Shift Rule is restricted to vowels that carry stress, though not necessarily primary stress.

The points to be noted are the following. Instead of the extremely complicated rules (74), (75), we now have the quite simple rules (78)–(81).[48] More important, we have succeeded in expressing the generalization underlying the rules (74) and their inverses, the rules (75). By extracting the Vowel Shift Rule from these processes, we are left with only rules (79) and (80) (the Tensing and Laxing Rules) as inverses. This is a bare and irreducible minimum. We have, in other words, avoided the absurdity of assuming that the processes stated as (74) and (75) have no relation to each other. We now have abstract underlying representations such as *profǣn*, *serēn*, *derīv*, *mænVger*. Observe that the device of capitalization used earlier corresponds to the phonological category of tenseness at the level of lexical representation. Note also that in the case of an underlying tense vowel, the corresponding phonetic element will invariably differ from the underlying vowel either in quality (if it remains tense) or in tenseness. For example, corresponding to the tense vowel in the boldface position in the underlying representation *serēn*, we have either [īy] (in the word *serene*) or [e] (in the word *serenity*). Once again, the postulated underlying forms are systematically related to conventional orthography (see note 44) and are, as is well known, related to the underlying forms of a much earlier historical stage of the language. There has, in other words, been little change in lexical representation since Middle English, and, consequently, we would expect (though we have not verified this in any detail) that lexical representation would differ very little from dialect to dialect in Modern English. If this assumption proves to be correct, it will follow that conventional orthography is probably fairly close to optimal for all modern English dialects, as well as for the attested dialects of the past several hundred years.

Bringing this discussion to a close, we will show that entirely independent considerations also support the postulation of the Vowel Shift Rule (81) for modern spoken English. In Section 7 we discussed the Velar Softening Rule that converts *g* to [ǰ] and *k* to [s] before nonlow front vowels, that is [i], [e], [ī], and [ē]. But consider words such as:

(87)
criticism–critical–criticize
medicine–medical–medicate

Using the symbol *c* to represent unvoiced velars in lexical entries that are subject to the Velar Softening Rule (72) (see note 39), we have the underlying representations *critic-*, *medic-* for the base forms of (87). Evidently the Velar Softening Rule must precede the Vowel Reduction Rule, since we have softening in the boldface position in *medicine* (before underlying *i*) but not *medical* (before underlying æ), although in both cases the vowel following the consonant in question is reduced to [ə] by Vowel Reduction. Under this assumption, the words *criticism* and *critical* also cause no difficulty. But consider the words *criticize* and *medicate*. In the case of *criticize*, we have velar softening before a vocalic nucleus which is phonetically [I] (= [āy]); in the case of *medicate*, we do not have velar softening before a vocalic nucleus which is phonetically [A] (= [ēy]). In other words, we have softening before a low back vowel but not before a nonlow front vowel, which is precisely the opposite of what we would expect in terms of rules of otherwise great generality. The paradox is resolved, of course, by the Vowel Shift Rule. The underlying representation for *criticize* is *criticīz*, and the underlying representation for *medicate* is *medicǣt* (as indicated in both cases by the spelling—see note 44). If Velar Softening applies not only prior to Vowel Reduction but also prior to Vowel Shift, then we will have softening in the case of *criticize*

[48] The sense in which the latter rules are much simpler will be explained later. We shall argue that this is the only sense of "simplicity" that is relevant to the choice of a grammar.

(before an underlying high front vowel) but not *medicate* (with an underlying low vowel after the *c*). After Velar Softening applies, the Diphthongization and Vowel Shift Rules convert *ī* to [āy] (giving [kritisāyz]) and ǣ to [ēy] (giving [medikēyt]); in our alternative notation, the Velar Softening, Diphthongization, and Vowel Shift Rules convert underlying *criticīz*, *medicǣt* to phonetic [kritisIz], [medikAt], respectively.

There are many other examples of this sort, some of which we will discuss when we deal with vowel alternations more carefully in Chapter Four. For the present, we simply point out that these examples provide an independent justification for the Vowel Shift Rule, and show once again the necessity of postulating lexical representations of a quite abstract sort.

PART II
ENGLISH PHONOLOGY

Chapter three

THE TRANSFORMATIONAL CYCLE IN ENGLISH PHONOLOGY

1. Introductory remarks

One of the most complex aspects of the phonetics of English is its intricate system of stress contours, both within the word and within the phrase. It has long been known to phoneticians that stress contours in English have at least four (and probably five or more) perceptual levels, so that many degrees of stress must be recorded in an adequate phonetic transcription. Furthermore, it is well known that a vowel that is insufficiently stressed, in some sense, reduces to a mid or high central "neutral" vowel.[1]

For the most part, the study of English sound structure has been limited to the problem of developing an adequate notation,[2] but there have also been a few attempts to go beyond this and discover the underlying principles that determine these phenomena.[3] Several years ago we showed (Chomsky, Halle, Lukoff, 1956) that the major stress contours are determined by the operation of a transformational cycle. We assumed then that the position of main stress was an independent ("phonemic") feature, and we did not investigate the rules that determine this or the rules that determine vowel reduction. In the present chapter, we will discuss the rules of stress assignment and vowel reduction on a somewhat larger scale. We will see that both the placement of main stress and the stress contours within

[1] We will represent this "neutral" vowel with the symbol [ə], using the symbol [ʌ] for the vowel of *but*, *luck*, etc. Phonetically the vowel which we represent here as [ə] may often (or, in some dialects, always) be raised to the high central vowel [ɨ]. We will not consider at this point the question of how, in detail, this vowel is phonetically realized in various contexts and dialects. For expository purposes, we may accept the fiction that the vowel we are representing as [ə] is distinct from all other vowels.

[2] See, for example, Bloomfield (1933), Bloch and Trager (1942), Trager and Smith (1951), Hill (1958), Kenyon (1958), Kurath (1964), and, for general discussion, Gleason (1961, Chapter 3).

[3] For example, Newman (1946). In particular, there have been studies in which affixes are classified in terms of their effect on stress placement (e.g., Kingdon, 1958), and others in which some of the major rules are stated (e.g., Cooper, 1687, Elphinston, 1765, Marchand, 1960, all of whom noted that in many cases placement of primary stress in English follows the familiar Latin rules).

The distinction between the problem of devising an adequate (so-called "phonemic") notation and that of discovering the underlying principles that determine phonetic representations is not a sharp one. Thus, even a phonemic notation takes an initial step toward systematization in that it is concerned with low-level generalizations about phonetic variation that can be stated in terms of immediate phonetic contexts.

the word and the phrase are largely predictable from the syntactic and the nonprosodic phonological structure of an utterance by means of a transformational cycle.

1.1. THE RULES OF THE PHONOLOGICAL COMPONENT

The rules of the grammar operate in a mechanical fashion; one may think of them as instructions that might be given to a mindless robot, incapable of exercising any judgment or imagination in their application. Any ambiguity or inexplicitness in the statement of rules must in principle be eliminated, since the receiver of the instructions is assumed to be incapable of using intelligence to fill in gaps or to correct errors. To the extent that the rules do not meet this standard of explicitness and precision, they fail to express the linguistic facts.[4]

In Chapter Two we outlined our assumptions regarding the ordering of rules in the phonological component of a generative grammar. To repeat the main points briefly, we assume that the rules are linearly ordered and that they are applied in the given order in forming a derivation. Furthermore, this order is cyclical, in the following sense. The syntactic component generates a string with a surface structure that is represented by labeled bracketing. The sequence of phonological rules is first applied to all innermost constituents of this string. Innermost brackets are then deleted, and the sequence applies to the new innermost constituents. This cyclical application is repeated until the maximal domain of phonological processes is reached. (The maximal domain is the "phonological phrase," which we assume to be marked in the surface structure.)

We will see that certain rules are limited to the context # # . . . —— . . . # #; that is, they apply only at word boundaries. These make up the "noncyclical phonology" that we will discuss in greater detail in the next chapter. Our attention here will be directed rather to the cyclical transformational rules that apply in contexts determined by major syntactic categories—rules that therefore reapply, in general, at successive stages of the transformational cycle.

We have also assumed that there may be a somewhat more complex principle of ordering within the linear sequence of rules. A certain subsequence may form a block of rules which are "disjunctively ordered" in the sense that if one of these rules applies to a certain substring, the other members of the block are not applicable to this substring in this stage of the cycle. Rules not subject to this restriction on their application are "conjunctively ordered." Disjunctive ordering must be indicated by an appropriate convention; we will show various examples and will suggest appropriate formal devices and generalizations as we proceed, extending the observations of Chapter Two. In Chapter Eight these notions will be further developed and sharpened.

In short, at this point in the exposition we suppose the phonology to consist of a linear sequence of rules, some subsequences of which form disjunctively ordered blocks. These rules apply in a cycle, as determined by the surface structure of the string to which they apply. In this way they convert a formal object generated by the syntactic component, that is, a string of formatives with surface structure marked, into a phonetic representation of the string. The sequence of representations formed in this process we call a "derivation" of the phonetic representation from the underlying phonological representation. Thus the

[4] It is a curious fact that this condition of preciseness of formulation for the rules of a generative grammar has led many linguists to conclude that the motivation for such grammars must be machine translation or some other use of computers, as if there could be no motive in clarity and completeness other than this.

phonological component specifies the relation between phonetic and phonological representation.

To be slightly more precise, the syntactic component generates a string of formatives, some of which are given in lexical representation, with surface structure marked. The readjustment rules, operating along the lines indicated in Chapter One (pp. 9–11), convert this formal object into a string in full phonological representation, with surface structure marked. The readjustment rules thus provide a link between the syntactic and the phonological components of the grammar. We presuppose, henceforth, that we are dealing with the formal objects provided by the readjustment rules which apply to the structures generated by the syntactic component. In Chapter Eight, we return to a brief consideration of readjustment rules.

1.2. NOTATIONAL CONVENTIONS

Let us now briefly review and extend the notational conventions introduced in the preceding chapters.

Where X, Y, Z, and W are strings of symbols of arbitrary complexity, an expression of the form (1) is an abbreviation for the sequence (1a), (1b), and an expression of the form (2) is an abbreviation for the sequence (2a), (2b), *in the order shown.*

(1) $X\begin{Bmatrix} Y \\ Z \end{Bmatrix}W$

(a) XYW
(b) XZW

(2) $X(Y)Z$

(a) XYZ
(b) XZ

In expression (1) there are two items enclosed by the braces; thus (1) abbreviates a sequence of two expressions, i.e., (1a), (1b). Similarly, (3) abbreviates the sequence (3a), (3b), (3c), and the same convention is extended to an arbitrary number of items in braces.

(3) $X\begin{Bmatrix} Y \\ Z \\ W \end{Bmatrix}P$

(a) XYP
(b) XZP
(c) XWP

When notations such as (2) have been used in the construction of generative grammars, it has generally been tacitly assumed that *the ordering abbreviated by the use of parentheses is disjunctive* (in this case the ordering (2a), (2b)). In the case of braces, however, the ordering is assumed to be conjunctive. Thus the expressions (3a), (3b), (3c), abbreviated as (3), are conjunctively ordered; but the expressions (2a), (2b), abbreviated as (2), are disjunctively ordered.

For any feature complex X, the symbol X_m^n stands for a string of no less than m and no more than n occurrences of X. Thus C_0^1 stands for one occurrence or zero occurrences of C, and C_1^1 stands for exactly one occurrence of C (where C stands for a segment which is

a nonvowel—see p. 68). The symbol X_m stands for a string of no less than m X's. Thus C_2 stands for a string of two or more occurrences of C. When no subscript or superscript is given, it is to be assumed that both the subscript and the superscript are "1." Thus CVC_0, for example, stands for a string of exactly one nonvowel followed by exactly one vowel followed by zero or more nonvowels; the notation $\begin{bmatrix} -\text{tense} \\ \text{V} \end{bmatrix}$ stands for exactly one occurrence of a lax (nontense) vowel; etc.

The notation X_m^n is definable in terms of the parenthesis notation. We will tentatively assume that it has the same formal conventions associated with it. Thus, a rule of the form $\ldots C_1^2 \ldots$, for example, abbreviates the two disjunctively ordered rules $\ldots CC \ldots$, $\ldots C \ldots$; we thus take $\ldots C_1^2 \ldots$ to be an abbreviation for $\ldots C(C) \ldots$. We will actually make little use of this property of the notation X_m^n (see, however, pp. 175–76, Chapter Four), and we mention it here only to clarify the meaning of the notation.

There is one ambiguity that must be resolved. The notation (4a), for example, is an abbreviation for (4b), which is ambiguously interpreted as either the sequence (5a) or the sequence (5b), depending on which parentheses are expanded first in (4b).

(4)
(a) $\ldots C_0^1(X) \ldots$
(b) $\ldots (C)(X) \ldots$

(5)
(a) $\ldots CX \ldots$
$\ldots X \ldots$
$\ldots C \ldots$
$\ldots\ldots$
(b) $\ldots CX \ldots$
$\ldots C \ldots$
$\ldots X \ldots$
$\ldots\ldots$

We will assume henceforth, rather arbitrarily, that alternative (5a) is correct and that, in general, substrings abbreviated as Y_i^j are expanded *later* than substrings enclosed in parentheses.

There are several other ambiguities to be resolved in the meaning of these notations. One, of crucial importance in our material, is this. Suppose that we have the sequence of expressions (6):

(6)
(a) XY
(b) XZ
(c) X

If we apply the brace notation to (6a), (6b), we derive (7):

(7) $X\begin{Bmatrix} Y \\ Z \end{Bmatrix}$

But now we can apply the parenthesis notation to the sequence (7), (6c), giving (8):

(8) $X(\begin{Bmatrix} Y \\ Z \end{Bmatrix})$

Alternatively, we might first have applied the parenthesis notation to (6b), (6c), giving (9),

and then applied the brace notation to the sequence (6a), (9), giving (10):

(9) $X(Z)$

(10) $X\left\{\begin{matrix} Y \\ (Z) \end{matrix}\right\}$

The alternatives that lead to (8) and (10), respectively, differ in their empirical consequences, because of the conventions just stated regarding conjunctive and disjunctive ordering. If the sequence (6) is abbreviated as (8), it follows that (6a) and (6b) are each disjunctively ordered with respect to (6c). If the sequence (6) is abbreviated as (10), it follows that only (6b) is disjunctively ordered with respect to (6c). Therefore, it is clearly an empirical question whether one or the other alternative is correct.

We have one clear case to illustrate the empirical effects of this choice, namely, the case of stress placement with affixes, which was discussed in Chapter Two (pp. 31–36), and which will be discussed in more detail in Section 6 of this chapter. The correct choice, in this case, is (8). That is, when confronted with a sequence such as (6), we must first apply braces and then apply parentheses. This was the decision made, without comment, in Chapter Two.

It is conceivable that this decision is ad hoc and depends on the empirical facts in each case. If so, it follows that one cannot determine from the sequence of rules constituting the grammar what is the organization of the grammar in terms of disjunctive and conjunctive ordering. In other words, this organization is in part arbitrary, a feature of grammar that must be specified independently of the linear ordering of rules. Evidently, it would be quite interesting to determine whether there is a general principle governing this organization, given the sequence of rules. A natural principle that suggests itself at once is this: *abbreviatory notations must be selected in such a way as to maximize disjunctive ordering.* Given the sequence of rules (6), this principle would lead us to assign the organization of rule application defined by (8) rather than that defined by (10). The principle seems to us a natural one in that maximization of disjunctive ordering will, in general, minimize the length of derivations in the grammar. The question of how an internalized grammar is used in performance (speech production or perception) is of course quite open. Nevertheless, it seems reasonable to suppose that the grammar should be selected in such a way as to minimize the amount of "computation" that is necessary, and that "length of derivation" is one factor in determining "complexity of computation." Naturally, this principle must be regarded as quite tentative. We will adhere to it where a choice arises, but we have very little evidence for or against it. To find empirical evidence bearing on a principle of this degree of abstractness is not an easy matter, but the issue is important, and one should bear it in mind in a detailed investigation of phonological structure.

These remarks by no means exhaust the quite deep question of how disjunctive and conjunctive ordering are to be assigned to the sequence of rules constituting the phonological component and how ambiguities in the interpretation of the notations are to be resolved. We shall have a few more comments to make on this matter as we proceed. There is no difficulty, in principle, in resolving all ambiguities one way or another. However, our feeling is that premature formalization should be avoided, and that we should leave questions open where we have no empirical evidence and no considerations of plausibility, however vague, that would lead us to one or another of the possible decisions. Research in phonology is barely beginning to reach the depth where questions of this sort can be examined.

With these remarks, we merely wish to point to the fact that these problems can now be posed in a meaningful way and that one can search for empirical evidence to resolve them.

Proceeding now to other types of notation used here, we will follow the convention of marking the heaviest (main) stress as 1 stress, the next heaviest (secondary) stress as 2 stress, etc. This convention conforms to familiar usage but has the disadvantage that weaker stresses are indicated by larger numbers. The reader should take note of this to avoid possible confusion. We will also occasionally use the conventional notation V́, V̂, V̀ for primary, secondary, and tertiary stress, respectively.

In stating rules of the transformational cycle, we will, as in the first two chapters, use boldface square brackets **[ ]** to indicate the syntactic IC analysis of the surface structure. If the brackets are labeled by a sequence of (one or more) category symbols, the rule in question is restricted to strings belonging to one of the indicated categories. If the brackets are unlabeled, the rule is unrestricted as to category. The boldface square brackets that are used to mark syntactic structure are not to be confused with the brackets [ ] used to enclose feature sets.

The rules that determine stress contours are, for the most part, rules that assign primary stress in certain positions, at the same time weakening the stresses in all other positions by one. We might think of these as rules that assign [0 stress], with the convention that after every application of such a rule, all integral values for stress within the domain of this rule (which is a maximal string containing no internal brackets) are increased by one. Whenever primary stress is placed by a rule V → [1 stress] / . . . , an interpretation of this sort is to be understood.

1.3. DISTINCTIVE FEATURES

We take "distinctive features" to be the minimal elements of which phonetic, lexical, and phonological transcriptions are composed, by combination and concatenation. The alphabetic symbols that we use freely in the discussion below are therefore to be regarded as nothing more than convenient ad hoc abbreviations for feature bundles, introduced for ease of printing and reading but without systematic import. Thus, for example, if the symbol /i/ appears in the discussion, it is to be understood as an abbreviation for a feature complex such as:

(11)
$$\begin{bmatrix} +\text{segment} \\ +\text{vocalic} \\ -\text{consonantal} \\ +\text{high} \\ -\text{low} \\ -\text{back} \\ -\text{round} \\ -\text{tense} \end{bmatrix}$$

A feature complex of this sort we call a "unit" if it is fully specified in terms of features; otherwise, an "archi-unit." If the unit has the feature [+segment], we call it a "segment" (or, if not fully specified, an "archi-segment"). If it has the feature [−segment], we call it a "boundary." However, in discussing examples, we will not always make a consistent distinction between fully specified segments and archi-segments where this is not relevant to the point at issue, and we will often use the same alphabetic symbol for a segment and various archi-segments of this segment. We do this simply to limit the use of alphabetic symbols in expository passages to some reasonable number. Except for this proviso, we will generally

use alphabetic symbols with their conventional phonetic interpretations as abbreviations for feature sets; but where possible ambiguity in the exposition might result, we will resort to the full use of features.

Our use of the concept "distinctive feature" differs from that of many others in a number of ways. On the one hand, we have made fairly extensive revisions in the catalog of features as well as in the terminology utilized in previous work. A detailed discussion of the revised framework is to be found in Chapter Seven. In addition, we distinguish sharply between the classificatory and the phonetic function of distinctive features. It is only in their classificatory function that all features are strictly binary, and only in their phonetic function that they receive a physical interpretation. As classificatory devices, the distinctive features play a role in the full specification of a lexical entry (along with syntactic and semantic features and idiosyncratic classifications of various sorts that determine the behavior of a lexical entry with respect to the rules of the grammar). As phonetic parameters, the distinctive features provide a representation of an utterance which can be interpreted as a set of instructions to the physical articulatory system, or as a refined level of perceptual representation. The major function of the phonological component is to derive the phonetic representation of an utterance from the surface structure assigned to it by the syntactic component, that is, from its representation in terms of classificatory features of the lexical items it contains, its other nonlexical formatives, and its analysis in terms of immediate constituents, all of this material having been modified in an appropriate way by readjustment rules.

As classificatory devices, features are binary. As a first approximation, we may assume that they are provided with a coefficient that can take one of two values: + (plus) or − (minus). On the other hand, since phonetic features are generally multivalued, we may think of them as having positive integers as coefficients. Thus, in the representations that constitute the surface structure (the output of the syntactic rules), specified features will be marked as plus or minus; but the phonological rules, as they apply to these representations, will gradually convert these specifications to integers. We will not actually give the rules that effect this conversion in most cases because our interest in sound structure, in this book, does not extend to matters such as degree of aspiration, degree of fronting of vowels, etc.; we will, however, give the rules that determine degree of stress. In principle, all rules should be given.[5]

It is conventional to enclose phonemic representations in diagonals (i.e., in the form /. . ./) and phonetic representations in square brackets (in the form [. . .]). We will follow a similar convention where it contributes to the clarity of the exposition, using diagonals for representations in which the features are functioning as classificatory devices (and are specified plus or minus) and square brackets for representations in which they function phonetically (and are specified with integers, in principle). But we cannot adhere to this convention rigidly. The diagonal vs. square-bracket convention was designed for a taxonomic theory that assumed two levels of representation, phonemic and phonetic, related by unordered taxonomic rules (e.g., phoneme A has the variant B in the context X——Y)[6] which apply simultaneously. However, a grammar consists of a long sequence of ordered rules

[5] See Sledd (1966) for a discussion of very detailed low-level phonetic rules for a Southeastern American dialect, within a general framework of the sort that we are discussing here.

[6] Whether phonetic or phonemic context is intended is not always made clear, and there is, in fact, some question as to how well the requirement of simultaneous application is met. For discussion, see Chomsky (1964).

that convert initial classificatory representations into final phonetic ones, and in the intermediate stages there will be representations of a highly mixed sort. We will therefore make no attempt to use the diagonal vs. square-bracket convention systematically, though we will use it when convenient.

It appears from our investigations that the optimal grammar of English is one in which stress is predicted by rule rather than one in which stress is inherent in the phonological matrix of a lexical entry. Thus we are assuming, in effect, that one of the earliest rules of the phonological component is a rule R which assigns to each segment and boundary (see Section 1.3.1) the feature specification [−stress]. Various rules will then replace [−stress] in vowel segments, but not in boundaries or consonants, by integral values of stress, in certain positions. We will assume, as a convention, that all integral values of stress are a subdivision of the category [+stress]. Thus, when a rule assigns the specified feature [*n*stress], for some integer *n*, in a certain segment, this segment now belongs to the category [+stress] rather than the category [−stress] to which it belonged after the application of rule R. The notation [+stress], then, serves as a "cover symbol" for all segments with integrally marked values of stress; a rule applying to a segment containing the specification [+stress] automatically applies to all segments which contain the specification [*n*stress], for some integer *n*, and which are not otherwise excluded by the formulation of the rule.

We expect that the same (or some similar) convention is needed for all features, but since we have not systematically investigated the problem of replacing categorial specification by phonetic degree in the case of features other than stress, we do not propose this now as a general convention but merely as a specific one for present purposes. We note, however, that some such convention is needed as part of general linguistic theory.

A detailed discussion of the phonetic correlates of the different features is given in Chapter Seven. For the present we will limit ourselves to a brief comment on the features that play a central role in determining stress contours. These are the features "segment," "vocalic," "consonantal," "tense."

1.3.1. BOUNDARY FEATURES

The feature "segment" distinguishes segments from boundaries. It seems to us that the appropriate way to exhibit the structure of a system of boundaries is by an explicit feature analysis. Thus each boundary will be a set of features, one of which is the feature [−segment].

Our tentative assumption is that the segmental features and the boundary features fall into distinct sets (with an exception noted on pages 67–68). Among the features of the boundary system, "formative boundary" (henceforth "FB") requires explicit mention. Only a single boundary is marked [+FB]. This boundary, which we will designate with the symbol +, appears between the final segment of one formative and the initial segment of the following formative. We can think of it as being inserted in this position in terminal strings by a general convention.[7] All other boundaries are marked [−FB]. One of the non-FB boundaries is the unit # that appears automatically before and after a word and in

[7] Alternatively, we could dispense with this element and permit reference in rules to formative-initial and formative-final position. Note that formative boundary is an actual symbol of the representation, with a feature structure, and is not to be confused with the concatenation operator that would be represented in a fully formalized version of linguistic theory.

In our formulation, formative boundary *never is preceded or followed by a boundary* but must be bounded on both sides by segments.

sentence-initial and sentence-final position.[8] We will also have occasion to refer to another boundary, which we will denote by the symbol =. In our terms, the unit = must be distinguished from # by some feature, let us say the feature "WB" (word boundary). Thus the symbol + stands for the feature complex [−segment, +FB, −WB],[9] # stands for the feature complex [−segment, −FB, +WB], and = for the feature complex [−segment, −FB, −WB].

We assign a very special status to formative boundary, in the following way. We assume that the presence of + can be marked in a rule, but that the absence of + cannot be marked in a rule. This means that a rule such as (12), where X, Y, and Z are segments, applies to the three-unit string $X+Z$, converting it to $Y+Z$; but a rule such as (13) is an abbreviation for the sequence (14).

(12) $$X \rightarrow Y \;/\; \text{——} + Z$$

(13) $$X \rightarrow Y \;/\; AB\text{——}C$$

(14) $$X \rightarrow Y \Big/ \begin{Bmatrix} A+B+\text{——}+C \\ AB+\text{——}+C \\ A+B\text{——}+C \\ A+B+\text{——}C \\ AB\text{——}+C \\ AB+\text{——}C \\ A+B\text{——}C \\ AB\text{——}C \end{Bmatrix}$$

This assumption regarding the role of formative boundary in phonological rules is indispensable. The other boundaries do not behave in this manner. Thus rule (13) does not abbreviate a sequence of rules like (14) but with + replaced by #. A string containing # is not subject to a rule unless this rule explicitly mentions # in the proper position. Notice that this convention amounts to a fairly strong empirical assumption about the nature of rules. It implies that although we can frame phonological processes which are blocked by the presence of the boundary #, we cannot frame processes that are blocked by the presence of formative boundary.[10] If a process applies to a sequence without formative boundaries, it also applies to otherwise identical sequences containing these units. This condition is inoperative only in the case of the lexical redundancy rules, which refer exclusively to the internal structure of formatives and really belong to the system of readjustment rules rather than the phonology (see pp. 9–11, Chapter One).

As noted on page 66, one of the earliest rules of the phonological component will assign to all units—both segments and boundaries—the feature [−stress]. Since our

[8] Recall the discussion of # and word boundary in Chapter One, pages 12–14.

[9] Thus we are supposing that [−WB] is an automatic, redundant feature of formative boundary. The general basis for this remark will become clear in Chapter Nine.

[10] More precisely, in order to express the fact that a process is blocked by the presence of formative boundary, we must resort to certain auxiliary devices, described in the next chapter, thus adding to the complexity of the grammar. The most highly valued ("simplest") grammar, then, is one in which phonological processes that apply when there is no formative boundary apply also when this unit is present, though not conversely, and in which processes stated in terms of other boundaries apply where and only where these appear in strings.

rules assign stress only to vowels, a sequence of n units specified $[-\text{stress}]_n$ may include not only unstressed vowels and consonants, but all types of boundaries as well. This unique treatment of the feature "stress" reflects the fact that stress is a prosodic feature, i.e., a feature whose domain extends over sequences that are longer than a word.

1.3.2. SEGMENTAL FEATURES

Let us turn now to the features that classify segments, limiting our discussion here to features that are relevant to the functioning of the transformational cycle.

The features "vocalic" and "consonantal" give a four-way classification of segments, as follows:

(15)

(a) $\begin{bmatrix} +\text{vocalic} \\ -\text{consonantal} \end{bmatrix}$ = vowel = V

(b) $\begin{bmatrix} -\text{vocalic} \\ +\text{consonantal} \end{bmatrix}$ = true consonant

(c) $\begin{bmatrix} +\text{vocalic} \\ +\text{consonantal} \end{bmatrix}$ = liquid (*l*, *r*)

(d) $\begin{bmatrix} -\text{vocalic} \\ -\text{consonantal} \end{bmatrix}$ = glide (*h*, ʔ, *y*, *w*)

} = C

As indicated in (15), we will use the cover symbol V as an (informal) abbreviation for the feature complex $\begin{bmatrix} +\text{vocalic} \\ -\text{consonantal} \end{bmatrix}$ and the cover symbol C as an abbreviation for nonvowel, that is, for the complex $\begin{Bmatrix} [-\text{vocalic}] \\ [+\text{consonantal}] \end{Bmatrix}$.

Among vowels we will rely on a further classification provided by the feature "tenseness." Our use of tenseness, as a phonetic feature, can be clarified by an examination of the following typical cases:[11]

(16)

APPRECIABLY TENSE	NEGLIGIBLY TENSE
bean	*bin*
bane	*Ben*
ban (in some dialects)[12]	*bat*
balm	*bun*[13]
pawn	*pot* (British RP)
bone	
boon	*put*

Phonetically the difference between tense and lax sounds can best be characterized as a difference in the manner in which the articulatory gesture is executed. A tense sound is executed deliberately so that the articulating organs actually attain their various target configurations; in producing a lax sound, on the other hand, the gesture is executed rapidly and with reduced

[11] There are certain dialects (western New England, for example) in which the gap in this chart, namely, the lax correlate of *bone*, is marginally filled.

[12] Namely, those in which (*tin*) *can* is distinct from the modal *can*. This distinction is fairly common, and almost completely predictable, in many American dialects, but the contexts in which it appears vary.

[13] The vowel of *bun* is higher as well as laxer than that of *balm*. Some dialects have another vowel corresponding more closely in quality to the vowel of *balm* but shorter, namely, the vowel of *bomb*. In general, of course, the tense vowels undergo many phonetic modifications.

amplitude. Tense vowels are, therefore, distinguished from the corresponding lax vowels by being more intense, of longer duration, and articulated with a greater deviation of the vocal cavity from its neutral (rest) position. These facts have led to the description of lax vowels as being "lazy" variants of the corresponding tense vowels.

It will often be convenient to use a special notation for the tense vocalic nuclei. As in Chapter Two, we will use capital Latin letters for this purpose, each letter being used for the sound which serves as its name.[14] Thus we will frequently make use of informal representations of the following kind:

(17)

bane	*bAn*	*rebate*	*rEbAt*
bean	*bEn*	*violate*	*vIolAt*
pine	*pIn*	*denotation*	*dEnOtAtion*
bone	*bOn*	*mutation*	*mUtAtion*
pure	*pUr*	*hibernate*	*hIbernAt*

Except for frequent use of this device, we will generally give examples in ordinary orthography (occasionally with internal morphological structure indicated and with occasional use of standard phonetic symbols). This slight deviation from ordinary orthography serves the present purpose of identifying certain vocalic nuclei as tense; but as we have already seen in Chapter Two, it has much other justification as well.

Our decision to use slightly modified conventional orthography in presenting examples instead of, let us say, familiar (taxonomic) phonemic notation is motivated in part by a desire to avoid burdening the reader with a new notation; but, much more importantly, it is justified by the fact that conventional orthography is remarkably close to the optimal phonological representation when letters are given a feature analysis—much closer, in most respects, than standard phonemic transcription. We have touched on this matter in Chapter Two, and we will return to it again in the next chapter where we will give a full analysis of the vowel system in terms of features.

2. *Stress placement in verbs—a first approximation*

Consider the stress assignment in the following list of verbs:

(18)

I	II	III
astónish	*maintáin*	*collápse*
édit	*eráse*	*tormént*
consíder	*caróuse*	*exháust*
imágine	*appéar*	*eléct*
intérpret	*cajóle*	*convínce*
prómise	*surmíse*	*usúrp*
embárrass	*decíde*	*obsérve*
elícit	*devóte*	*cavórt*
detérmine	*achíeve*	*lamént*
cáncel	*careén*	*adápt*

The verbs in column I have main stress on the penultimate vowel, whereas in columns II and III stress falls on the final vowel. A closer examination of the list shows that the verbs with penultimate stress end in a nontense vowel followed by a single consonant, while the verbs

[14] We are thus considering diphthongs (and the triphthong [yūw]) to be, phonologically, tense vowels.

with final stress have a tense vowel or a diphthong in the last syllable (column II) or they end in two consonants (column III). To account for the observed stress distribution, we propose, as a first approximation, the following rule:

(19) Assign main stress to
(i) the penultimate vowel if the last vowel in the string under consideration is non-tense and is followed by no more than a single consonant;
(ii) the last vowel in the string under consideration if this vowel is tense or if it is followed by more than one consonant.[15]

Using the customary formalism for the statement of phonological rules, we can restate (19) as (20):

(20)
$$V \rightarrow [1 \text{ stress}] \Big/ \left\{ \begin{array}{ll} \text{——} C_0 \begin{bmatrix} -\text{tense} \\ V \end{bmatrix} C_0^1 & \text{(i)} \\ \left\{ \left[\begin{array}{c} \text{——} \\ +\text{tense} \end{array} \right] C_0 \right. & \\ \left. \text{——} C_2 \right\} & \text{(ii)} \end{array} \right]$$

As in Chapter Two, let us tentatively refer to a string of the form $\begin{bmatrix} -\text{tense} \\ V \end{bmatrix} C_0^1$ as a "weak cluster," and a string of the form $\begin{bmatrix} +\text{tense} \\ V \end{bmatrix} C_0$ or VC_2 as a "strong cluster." (We will later extend these notions slightly—see pp. 83, 103–104.) Thus case (i) asserts that primary stress is placed on the penultimate syllable if the final syllable terminates in a weak cluster; and case (ii) asserts that a final strong cluster receives primary stress.

As just formulated, rule (20) is unduly cumbersome, since the same condition is, in effect, stated twice, case (i) and case (ii) being mutually exclusive. Case (ii) can therefore be replaced by the condition that the rule applies in all contexts other than those specified in case (i). We can achieve this effect by making use of the notion of disjunctive ordering. Suppose that we replace rule (20) by (21), *specifying that the two rules abbreviated by* (21) *be a disjunctively ordered block.*

(21)
$$V \rightarrow [1 \text{ stress}] \Big/ \text{——} \left\{ \begin{array}{ll} C_0 \begin{bmatrix} -\text{tense} \\ V \end{bmatrix} C_0^1 & \text{(i)} \\ C_0 & \text{(ii)} \end{array} \right]$$

Case (i) of rule (21) is identical to case (i) of (20). Case (ii) of (21) asserts that:

(22) The last vowel in the string under consideration receives primary stress.

The requirement of disjunctive ordering guarantees that case (ii) (= (22)) will apply only where case (i) has not applied; that is, it allows us to express the notion "elsewhere."

The two parts of rule (21) apply in sequence, the first assigning primary stress to a penultimate vowel if the final syllable terminates in a weak cluster, and the second part assigning primary stress to the vowel of the final syllable if this syllable terminates in a

[15] We note without further comment the essential identity of (19) and the rule governing stress distribution in Latin. See Halle and Keyser (forthcoming) for discussion of how this rule was incorporated into the phonology of English.

Recall that we regard diphthongs as tense vowels in underlying lexical representations, the glide being inserted (and the quality of the vowel determined) by phonological rules (see Chapter Two, Section 8).

strong cluster (i.e., elsewhere). Thus, (21), plus the condition of disjunctive ordering, restates (20) precisely.

However, our notations permit a somewhat more compact statement of (21), namely:

(23) $$V \rightarrow [1 \text{ stress}] \; / \; \text{——} C_0 \left(\left[\begin{matrix} -\text{tense} \\ V \end{matrix} \right] C_0^1 \right)]$$

The fact that the rule must, in our terms, be stated in the form (23)[16] explains why the ordering is disjunctive, given our general conventions regarding the parenthesis notation (see Chapter Two, p. 30). We therefore need make no separate statement about the disjunctive ordering of cases (i) and (ii) of (21), since it follows as a consequence of the fact that (23) is the correct representation for these rules. Notice that the appropriateness of the abbreviation (23) depends on the convention regarding the order of expansion of parentheses discussed on pages 61–63.

For ease of exposition, we will continue to refer to the rule of stress placement in the form (21) rather than in the fully reduced form (23), keeping in mind that the two cases of (21) are disjunctively ordered.

Let us now return to the examples in (18), at the beginning of this section. The items in column I of (18) (e.g., *astonish*) are assigned primary stress on the penultimate vowel by case (i) of (21), since the final syllable terminates in a weak cluster. If the ordering of (21) were not disjunctive, case (ii) would now apply, assigning primary stress on the final syllable to give **astonish*.[17] As matters stand, however, case (ii) is inapplicable and we derive *astonish*, as required. The examples of column II (e.g., *maintain*) and column III (e.g., *collapse*) are not subject to (21i) because the final cluster is strong. Consequently case (ii) applies, assigning primary stress to the vowel of the final syllable. Notice that monosyllables (e.g., *eat, fit*) are also assigned primary stress by (21ii).

3. *Stress placement in nouns—a first approximation*

Consider now the stress pattern in the following nouns:

(24)

I	II	III
América	*aróma*	*veránda*
cínema	*balaláika*	*agénda*
aspáragus	*hiátus*	*consénsus*
metrópolis	*horízon*	*synópsis*
jávelin	*thrombósis*	*amálgam*
vénison	*coróna*	*uténsil*
ásterisk	*aréna*	*asbéstos*
ársenal	*Minnesóta*	*phlogíston*
lábyrinth	*angína*	*appéndix*
análysis	*factótum*	*placénta*

[16] To say that the rules may be given in a simpler form implies that they *must* be given in that form. More precisely, the notations that we use define a certain valuation measure for grammars; the value of a grammar is determined by the number of symbols that appear in it when notations are used in the optimal fashion. Rules are ordered by conventions associated with the parenthesis (or other) notation when the use of this notation is in fact optimal in the case in question. See Chapter Eight for more detailed discussion.

[17] Other conditions can be invented to prevent application of case (ii); for example, we might propose that stress is placed by (22) only in the context $[-\text{stress}]_0$ ——. Stronger evidence that it is the condition of disjunctive ordering that is actually involved here will be forthcoming in Section 6, where examples are presented that rule out the apparent alternatives.

We have here a stress pattern that is identical with that exemplified in (18) except for the final extra syllable, which, it will be observed, consists in each case of a nontense (lax) vowel followed by zero or more consonants. We can therefore apply rule (21) here too if we exclude the final lax vowel (with the consonants following it, if any) from the domain of application of the rule. It appears, then, that rule (21) operates in two separate contexts: first, it applies to nouns ending in a nontense vowel followed by zero or more consonants,[18] this last VC_0 string being omitted from consideration; secondly, it applies in an environment which we will provisionally describe simply as "elsewhere." More formally, we have the following rule:[19]

(25)
$$\mathrm{V} \rightarrow [1\ \text{stress}] \Big/ \begin{cases} \mathrm{C}_0 \begin{bmatrix} -\text{tense} \\ \mathrm{V} \end{bmatrix} \mathrm{C}_0^1 & \text{(i)} \\ \mathrm{C}_0 & \text{(ii)} \end{cases}$$
$$\Big/ \begin{cases} \begin{bmatrix} -\text{tense} \\ \mathrm{V} \end{bmatrix} \mathrm{C}_0]_{\mathrm{N}} & \text{(b)} \\ ] & \text{(e)} \end{cases}$$

Notice that we have here a rule of the form $A \rightarrow B / C \_\_ D / E \_\_ F$. Recall that the notation $A \rightarrow B / C \_\_ D$ has the meaning $CAD \rightarrow CBD$. By a double application of this convention, the notation $A \rightarrow B / C \_\_ D / E \_\_ F$ has the meaning $ECADF \rightarrow ECBDF$. Thus our earlier conventions have already accounted for rules of the form (25). The order of the rules abbreviated in this way, which we will discuss below, is also strictly determined by the definition of the notation $A \rightarrow B / C \_\_ D$ as an abbreviation for $CAD \rightarrow CBD$. (See pp. 31–33, Chapter Two.)

To apply rule (25) to a string φ, we ask first whether φ is a noun with a lax vowel in its final syllable, that is, whether it meets condition (b). If not, we turn to condition (e). Suppose, however, that the answer to the first question is yes, so that φ is of the form:

(26)
$$\varphi = \psi \begin{bmatrix} -\text{tense} \\ \mathrm{V} \end{bmatrix} \mathrm{C}_0]_{\mathrm{N}}$$

We now ask whether ψ falls under case (i). If it does, we assign primary stress as indicated by (25bi), and we skip (ii) since the order (i), (ii) is disjunctive. If ψ does not fall under case (i), we ask whether it falls under case (ii), and, since the answer to this question is always yes, we assign stress to the last vowel of ψ, as required by (25bii).

No matter what has happened so far to the string φ, we now ask whether it meets condition (e). The answer is always positive. We therefore apply case (i) if the final cluster of φ is weak (skipping case (ii) because of the disjunctive ordering), or we apply case (ii) if the final cluster of φ is strong.

As matters now stand, rule (25) abbreviates a sequence of four rules which apply in the order of (27):

(27) (25bi), (25bii), (25ei), (25eii)

[18] The stress pattern of nouns with a tense vowel in the final syllable does not follow the present rule; e.g., *anecdote*, *Palestine*, *magazine*, *attaché*. These cases are discussed in Sections 4 and 16.

[19] In order to preserve uniformity of reference in the various versions of the rules that we will consider, we will designate the subparts of these rules by the symbols that will identify them in the final formulation to be given in this chapter. Thus here we give only conditions (b) and (e); others will be added below.

The subsequence (25bi), (25bii) forms a disjunctively ordered block, as does the subsequence (25ei), (25eii). The block (25ei), (25eii) is simply the sequence represented as (21) and discussed in Section 2. In the case of the verbs of Section 2, condition (b) is never met and (25) has exactly the effect of (21).

Let us now turn to the examples of (24). Consider first *America*, as a prototype of column I. Condition (b) of (25) holds, since the last vowel of *America* is nontense and the word itself is lexically marked as a noun. Dropping from consideration the context indicated in condition (b), we are left with the string *Americ-*, to which we must apply rules (i) and (ii) of (25), in that order. Case (i) is applicable; it assigns primary stress to the penultimate vowel of *Americ-*, giving *América*. Case (ii) is skipped because of disjunctive ordering. We next turn to condition (e) of rule (25). Unfortunately, this is applicable, as it always is, and case (i) will give the form **América*. We must therefore prevent the application of condition (e) in this case. In fact, as we shall see, application of condition (e) must always be blocked when condition (b) has applied. In other words, the ordering of (b) and (e) must be disjunctive if the rules are to apply correctly.

We will return directly to the question of the disjunctive ordering of conditions (b) and (e). Let us now simply assume that the ordering of (27) is fully disjunctive; that is, if any one of the rules of (27) applies, the later ones in the sequence are skipped.[20] The examples of column I of (24) are now correctly handled.

Turning to column II, let us take *arOma* as a prototype. Condition (b) holds, giving *arOm-* as the string to which cases (i) and (ii) are to be applied. Case (i) is blocked by the tense vowel of the final syllable of *arOm-*. We can therefore go on to case (ii), which assigns primary stress to this tense vowel. Condition (e) is then skipped because of the disjunctive ordering, and we are left with *arÓma*. The example *veranda* of column III is treated in exactly the same way, except that application of case (i) under condition (b) is now blocked by the consonant cluster *-nd-* instead of by the tenseness of the penultimate vowel. The other examples of columns II and III are handled in exactly the same way.

Thus rule (25) correctly determines the placement of primary stress for the verbs of (18) and the nouns of (24). The only difference between the verbs and the nouns is that for the latter, a final string VC_0 (where V is lax) must be omitted from consideration before the application of the rule to either (i) the syllable preceding a weak cluster or (ii) the final vowel, that is, the strong final cluster of the string under consideration at this point.

This distinction between nouns and verbs with respect to stress placement can be illustrated with bisyllabic forms as well as with the longer examples of (24). Thus, nouns such as *lárynx*, *lántern*, *témpest*, *stípend*, *ínfant*, *ónyx*, *mállard* have penultimate rather than final stress, indicating that stress has not been assigned under condition (e) of rule (25).

Further support for the rule in the form given is provided by doublets such as *umbílicus–umbilÍcus*, *ábdomen–abdÓmen*. In accordance with (25), we have penultimate stress if the penultimate vowel is taken to be tense in the underlying representation, and antepenultimate stress if the penultimate vowel is taken to be lax.

Exceptions to rule (25) will readily come to mind, e.g., *cemént*, *giráffe*, *burlésque*, *Mississíppi*, *ellípse*, *umbrélla*. We will return to several classes of real and apparent exceptions in Section 16.[21]

[20] Since the ordering of cases (i) and (ii) is disjunctive, to achieve full disjunctive ordering in (27) it is necessary only to add the condition that the ordering of (b) and (e) is disjunctive.

[21] See also Chapter Two, Section 7.

The following nouns have the same stress pattern as those of (24):

(28)

I	II	III
búffalo	*albíno*	*commándo*
archipélago	*casíno*	*embárgo*
rádio	*volcáno*	*fiásco*
bróccoli	*macaróni*	*chiánti*
menágerie	*shillélagh*	*attórney*
Menómini	*Winnipesáukee*	*Ypsilánti*
kínkajou	*Kikúyu*	*jujítsu*

In the dialect of American English that is the basis for our description, these nouns end in tense vowels. Therefore they do not fall under rule (25), and their stress pattern is still unexplained.

We note, however, that in this dialect, there are peculiar gaps in the phonetic distribution of vowels in final position. Roughly speaking, we have the following vowel system in English:

(29)

i	u	NONLOW
e	o	
æ	ɔ	LOW

For the purposes of this discussion, we distinguish only the low vowels from the nonlow vowels, and we note that in each position in (29) there is a tense-lax pair (see discussion of (16), p. 68). Limiting ourselves to nonstressed (i.e., minus-stressed) vowels in final position, we find only tense nonlow vowels, as in (28), and the reduced vowel [ə] (see note 1). There are no lax nonlow vowels in this position,[22] and the low vowels of (29) do not appear at all, tense or lax (with apparent exceptions that we will note). Thus it would seem that unstressed low vowels reduce to [ə] in final position, while unstressed nonlow vowels become tense. Since there are no stressed lax vowels in final position, these must become tense as well. These observations suggest that we add to the grammar a rule tensing stressed vowels and nonlow nonstressed vowels in final position, and that we then formulate the Vowel Reduction Rule so that it does not apply to vowels that are tense. Further investigation of vowel reduction in Section 14 will support this suggestion, as we shall see.

Notice, furthermore, that the rule tensing vowels applies not only in final position, but also in prevocalic position. Thus, in words such as *society*, *neophyte*, *archaic*, the vowel in boldface position is tense [I], [E], [A], respectively.

Combining these observations, we might give the Tensing Rule in the form (30):

(30)

$$V \rightarrow [+\text{tense}] \; / \; \left[\begin{array}{c}\overline{\qquad}\\ \alpha\text{low} \\ \beta\text{stress}\end{array}\right] \left\{\begin{array}{l}V \\ \#, \text{ where } \beta = + \text{ if } \alpha = +\end{array}\right\}$$

With rule (30) in the grammar, we can now allow all vowels to appear freely in final and

[22] There is apparently considerable dialectal variation here, as has been noted repeatedly in the literature, as, for example, the comments on final *-y* in Kenyon and Knott (1944): "When final, the unaccented vowel in *pity* . . . and similar words varies with different speakers in America from a sound like the ɪ in *bit* . . . or like the first ɪ in *pity* . . . to a sound that approaches the *i* in *bee*. . ." (p. xviii).

Notice that of the nonlow vowels, only [i], [o], and [u] appear in the examples of (28) ([u] only marginally). Thus there is an additional gap in phonetic distribution beyond that under discussion here, namely, in the case of final [e]. We return to this matter in Section 16.

prevocalic position in underlying forms. In particular, the final vowel of the items of (28) can be lax. Thus the examples of (28) are assigned stress by rule (25) in exactly the same way as those of (24). Then, after stress assignment, they become subject to rule (30) and the Vowel Reduction Rule. When the final vowel is phonologically low and lax, it will reduce, as in *Canada* (from /kænædæ/), *agenda* (from /ægendæ/). When it is nonlow, it will become tense by rule (30) and will remain unreduced, as in the examples of (28).

Notice that as rule (30) now stands, it tenses all vowels in prevocalic position, independent of lowness or stress. Thus we find unstressed tense vowels in the boldface positions of *várious*, *árduous*, *árchaism* ([árkAizm]), *Hébraism* ([hébrAizm]), etc. We shall see in the next chapter that the [A] of the last two examples derives from a phonologically low vowel. There is, however, another dialect in which the forms *archaism*, *Hebraism* are phonetically [arkəizm], [hebrəizm]. To derive these results, we assume that the affix *-ism* is preceded by #.

We shall observe, as we proceed, that there are quite a few examples of conditions such as that on α and β. Conditions of this sort are not, strictly speaking, formulable within the framework we have established up to this point. However, in Chapter Eight, where we give a careful analysis of the postulated notational system, it will be seen that such conditions can actually be accommodated in a rather natural way.

We will see in the next chapter that rule (30) is one of several tensing rules. Examples with phonologically tense vowels in final position will be considered at the conclusion of the next section.

Our decision to represent the underlying final vowel in words such as *fiásco*, *Chicágo* as nontense may raise some question, since a nontense /o/ (i.e., the lax counterpart to the vowel in *cone*) does not appear phonetically in the utterances of the dialect we are describing. But we specifically reject the assumption that there must be a one-one relationship between the underlying lexical or phonological representation and the phonetic output, and we see no reason to suppose that underlying representations will be restricted to segments that appear in phonetic representations. Such a requirement would, in fact, be quite artificial and ad hoc. Whatever motivation it might have had is lost once the classificatory and phonetic functions of distinctive features are distinguished. We will find other empirical examples which, like the example of /o/ just discussed, indicate that no strong one-one requirement on linguistically significant representations can be maintained; and we will, furthermore, find good evidence that underlying /o/ also appears nonfinally in lexical representations. Postulation of phonetically unrealized segments is no great departure from established practice. Thus, junctures (i.e., what we are calling "boundaries") of the sort that are freely used in all phonemic descriptions do not generally have uniquely identifiable direct reflexes in the utterance.[23]

[23] See Z. S. Harris (1951, Chapter 8); Hockett (1955); Chomsky, Halle, Lukoff (1956). It was once thought that a useful notion of juncture might be developed in purely phonetic terms, specifically, in terms of the tempo of the preceding segments. (See, for example, Stockwell, Bowen, Silva-Fuenzalida (1956, p. 643); Hill (1958, p. 24); and the discussion in Hill (1962).) This proposal was supported by the claim that such phonetic correlates are "clearly audible" and by reference to a few observations reported by Joos (in Hill, 1962), which were taken to show that the slowing down in tempo for the three postulated junctures was, respectively, "approximately two average phoneme lengths," "about one-half phoneme length less," and "about one average phoneme length" (Stockwell, et al., 1956). That anyone still retains this hope is doubtful, particularly in the light of the criticism in Lehiste (1964) and the results of Lieberman (1965).

(*continued on page 76*)

Summarizing the discussion so far, we have established the rule (25), which, as a first approximation, accounts for placement of primary stress in nouns with a lax vowel in the final syllable (condition (b)) and elsewhere (condition (e), which we have so far illustrated only with verbs). The rule has two cases which apply under each of these conditions: case (i) assigns primary stress in the syllable preceding a weak cluster and case (ii) assigns primary stress to the final vowel. The two cases are disjunctively ordered, so that case (ii) in fact applies to monosyllables and to strings with final strong clusters. The two conditions (b) and (e) are also disjunctively ordered, so that the parts of the rule (namely, (bi), (bii), (ei), (eii)) constitute a disjunctively ordered block. Rule (25), with its successive modifications, will henceforth be referred to as the Main Stress Rule.

Still to be accounted for is the requirement that conditions (b) and (e) are disjunctively ordered. We will naturally try to accomplish this on the basis of some general empirical assumption regarding the form of grammars, instead of leaving it as an ad hoc and particular constraint. Earlier, we proposed that when rules can be simplified by the parenthesis notation, they are disjunctively ordered. Suppose, in fact, that we were to modify slightly our notation for marking surface structure, using a string of symbols such as N] instead of labeled brackets such as $]_N$. The two conditions of rule (25) would, in this notation, be expressed as:

(31) $$\text{—} \left\{ \begin{array}{ll} \left[\begin{array}{c} -\text{tense} \\ \text{V} \end{array} \right] C_0\, \text{N}] & \text{(b)} \\ ] & \text{(e)} \end{array} \right\}$$

Utilizing the parenthesis notation, we can simplify this to:

(32) $$\text{—} \left(\left[\begin{array}{c} -\text{tense} \\ \text{V} \end{array} \right] C_0\, \text{N} \right)]$$

Hence, if we were to use the notation N] instead of $]_N$ for representing surface structure, the conditions (b) and (e) would be assigned a disjunctive ordering automatically by our general empirical assumption about simplifiability with the parenthesis notation. But obviously there can be nothing of any significance that turns on the choice between these two notations for representing surface structure. We must therefore extend our system for expressing rules in such a way as to eliminate this particular discrepancy between the notations. This can be accomplished readily by generalizing the parenthesis notation so that it permits the expression of discontinuous dependencies. For this purpose, we will make use of angled brackets $\langle\ \rangle$ in the following way. An expression of the form (33) is to be an abbreviation for the

---

McCawley (1967b) gives evidence that Sapir, in his phonological analysis, accepted the convention that we are rejecting here, namely, that segments can appear in a phonological representation only if they also appear, somewhere, in phonetic representations. (Actually, due to other differences in the theoretical framework, the assumptions are not strictly identical.) We have remarked in various places that our approach to problems of phonological structure is in many respects very similar to that of Sapir, although quite different from that developed in both the United States and Europe since the mid-1930s. (In fact, the title of this book is intended to suggest just this.) If McCawley's observations are correct, this historical remark must be qualified, though it remains true that in many significant respects we are following in the general line of Sapir's approach to linguistic structure.

two expressions in (34), in the order given:[24]

(33) $$X_1\langle Y_1\rangle X_2\langle Y_2\rangle \ldots X_n\langle Y_n\rangle X_{n+1}$$

(34) (a) $X_1 Y_1 X_2 Y_2 \ldots X_n Y_n X_{n+1}$
(b) $X_1 X_2 \ldots X_n X_{n+1}$

In other words, an expression with angled brackets abbreviates two expressions—one in which all angled elements appear and another in which none of these elements appear. This is a generalization of the use of parentheses to the case of discontinuous dependencies. It is therefore quite natural to stipulate as a general principle that when rules can be simplified by this notation, they are disjunctively ordered.

Returning to the two conditions of rule (25), we can now abbreviate them in the form:

(35) $$\text{——}\langle\begin{bmatrix}-\text{tense}\\ \text{V}\end{bmatrix} \text{C}_0\rangle]_{\langle \text{N}\rangle}$$

Summarizing, the Main Stress Rule can now be given in its fully abbreviated form (36):

(36) $$\text{V} \rightarrow [1\ \text{stress}] \;/\; \text{——C}_0\left(\begin{bmatrix}-\text{tense}\\ \text{V}\end{bmatrix}\text{C}_0^1\right) \;/\; \text{——}\langle\begin{bmatrix}-\text{tense}\\ \text{V}\end{bmatrix}\text{C}_0\rangle]_{\langle \text{N}\rangle}$$

The expression (36) abbreviates the four rules (27), and, furthermore, it assigns a fully disjunctive ordering to these four rules. For ease of exposition, we will continue to present the rules in the expanded form (25), bearing in mind, however, that they are disjunctively ordered.

As far as we know, the only cases of disjunctive ordering are those in which rules can be simplified in terms of parentheses and angled brackets, and in all such cases the rules are disjunctively ordered. If this is correct, we can tentatively propose the following quite strong empirical hypothesis: *where parentheses or angled brackets are required* (see note 16) *for the abbreviation of a sequence of rules, these rules are disjunctively ordered; in all other cases, rules are conjunctively ordered* (but see Chapter Eight, Sections 3 and 4). We have too little evidence to be able to assert this as a general hypothesis about linguistic structure with full confidence, but we will adhere to it, with some refinements and elaborations, in this study of English phonology.

4. *Alternating Stress Rule*

Let us now consider the effect of the Main Stress Rule on nouns with a tense vowel in the final syllable of the phonological representation, for example, the word *domaín* (phonologically, /dOmAn/). Since the vowel in the final syllable is tense, condition (b) of rule (25) is not met, and case (i) is inapplicable under condition (e). Thus, by (eii), primary stress is

[24] We will use the angle notation in several closely related ways as we proceed, giving a precise and general account in Chapter Eight, where parentheses are also covered as a special case. We will interpret a string $X\langle Y\rangle Z$, where X and Z contain no angles, as the same in meaning as XZ.

We should point out that the angle notation is not invented ad hoc for the description of English. In fact, the angled bracket and parenthesis notations have been used in essentially the way we use them here in most of the work in generative grammar, particularly generative phonology, during the past fifteen years. As we have now noted several times, the choice of abbreviatory notations within our framework amounts to an empirical hypothesis regarding the notion "linguistically significant generalization" and, ultimately, regarding the basis for language acquisition. The fact that the same notations appear adequate in a wide variety of cases is therefore a matter of some interest.

placed on the final syllable, giving *dOmÁn*. In the same way, rule (25) accounts correctly for the position of primary stress in nouns such as:

(37) *machíne, brassiére, regíme, careér, baróque, toupée, canóe, cheróot, políce, bazáar, brocáde*

In searching for additional examples of nouns with final stress, we observe that there are few examples with three or more syllables. There are, of course, words such as *Tennessée, attaché, chandeliér, kangaróo, chimpanzée*, and almost all words ending in certain suffixes (e.g., *-eer, -ier, -ee, -ette*). However, the large majority of words of three or more syllables have primary stress on the antepenultimate vowel and tertiary stress on the final vowel, as in the examples in (38):

(38) *húrricàne, ánecdòte, pédigrèe, níghtingàle, mártingàle, mátadòr, formáldehỳde, báritòne, gúillotìne, Árkansàs, ántelòpe, stévedòre, hypótenùse, cándidàte, cávalcàde, cántalòupe*

The Main Stress Rule will account for *Tennessée, attaché*, etc., but not for the large mass of examples illustrated by (38), which would incorrectly receive final primary stress by case (ii), under condition (e). To account for forms such as those in (38), we must add a new rule that applies after the Main Stress Rule and assigns primary stress to the vowel of the antepenultimate syllable. We will call this rule, which we formulate as (39), the Alternating Stress Rule:

(39) $$V \rightarrow [1 \text{ stress}] \ / \ \text{——} C_0VC_0\overset{1}{V}C_0]$$

Consider now a typical example with (39)—*hurricAn*, for instance. By rule (25eii), primary stress is assigned to the final vowel, giving $hurric\overset{1}{A}n$. By the Alternating Stress Rule (39), primary stress is then assigned to the first vowel, and the stress on the final vowel is automatically reduced to secondary (see p. 64), giving $\overset{1}{h}urric\overset{2}{A}n$. To obtain the conventional representation, we add the very late subsidiary rule (40), which limits secondary stress to constructions longer than the word:

(40) Within a word, all nonprimary stresses are weakened by one.[25]

We will refer to rule (40) as the Stress Adjustment Rule. In the case of *hurricane*, it gives, finally, $\overset{1}{h}urric\overset{3}{A}n$, as required. The other examples of (38) are taken care of in exactly the same way. The few words like *Tennessée* and *attaché*, on the other hand, must be lexically categorized in some way so as to prevent application of the Alternating Stress Rule (39). We thus put them, for the moment, in the class of exceptions. Notice, incidentally, that for some words (e.g., *refugee, magazine*), application of the Alternating Stress Rule is optional.[26]

Rule (39) produces alternations of stressed and unstressed vowels. It is thus one of the factors contributing to the frequently observed predominance of iambic rhythms in English.

[25] We will formulate this rule precisely later on. Notice that the rule is, in effect, a terminological convention regarding the designations "primary," "secondary," etc. It is a natural convention, since it retains integral values for the perceptual stress levels. Notice also that this rule does not apply until we reach the level of word boundary in the cycle.

[26] In the next chapter, we will discuss a method for marking exceptions to rules which will also make it possible to describe situations such as this.

Notice that the final stress of such words as *Tennessee* may shift in certain syntactic constructions (cf. *Tênnessèe Williams, Tênnessèe Válley*). We return to this phenomenon on page 117.

The examples of (38) are all nouns, but the Alternating Stress Rule applies to verbs as well. In columns II and III of (18) (that is, the verbs with final stress, p. 69) all the examples were bisyllabic. But consider verbs such as:

(41) *víolàte, extrápolàte, insínuàte, expérimènt, ímplemènt, gállivànt, cáterwàul, éxercise, éxorcise, órganize, récognize, solídifỳ, transmógrifỳ*

In these cases the tense vowel of the final syllable receives tertiary rather than primary stress, and the primary stress is antepenultimate, exactly as in the case of the nouns of (38). The reason is identical. Thus, the final vowel of *vIolAt* receives primary stress under case (25eii) of the Main Stress Rule, and rule (39) shifts the primary stress to the first syllable, giving $\overset{1}{v}I\overset{2}{o}lAt$. Rule (40) then adjusts this representation to $\overset{1}{v}I\overset{3}{o}lAt$. The other examples are derived in the same way.

In discussing the examples of (28) in Section 3, we concluded that all vowels can appear in word-final position in underlying representations, and the Tensing Rule (30) will combine with Vowel Reduction to convert the nonlow lax vowels to their tense counterparts and the unstressed low vowels to [ə] in this position. Now we are able to compare polysyllabic words having final lax vowels in their lexical representations (e.g., words such as *búffalo, albíno, commándo*, and the others of (28)) with words having final tense vowels in their lexical representations.

Consider, for example, the word *Arkansas*. Notice first of all that there are the alternative pronunciations [$\overset{1}{\text{ā}}$rkənsɔ̄$\overset{3}{\text{w}}$], [$\overset{1}{\text{ā}}$rkænzəs]. The latter is straightforward; it derives from /ærkænzVs/, with an unspecified lax vowel in the final syllable, by case (25bii) of the Main Stress Rule and other rules irrelevant here. The former derives from a lexical representation in which the final vowel is tense rather than lax, and in absolute final position rather than before /s/. Condition (b) of the Main Stress Rule (25) is therefore excluded, and by (25eii) we derive $\overset{1}{a}rkans\overset{1}{a}s$. This becomes $\overset{1}{a}rk\overset{2}{a}ns\overset{1}{a}s$ by the Alternating Stress Rule (39) and $\overset{1}{a}rk\overset{3}{a}ns\overset{1}{a}s$ (= [$\overset{1}{\text{ā}}$rkənsɔ̄$\overset{3}{\text{w}}$]) by the Stress Adjustment Rule (40).

Similarly, consider such familiar pairs as $\overset{1}{e}ffigy$–$ref\overset{1}{U}g\overset{3}{E}$ and $\overset{1}{K}ennedy$–$chickad\overset{3}{E}$. Here we have a phonetic contrast of tertiary versus quaternary (zero) stress on the final [E]. We account for the distinction by giving the lexical representations /efVgi/–/refug+E/, /kenVdi/–/čikVdE/, respectively.[27] The stress pattern of $\overset{1}{e}ffigy$ and $\overset{1}{K}ennedy$ is, then, determined by rule (25bi), exactly as in the case of the examples of (28), column I. The stress pattern of $\overset{1}{r}efug\overset{3}{e}e$ and $\overset{1}{c}hickad\overset{3}{e}e$, on the other hand, is determined by rules (25eii), (39), and (40), exactly as in the case of *hurricane*, *Arkansas*, etc. We have here the alternants $ref\overset{1}{U}gee$, $\overset{1}{c}hickadee$ in the case where application of rule (39) is blocked (as in *Tennesseé*, *attaché*). The (fairly free) alternation in this case supports the decision to take the final vowel to be lexically tense. The variants are then determined by an optional lexical feature which blocks rule (39). Tensing and diphthongization of the final vowel are automatic, by the Tensing Rule (30) and other rules that we discuss in the next chapter, in all the cases in question here.

5. *Stress placement in adjectives*

We have so far considered only nouns and verbs, but the rules we have given apply to adjectives as well. Consider the examples of (42), in which columns I, II, III correspond to columns

[27] We are concerned here only with the final vowel, but, as we shall see in the next chapter, the lexical representations given here are essentially correct, *in toto*.

I, II, III of (18) and (24), and column IV corresponds to (38) and (41):

(42)

I	II	III	IV
sólid	*supréme*	*absúrd*	*mánifèst*
frántic	*sincére*	*corrúpt*	*résolùte*
hándsome	*secúre*	*imménse*	*dérelìct*
clandéstine	*ináne*	*abstráct*	*díffícùlt*
cértain	*obscéne*	*robúst*	*móribùnd*
cómmon	*obscúre*	*ovért*	*cómatòse*
vúlgar	*extréme*	*augúst*	*sáturnìne*
wánton	*remóte*	*succínct*	*rétrogràde*
shállow	*discréet*	*occúlt*	*láchrymòse*
stúrdy	*compléte*	*diréct*	*érudìte*

The placement of primary stress on the penult in column I is determined by rule (25ei). (The last two examples in column I involve an application of rule (30) as well, to tense the underlying lax vowel in word-final position.) In columns II and III, the final syllable is stressed by rule (25eii). In column IV, the final syllable is stressed by rule (25eii), exactly as in the case of columns II and III, but then the primary stress is shifted two syllables to the left by the Alternating Stress Rule (39) and the contour is adjusted by rule (40). Thus the four types of forms *solid*, *supreme*, *absurd*, *manifest* are all assigned their proper stress contours.

We find, as in the case of nouns, that the Alternating Stress Rule is optional for certain adjectives. Thus, alongside of *obsolete* we have *obsolete*; alongside of *absolute* we have *absolute*. This option is restricted to certain adjectives with tense vowels in the final syllable. Another occasional doublet is *clandestine* (with a final lax vowel and penultimate stress) versus *clandestIn* or *clandestEn* (with a tense vowel in the final syllable and antepenultimate primary stress). In this case it is the choice of the final vowel that is free. Once its tenseness is determined, the position of primary stress is automatic.

To the exceptions that we noted before, we must now add several others, e.g., *módern*, *hónest*, *hággard*.

6. *Derivational affixes*

Consider the following adjectives, all of which end in a suffix consisting of a lax vowel followed by one or more consonants:[28]

[28] Strong examples for column II in (43) are rare: there are few polysyllables with final tense vowels before these affixes, and some of them (e.g., *sonórous*, *decórous*) have variants with a lax vowel (in which case the examples will fall in column I). The reason for including *polyhedral* and *polyhedrous* in column II rather than column III will be given directly.

Certain words that might seem appropriate for column II (e.g., *audácious*, *ferócious*) actually belong in column I, since the orthography is, in these cases, essentially correct as an underlying representation, for reasons which will become clear in the following chapter. Notice that if this were not so, certain examples (e.g., *judícious*, *auspícious*) would be exceptions.

(43)

I	II	III
pérsonal	*anecdótal*	*dialéctal*
máximal	*adjectíval*	*incidéntal*
medícinal	*sacerdótal*	*fratérnal*
munícipal	*polyhédral*	*univérsal*
ephémeral	*mediéval*	*abýsmal*
magnánimous	*desírous*	*moméntous*
polýgamous	*polyhédrous*	*amórphous*
rígorous		*polyándrous*
precípitous	*sonórous*	*treméndous*
calámitous	*decórous*	*stupéndous*
vígilant	*complaísant*	*repúgnant*
méndicant	*defíant*	*relúctant*
signíficant	*clairvóyant*	*obsérvant*
árrogant	*obeísant*	*indígnant*
díssonant	*adjácent*	*redúndant*
ínnocent	*complácent*	*depéndent*
díffident	*antecédent*	*contíngent*
benévolent	*inhérent*	*recúmbent*

The similarity of these examples to those of (18), (24), and (42) is evident, and we therefore would naturally expect that the Main Stress Rule (25) would account for (43) with at most minor modifications. Notice, in fact, that rule (25) would account for these examples directly if we were to extend condition (b) of (25) to adjectives as well as nouns. We cannot simply do this, however, for consider the effect on the examples of (42), in particular those of column III. If these are assigned stress by the noun rule (25b), stress will fall on the first syllable.[29] Similarly, the examples of column IV of (42) with final double consonant require the verb rule (25e), rather than the noun rule (25b), to account for the tertiary stress on the final syllable.

We conclude, then, that the adjectives of (43) are subject to the noun rule, while those of (42) are not. The basis for the distinction of these two classes is evident; the examples of (42) are primary adjectives, unanalyzable into stem plus adjectival suffix, while those of (43) are secondary adjectives, formed by adding a suffix to a stem. Thus primary adjectives are assigned stress by the verb rule (25e), while secondary adjectives are assigned stress by the noun rule (25b).

We can express this fact by adding, alongside of condition (b), a new condition (a) which is exactly like (b) except that the sequence it specifies is a monosyllabic formative. Thus we have the two conditions (44a) and (44b) (where $+$ in (a) stands for formative boundary—see pp. 66–67):

[29] As it actually does in the case of the exceptions *hónest*, *módern*, *hággard*, etc., noted above. Thus an extension of condition (b) to adjectives would make these regular and the examples of (42), column III, exceptions. But the latter are much more numerous, and, furthermore, there are subregularities among the former that allow a still more succinct statement of exceptions in this case. There are also, as we will see, other reasons for distinguishing the adjective rule from the noun rule.

(44) $$+C_0\begin{bmatrix}-\text{tense}\\ V\end{bmatrix}C_0]_A \quad \text{(a)}$$

$$\begin{bmatrix}-\text{tense}\\ V\end{bmatrix}C_0]_N \quad \text{(b)}$$

Using the angle convention discussed on pages 76–77, we can abbreviate the two cases of (44) as (45):

(45) $$\langle +C_0\rangle\begin{bmatrix}-\text{tense}\\ V\end{bmatrix}C_0]_{N\langle A\rangle}$$

This abbreviates a disjunctively ordered sequence of two conditions: the first applies to a noun or an adjective with a final monosyllabic formative containing a lax vowel; the second applies to a noun with a lax vowel in its final syllable. Since the ordering is disjunctive, (45) truly abbreviates (44). (If the ordering were conjunctive, (45) would have a different effect from (44) in the case of nouns, since both of the rules abbreviated by (45) would apply.)[30]

The formula (45) is the appropriate way to present the facts that we have so far exhibited, but for ease of exposition, we will keep the two cases separate in this discussion and refer to the unabbreviated form (44). We will consider in the next section the question of compatibility between (45) and the abbreviation (36) for conditions (b) and (e) of the Main Stress Rule.

In sum, we allow the Main Stress Rule to apply under both of the conditions given in (44) (= (45)), that is, to a noun with a lax vowel in the final syllable or to an adjective with a monosyllabic suffix containing a lax vowel. We apply cases (i) and (ii) of (25) after omitting from consideration the final $+C_0\check{V}C_0$ string (or $\check{V}C_0$ string in the case of nouns).

Before restating the expanded Main Stress Rule, we take note of another qualification that must be added. Consider the adjectives:

(46) *éloquent, recálcitrant, chívalrous, lúdicrous, vértebral*

These have stress on the antepenultimate vowel, indicating that they are treated by the Main Stress Rule as examples of column I rather than column III of (43). In other words, stress is assigned to these words by case (i) of (25) rather than by case (ii). But case (i) assigns stress to a syllable followed by a weak cluster, that is, followed by a lax vowel and no more than a single consonant, whereas in (46) the penultimate lax vowel is followed by two consonants. Evidently, we must extend the notion "weak cluster" to include a lax vowel followed by no more than a single consonant followed by an optional liquid or glide.

Closer examination reveals that clear examples of such clusters are restricted to those ending with [r] and [w]. Since the absence of clusters ending with [y] is due to the fact that [y] is generally not found in postconsonantal position, we need not restrict our rule so as to exclude such sequences explicitly. On the other hand, the absence of weak clusters ending in [l] suggests that we explore the possibility that clusters ending in a consonant followed by [l] are strong rather than weak. An immediate consequence of this is that the geminate

[30] There is a further difference between (44) and (45) for the case of nouns of the form $\ldots VC_0\check{V}C{+}C_1VC_0$ or $\ldots VC_0\check{V}{+}C_2VC_0$, where $\check{V}$ is a lax vowel. Rule (44) would assign primary stress to the penultimate syllable in such cases, whereas rule (45) would assign antepenultimate stress. We have no very clear examples one way or the other. We may, however, make use of (45) in describing such exceptions to the general rules as *minister*, for example. The lexical representation cannot be /ministr/ (cf. *ministérial*), but must rather have /ster/ as its final syllable. By rule (44) the stress contour should then be **minister*. If we give the lexical representation as /mini+ster/, however, rule (45) will assign stress in the proper way.

sequence [ll] renders a cluster strong. There must be in the grammar a special rule that simplifies geminate sequences of consonants (see (156) below and rule (67) of Chapter Two). We can, then, account for the placement of primary stress in adjectives such as *cerebéllar, morbíllous, medúllar* by representing these with geminate /ll/, as opposed to *céphalous, périlous, scúrrilous*, etc., which have a single /l/ in the underlying representation, or *chívalrous*, which contains a weak cluster ending with /r/. Notice that [r] *followed by* a true consonant gives a strong rather than a weak cluster:[31]

(47) *fratérnal, detérgent, univérsal, obsérvant, amórphous*

The proposed extension of the concept "weak cluster" (and the corresponding modification of the Main Stress Rule) is needed also for nouns, that is, for the examples falling under condition (b). Thus we have *álgebra, vértebra*, with antepenultimate rather than penultimate stress, indicating that the penultimate syllable is treated as a weak cluster, as opposed to *armadíllo, vanílla, umbrélla*, with a strong cluster ending in a geminate /ll/.[32]

To express the concept of weak cluster properly in our rules, we refer to the feature analysis of liquids and glides given in (15) (p. 68). Liquids are consonantal and vocalic; glides are nonconsonantal and nonvocalic. Thus liquids and glides are the categories that are identical in specification with respect to the features "vocalic" and "consonantal." We will follow the practice of using small Greek letters as variables ranging over feature specifications (that is, over the symbols + and − and the integers). With this convention, we can characterize liquids and glides as the category:

(48) $$\begin{bmatrix} \alpha\text{vocalic} \\ \alpha\text{consonantal} \end{bmatrix}$$

However, we need to exclude [l] as the last segment in a weak cluster while allowing [r]. The difference between [l] and [r] in feature terms is that [l] is [+anterior], whereas [r] is [−anterior]. Glides, on the other hand, are [−anterior]. (See Section 3 of Chapter Four.) Thus, in the feature notation that we have adopted in this book, a cluster is weak if it ends in a consonantal segment followed by a segment which is [−anterior] and in which the coefficients of the features "vocalic" and "consonantal" assume the same value. A weak cluster will therefore be represented as:

(49) $$\begin{bmatrix} -\text{tense} \\ \text{V} \end{bmatrix} C_0^1 \begin{bmatrix} \alpha\text{voc} \\ \alpha\text{cons} \\ -\text{ant} \end{bmatrix}_0$$

7. *Summary of stress placement rules*

The stress rules we have discussed so far are the Main Stress Rule, the Alternating Stress Rule, and the Stress Adjustment Rule. These rules now have the following tentative form:

[31] At this stage of representation, there are no sequences VGC, where G is a glide, since diphthongs are still represented as single tense vowels. See note 15.

[32] We again make note of several apparent exceptions, e.g., *pellágra, candelábra, allégro* (in the dialectal variant with a phonetically lax penultimate vowel). We return to these in Section 16. There also seem to be some cases where the sequence VC*l* acts as a weak cluster. See note 82 and pages 140 and 197.

We are indebted to J. Fidelholtz and J. R. Ross for the particular form of the concept of weak cluster that has been adopted here.

(50) MAIN STRESS RULE

$$V \rightarrow [1\ \text{stress}] \Big/ [X \text{——} \begin{cases} C_0 \begin{bmatrix} -\text{tense} \\ V \end{bmatrix} C_0^1 \begin{bmatrix} \alpha\text{voc} \\ \alpha\text{cons} \\ -\text{ant} \end{bmatrix}_0 & \text{(i)} \\ C_0 & \text{(ii)} \end{cases}$$

$$\Big/ \text{——} \begin{cases} +C_0 \begin{bmatrix} -\text{tense} \\ V \end{bmatrix} C_0]_{NA} & \text{(a)} \\ \begin{bmatrix} -\text{tense} \\ V \end{bmatrix} C_0]_N & \text{(b)} \\ ] & \text{(e)} \end{cases}$$

(51) ALTERNATING STRESS RULE

$$V \rightarrow [1\ \text{stress}] \ / \text{——} C_0 V C_0 \overset{1}{V} C_0]_{NAV}$$

(52) STRESS ADJUSTMENT RULE

Within a word, all nonprimary stresses are weakened by one.

Rule (52) is noncyclical, applying just at the level of word boundary in the cycle. Rule (50) is the central cyclic rule. Rule (51) will, in fact, apply only once in a derivation, for other reasons, but it is not restricted to the level of word boundary.

Within rule (50) the ordering is automatically determined as (ai), (aii), (bi), (bii), (ei), (eii). Furthermore, the ordering of cases (i) and (ii) is disjunctive, and the ordering of conditions (a), (b), and (e) is disjunctive. These facts are made explicit if we state the Main Stress Rule in its more abbreviated form (see (36), (45)) as follows:

(53)

$$V \rightarrow [1\ \text{stress}] \Big/ [X \text{——} C_0 \left(\begin{bmatrix} -\text{tense} \\ V \end{bmatrix} C_0^1 \begin{bmatrix} \alpha\text{voc} \\ \alpha\text{cons} \\ -\text{ant} \end{bmatrix}_0 \right)$$

$$\Big/ \text{——} \langle_1 \langle_2 + C_0 \rangle_2 \begin{bmatrix} -\text{tense} \\ V \end{bmatrix} C_0 \rangle_1]_{\langle_1 N \langle_2 A \rangle_2 \rangle_1} \qquad \begin{matrix} \langle_2 (a) \rangle_2 \\ \langle_1 (b) \rangle_1 \\ (e) \end{matrix}$$

Angled brackets with the same numerical indices are expanded together. We number the angles here only to bring out the structure of (53) more clearly. The indices are actually superfluous in this case since there is only one way to expand the expression (53) in accordance with our conventions. Later we will make use of indexing of brackets to enrich our system for the formulation of phonological rules.

In accordance with the convention for angled brackets, the expression (53) states that the two rules (50i) and (50ii) are applied in the three contexts (50a), (50b), and (50e), obtained by reading (53) first with all angled material included (case (a)), then with the material enclosed in $\langle_2\ \rangle_2$ excluded (case (b)), and finally with all angled material excluded (case (e)). Furthermore, the ordering of (a), (b), and (e) and of (i) and (ii) is disjunctive. The parenthesis and angle notations therefore characterize the ordering explicitly.

Before illustrating these rules with several examples, we will mention some additional limitations on the applicability of condition (a). Alongside of the affixes that affect stress placement and that are subject to condition (a), there are other "neutral affixes" which characteristically play no role in the placement of stress, for example, the adjective-forming

affixes *-y*,[33] *-like*, *-able*, *-ish*, and affixes such as *-ing*, *-past tense*, *-hood*, *-ness*, *-ly*, *-wise*. We can indicate the fact that an affix is neutral by making use of the # boundary which is introduced, by a universal convention, before and after each string belonging to a lexical category, that is, each string dominated by N, A, or V in the surface structure (see Section 1.3.1 and Chapter One, Section 5.3). Thus, the word *soliloquizing*, for example, might be represented in surface structure as:

(54) $$[\,[_{V}\#\text{soliloquIz}\#]_{V}\ \text{ing}]$$

where the word may be functioning as a verb (*he is soliloquizing*), as a noun (*soliloquizing is out of fashion*), or as a noun modifier (*the soliloquizing Dane*). On the first cycle, the innermost constituent receives the stress pattern $[_{V}\text{sóliloquíz}]_{V}$ by rule (50eii) and rule (51). On the second cycle, condition (a) is ruled out since it is limited to affixes preceded by +. Condition (b) is also inapplicable, because of the presence of # in *soliloquiz#ing*. (Recall that #, as opposed to +, must be mentioned in a rule if that rule is to apply to a string containing #.) Condition (e), however, applies, and will shift primary stress, incorrectly, to the affix *-ing* because of the double consonant in the underlying form. To eliminate this possibility, we add to the Main Stress Rule (50), (53) the qualification:

(55) *X* contains no internal # boundary.

This qualification guarantees that a word-internal cycle will be vacuous when it applies to a string of the form $\ldots\#C_0VC_0]$.

Notice that the presence of the # boundary is quite well motivated on different grounds in many of these cases. The inflectional affixes which are neutral with respect to stress also characteristically affect final clusters in the same way as word boundary does. For example, in many dialects /g/ drops after nasals in word-final position but remains in word-medial position, so that we have [siŋ] but [miŋgl] (from underlying /siNg/, /miNgl/, respectively, /N/ being the archi-segment "nasal consonant"). But before *-ing*, *-er* (agentive), *-ed*, *-ly*, etc., /g/ also drops, so that we have [siŋiŋ], [siŋr], contrasting with [fiŋgr]; [riŋd], [hōltiŋly] (or, with a different *-ly* affix, [kiŋly]), contrasting with [siŋgly], the latter from phonological /siNgl#ly/, with the /l/ of /#ly/ dropping after /Cl/; or [kiŋlət], from /kiNg#lVt/, contrasting with [siŋglət], from /siNgl#lVt/.

Furthermore, we must have a rule:

(56) sonorants become syllabic / C—— #[34]

This is needed to account for the fact that in words such as *hinder*, *cylinder*, *remember*,

[33] Not to be confused with the noun-forming *-y* of *democracy*, *presidency*, etc.

[34] The feature "sonorant" is redundant in English, though not in all languages. It distinguishes vowels, liquids, glides, and nasals from nonnasal (obstruent) consonants. A syllabic sonorant consonant will ultimately have the neutral vowel (which we are representing as [ə]—see note 1) inserted before it. Thus *hinder* is phonetically [hindr] = [hindər]. Notice that not all words with a final syllabic sonorant have a final consonant-sonorant cluster in the underlying representation. Thus *odor*, *danger*, *valor*, *titan*, *Homer*, for example, have final vowel-sonorant clusters in both underlying and phonetic representations, as we can see from the forms *odorous*, *dangerous*, *valorous*, *titanic*, *Homeric*.

Notice that rule (56) is also needed to account for stress placement, and that it must follow the Main Stress Rule in the sequence of rules. Consider, for example, the forms *cýlinder*, *cárpenter*. Only rule (50bii) can assign primary stress in the first syllable to these words, but the application of (50bii) here requires that the final cluster be of the form /V̆ndr/, /V̆ntr/, respectively, where V̆ is a lax vowel.

carpenter, *disaster*, *schism*, *burgle*, *twinkle*, the sonorant is syllabic in word-final position although the underlying representations must be /hiNdr/, /siliNdr/, /rEmeNbr/, /kærpVNtr/, /disæstr/, /sizm/, /burgl/, /twiNkl/, as shown by the related forms where these sonorants are not syllabic: *hindrance*, *cylindric*, *remembrance*, *carpentry*, *disastrous*, *schismatic*, *burglar*, *twinkling* (in the sense of "instant," from /twiNkl+liNg/, the /l/ of /liNg/ dropping, as above, after /Cl/). However, the sonorant is also syllabic in forms such as *hindering*, *hindered*, *remembering*, *burgled*, *twinkling* (the participle),[35] indicating that these neutral affixes also carry the boundary #. Similarly, the noun-forming *-y* affix, which is not neutral with respect to stress placement, changes preceding /t/ to [s] (*democrat–democracy*, *president–presidency*), but the neutral, adjective-forming *-y* does not affect final /t/ (*chocolaty*, *bratty*, etc.),[36] indicating that it carries the boundary # that blocks this process.

The affixes that carry # are, to a certain extent, syntactically distinguished. For the most part, these are the affixes that are assigned to a word by a grammatical transformation, whereas the derivational affixes that affect stress placement are, largely, internal to the lexicon. In other words, if # is automatically associated with lexical items and automatically introduced to the right of a suffix (or the left of a prefix) attached to a member of a lexical category by a transformation, then the resulting distribution of boundaries is fairly close to what is required for the operation of the phonological component. This principle for assigning # is the same, in many cases, as the principle that # should be introduced at the boundary of strings dominated by a lexical category in the surface structure (see Chapter One, pp. 12–14). Thus the word *singing* is a verb containing the verb *sing*, and so on.

Notice that # may be deleted before affixes under certain circumstances. Consider, for example, the variants $\overset{1}{a}\overset{3}{n}\overset{3}{a}\overset{1}{l}yzable$–$\overset{3}{a}\overset{1}{n}alyzable$. We can derive the former from the phonological representation $[_{A}\,[_{V}ana+lIz]_{V}\,\#abl]_{A}$, and the latter from the same representation with # deleted. When the word boundary # is present, the stress pattern is that of the underlying form $\overset{1}{a}\overset{3}{n}alIz$ in isolation, since the second cycle is vacuous. When the boundary is dropped, as is not uncommon when *-able* is added to longer forms, the affix *-able* (represented /æbl/) is subject to condition (a) of the Main Stress Rule. Thus, in the second cycle, case (ii) of the rule shifts primary stress to the strong cluster immediately preceding the affix in this example.

So far, then, we have two classes of affixes, those that assign primary stress by the Main Stress Rule and those that carry # boundary and are therefore neutral. Superficial examination would suggest that it is necessary to distinguish two other classes of affixes (apart from those that take primary stress), namely, those of the -1 category, which place primary stress on the final syllable of the string to which they are affixed (e.g., *-ion*, *-ic*, *-ity*, *-ify*), and those of the -2 category, which generally place stress on the penultimate syllable of the string to which they are affixed (e.g., *-y*, *-ate*, *-ize*). Actually, most of these affixes are perfectly regular and require no special comment. In particular, the -2 category is superfluous. As far as *-y* is concerned, we will see in Section 15 that it is entirely regular. Examples such as *íllustr-àte*, *antágon-ìze*, as we shall see, receive their stress contour by the Main Stress Rule, which places primary stress on the final strong cluster, and the Alternating Stress

[35] In more casual speech, the syllabicity of [l̩] (and sometimes even of [r̩]) may disappear as one of many optional modifications of the idealized phonetic form.

[36] Notice that not all cases of adjective-forming *-y* are to be assigned to this /#y/ formative. Thus we have *angry*, *hungry* with the lexical representations /æNgr+y/, /huNgr+y/ (where N represents the archisegment "nasal"). Here the affix is not /#y/, but a different affix, identical in its phonetic form but not in its phonetic effects; it does not carry # and is restricted to adjectives derived from abstract nouns. Clearly this distinction is in accord with the sense as well as the phonetics.

Rule (51), which then shifts primary stress two syllables to the left. In other examples (e.g., *cháracterize*, *rádicalize*), *-ize* is simply a neutral affix preceded by #.

As far as the -1 category is concerned, we see at once that most of its members simply fall under the Main Stress Rule. If we analyze *-ity*, for example, as *-i+ty*,[37] then the fact that stress falls on the syllable immediately preceding it is accounted for by case (ai) of the Main Stress Rule (50), since the "stem-forming" element *-i-* that precedes the final affix is lax.

In fact, aside from the two categories of neutral affixes and affixes that assign stress by the Main Stress Rule, we have only the exceptions *-ic* and *-ion* to deal with among lax affixes, and no further classification need be given. Furthermore, as we have noted, the distinction between neutral and nonneutral affixes is drawn fairly clearly on general grounds. It seems, then, that there is no significant classification of affixes with respect to stress placement; there is the mass of affixes that fall under the general Romance Rule, and, in addition, there is the margin of exceptions to be expected in the case of any phonological rule.

The best way to deal with exceptions is to modify their representations in some ad hoc way so as to enable them to fall under the regular rules, which can then remain unaltered in their simplest and most general form. Thus the fact that *-ion* always places primary stress on the syllable immediately preceding it is easily accounted for if we give *-ion* the underlying representation /iV̆n/, /V̆/ standing for the archi-segment "lax vowel." Words such as *prohibition*, *inhibition*, *nutrition* will now be represented [prohi$\overset{1}{\text{b}}$it+iV̆n], etc., when we enter the second cycle. Condition (a) of the Main Stress Rule (50) does not apply, since the affix contains two vowels, but condition (b) does apply, excluding the final string /V̆n/ from consideration and assigning primary stress to the syllable preceding the weak cluster of the residue /prohibit+i/ by case (i). Thus we have [pro$\overset{2}{\text{h}}$i$\overset{1}{\text{b}}$itiV̆n], which receives its full stress contour in the appropriate way by rules to which we shall turn later on. Primary stress, however, is now correctly placed. The forms in *-Ation* will receive primary stress on /At/, as required, in the same way. In the case of words such as *compúlsion*, *permíssion*, *invásion*, *profúsion*, primary stress will have been placed on the second syllable in the first cycle. (The final stress on verbs like *compél* and *permít* will be accounted for in Section 10 of this chapter.) The second cycle, then, is vacuous. Primary stress will also be placed properly by the same rule in words such as *pavílion*, *battálion*, *chámpion*, *compánion*, *domínion* if we give them the representations /pævil+iV̆n/, etc. Other reasons for treating *-ion* as bisyllabic in the underlying form will appear in Chapter Four, Section 4.1.

To complete the account of *-ion*, we must add the rule:

$$(57) \qquad \text{i} \rightarrow \text{y} \;/\; \begin{bmatrix}\text{dental}\\ \text{C}\end{bmatrix} + \text{---} \text{V}^{38}$$

Thus, rule (57) applies in words such as *battalion*, *pavilion*, *million*, *rebellion*,[39] *companion*, *dominion*, *union*, but it does not apply in *Albion*, *champion*, *clarion*, *criterion*, *oblivion*.

[37] This is well motivated. See note 23, Chapter Two.

[38] In terms of distinctive features, dental consonants are coronal and anterior. We regard [l] as dental, [r] as nondental (in this case, coronal and nonanterior), throughout. Thus the rule applies after [l] and [n] as well as the dental obstruents. We will return to a somewhat more careful formulation of this rule in Section 6 of the next chapter.

[39] In the case of *rebel* (and several other words), rule (57) also applies before *-ous*, giving *rebellious* [rEbelyəs], as opposed to *punctilious* [pʌŋktilEəs], for example. For more discussion of this matter, see Chapter Four, Section 6.

Notice that rule (57) must be in the cycle. Consider the form *convéntional*, for example. On the first application of the cycle we obtain the representation [convent^{1}+iV̌n]. If this representation is submitted to the second cycle with the affix *-al*, primary stress will be placed incorrectly on the /i/ of the affix string /iV̌n+al/ by case (i) of the Main Stress Rule (50) under condition (a). Hence (57) must apply, removing this vowel, before the application of the second cycle.[40] As we shall see rule (57) is actually somewhat more general.

In the case of the second exceptional suffix, namely, *-ic*, we must resort to some similar artifice to account for the fact that it places stress on the immediately preceding syllable. The simplest method is to represent *-ic* as the variant form /ik+æl/. We then add the ad hoc rule (58) after the Main Stress Rule:

(58) $$æl \rightarrow \phi \quad / \; ik+ \text{——}$$

Using certain devices that we will develop in Chapter Four, Section 2.2, we will associate with each lexical item taking *-ic*+*æl* an indication as to whether it may or may not undergo rule (58). Thus, in the words *basic*, *public*, *sulfuric*, rule (58) is obligatory; in *theatrical*, *neurological*, it is inapplicable; in *ironic(al)*, *analytic(al)* the rule is optional. In some cases (e.g., *economic(al)*, *historic(al)*) the applicability of rule (58) depends on the sense of the word, that is, its semantic features.

We shall see in the next chapter that we can make use of this underlying bisyllabic representation and rule (58) to account for other exceptional features of *-ic*, in particular, its effect on stressed vowel alternations. Notice that all forms undergo rule (58) when the affix *-ly* is added; thus the rule is needed even apart from the considerations mentioned here.[41]

A word such as *titánic* will now have the representation [$_{A}$tItæn+ik+æl]$_{A}$ as we enter the second cycle. The Main Stress Rule will assign primary stress to the antepenultimate syllable by case (i) under condition (a), and [æl] will then be deleted by rule (58).

We now give two examples—*theatricality* and *indemnification*—to illustrate the stress placement rules in the case of affixes. Consider first the word *theatricálity*, with the underlying representation indicated in the derivation (59):

(59)

[$_{N}$ [$_{A}$ [$_{N}$θeætr]$_{N}$ ik+æl]$_{A}$ i+ti]$_{N}$		
1		RULE (50bii)
21		RULE (50ai)
32	1	RULE (50ai)
43	1	RULE (52)

[40] An apparent alternative to rule (57), in such cases, would be to introduce into the cycle the rules that convert /ti/ to [š], as in *convention*, so that on the final cycle we consider the full form *conventional* with the representation [convenšV̌n+æl]. This is impossible, however, as we shall see in Chapter Four, Section 6, because the reduction of the vowel is conditional upon the degree of stress on the following vowel (compare *cordial-cordiality*), and this is determined later in the cycle.

[41] The adjective-forming suffix *-ic*, which we are at this point representing as /ik+æl/, is not to be confused with the noun-forming ending *-ic*, which we represent simply as /ik/. The latter, then, will assign stress in the normal way in nouns such as *aríthmetic*, *Cátholic*, *ársenic*, *climácteric*. Notice that only *-al* and not *-ical* is affixed to forms ending in *-ic*. The effect is to shift the stress, giving such pairs as the noun *aríthmetic* versus the adjective *arithmétic* (from *arithmetical*, by rule (58)), as in *arithmetic progression*. There are a few well-known examples in which the adjective-forming affix assigns stress to a syllable preceding it by two (e.g., *Árabic*, *chóleric*); we might indicate this by a readjustment rule deleting *-al*. Presumably the adjectives *Catholic*, *politic* are derived from the corresponding nouns by an adjective-forming process that does not involve affixation of *-ic*.

We are indebted to G, Carden and G. H. Matthews for suggestions regarding the analysis of *-ic*.

The final line of (59) becomes a full phonetic representation by other rules that we have not discussed.

Reviewing the steps of this derivation briefly, we see that in the first cycle the innermost constituent $[_N$θeætr$]_N$ falls under condition (b) since it is a noun with a lax vowel in the final syllable. Case (i) does not apply, since there is only the single syllable /θe/ under consideration when the final $\check{V}C_0$ string /ætr/ is excluded. Thus case (ii) applies, assigning stress to /θe/. This completes the first cycle and we erase innermost brackets. If we were dealing with *theater* in isolation, we would now apply rule (56), to make the final *r* syllabic, and the Vowel Reduction Rule, giving, finally, [θÉətr̩]. (The change of [e] to [E] in this position results from rule (30), the quality change (Vowel Shift) being contingent on tensing for stressed vowels.)

In the second cycle we are dealing with an adjective with a lax vowel in the final monosyllabic affix. Thus condition (a) is applicable, and case (i) shifts primary stress one syllable to the right. We pass by case (ii) and conditions (b) and (e) because of the disjunctive ordering. If were dealing with *theatrical* in isolation, we would derive the phonetic representation [θ$\overset{3}{\text{É}}\overset{1}{\text{æ}}$trəkəl], by rule (52), rule (30), Vowel Shift, and Vowel Reduction.

In the third cycle, condition (a) holds and case (i) shifts stress to the right once again. The disjunctive ordering requires us to skip case (ii) and conditions (b) and (e). Finally, we apply the Stress Adjustment Rule (52), giving *theatricality*, as in the last line of (59). Rule (30), Vowel Shift, and Vowel Reduction give [θ$\overset{4}{\text{É}}\overset{3}{\text{æ}}\overset{1}{\text{æ}}$trəkælətE].

Consider now the word *indemnificátion*:

(60)

$[_N\,[_V$indemn+i+fIk$]_V$ At+iV̌n$]_N$			
	1		RULE (50eii)
1	2		RULE (51)
2	3	1	RULE (50bi)
3	4	1	RULE (52)

In the first cycle conditions (a) and (b) are not met, and we turn to condition (e). Case (i) is inapplicable because of the final strong cluster, and case (ii) assigns primary stress to the final syllable. The Alternating Stress Rule (51) then shifts primary stress to the antepenultimate vowel. In isolation, therefore, we would have *$\overset{1}{\text{i}}$ndemnify$\overset{3}{}$*, by Stress Adjustment and a rule which deletes [k] in the position $+C_0I$——$]\#\,\#$.

In the second cycle, we are dealing with a noun that falls under condition (b),which shifts stress to the right by case (i). Case (ii) and condition (e) are skipped because of the disjunctive ordering. The Stress Adjustment Rule (52) then gives us the desired stress pattern. Vowel Reduction, consonant softening, and other rules we will discuss give, finally, [$\overset{3}{\text{i}}$ndemnəfək$\overset{1}{\text{A}}$šən].

Innumerable other examples receive their stress patterns by these rules in similar ways.

8. *Nuclear stress*

The rules we have given so far apply only within the word; the condition (55) in the Main Stress Rule, that *X* must not contain the boundary # internally, is sufficient to guarantee this. In Chapter Two we described the operation of the transformational cycle above the level of the word, noting that two rules are involved, the Compound Rule and the Nuclear

Stress Rule. We must now incorporate these "higher level" processes into the formulation of the rules of stress placement.

The salient facts concerning nuclear stress were well summarized by S. S. Newman (1946), as follows: "When no expressive stress disturbs a sequence of heavy stresses, the last heavy stress in an intonational unit receives the nuclear heavy stress" (p. 176). Thus, in a noun phrase such as *absolute equality* or a verb phrase such as *demand capitulation*, the main stress of the second word is heavier than that of the first.

Suppose that we have the phrase *absolute equality*, with the phonological representation taken tentatively as (61) (with segments which will be justified later):

(61) $[_{NP}\#\ [_{A}\#\text{æbsəlUt}\#]_{A}\ [_{N}\#\ [_{A}\text{Eku}+\text{æl}]_{A}\ \text{i}+\text{ti}\#]_{N}\ \#]_{NP}$

In the first cycle, *absolute* becomes $\overset{1}{a}\overset{3}{b}\text{solute}$ by rules (50eii), (51), and (52); and *equal* becomes $\overset{1}{e}\text{qual}$ by (50ai). Innermost brackets are now erased, and the second cycle applies to the noun *equality*, giving $\overset{3}{e}\overset{1}{q}\text{uality}$ by (50ai) and (52). Thus, at the end of the second cycle we have the representation (62) (after the nontransformational, word-level rules have also applied):

(62) $[_{NP}\#\ \#\overset{1}{\text{æ}}\text{bsəl}\overset{3}{\text{U}}\text{t}\#\ \#\overset{3}{\text{E}}\text{kw}\bar{\text{a}}\overset{1}{\text{l}}\text{ətE}\#\ \#]_{NP}$

As our rules now stand, the next cycle is vacuous and gives (62) as the final output.[42] We may take account of the phenomenon of nuclear stress by adding the new rule (63):

(63) $$V \rightarrow [1\ \text{stress}] \ / \ [\#\#X\left[\frac{\quad}{1\ \text{stress}}\right] Y\#\#]$$

where Y contains no vowel with the feature [1 stress]

We will call this the Nuclear Stress Rule, as in Chapter Two. As formulated, it will not apply to units smaller than a word. Applying it to (62), we derive (64), as required:[43]

(64) $[_{NP}\#\ \#\overset{2}{\text{æ}}\text{bsəl}\overset{4}{\text{U}}\text{t}\#\ \#\overset{4}{\text{E}}\text{kw}\bar{\text{a}}\overset{1}{\text{l}}\text{ətE}\#\ \#]_{NP}$

Notice that we can now eliminate the Stress Adjustment Rule (52), since it is simply the special case of the Nuclear Stress Rule that applies at the level of word boundary (when X contains no primary-stressed vowel). However, we will generally continue to refer to the Nuclear Stress Rule as the Stress Adjustment Rule when it applies to the single primary-stressed vowel that appears at the level of words.

[42] One of the widely accepted conventions for representing stress levels is precisely this. See, e.g., Jones (1956b). We will, however, accept the position of Newman, Trager and Smith, and others regarding nuclear stress in such constructions, and will modify the rules so as to accommodate their descriptions of the impressionistic phonetics.

[43] Recall the discussion in Chapter Two, Section 2, regarding the accuracy of such transcriptions and the physical basis for them. If one makes the assumption (quite gratuitous, for the moment) that stress contours are physical as well as perceptual phenomena, then it would make sense to ask whether the internal relations of stress in the words *absolute* and *equality* are the same when these words are in isolation as when they appear in the phrase *absolute equality*. The familiar paired utterance test should provide an answer to this question. The representation (64) implies that the internal relations of *absolute* are the same in the phrase *absolute equality* as in isolation, while those of *equality* differ. Our conventions could be modified to permit other representations, but in the absence of any evidence bearing on the matter, it seems pointless to pursue such possibilities. See also the discussion in Chapter Two, Section 1, page 23.

Suppose that we were to define a scale of "sonority" in such a way that more heavily stressed vowels are greater in sonority than less heavily stressed vowels and that all vowels are greater in sonority than consonants or boundaries. Then the Nuclear Stress Rule states that primary stress is placed on the last sonority peak of a string that contains at least one word (the only sonority peak, in the case of Stress Adjustment). Similarly, in the first cycle case (ii) of the Main Stress Rule has the effect of placing primary stress on the last sonority peak of the string under consideration (the only sonority peak, where this string is a monosyllable). In [ErAs], for example, the second vowel is the final sonority peak; in [rAn] (*rain*) there is only one sonority peak, namely, the vowel. This observation suggests that it might be possible to formulate the Main Stress Rule so as to include the Nuclear Stress Rule as a special case, combining it with case (ii). We have investigated this possibility in detail, but we are inclined to think that this is a spurious generalization since such a reformulation requires a network of otherwise unnecessary conditions in the statement of these rules. (See Chapter Five for some further discussion.)

The verb phrase *demand capitulation* will be derived in exactly the same way as the noun phrase *absolute equality*. Thus we have the following derivation:

(65) $[_{VP}\#\ [_{V}\#\text{dEmænd}\#]_{V}\ [_{N}\#\ [_{V}\text{kæpitUlAt}]_{V}\ \text{i}\check{\text{V}}\text{n}\#]_{N}\ \#]_{VP}$

1	1		RULE (50eii)
	1 2		RULE (51)
	2 1		RULE (50bi)
	3 1		RULE (63)
2	4 1		RULE (63)

In the first cycle, primary stress is placed on the final syllable of the two innermost constituents, both of which are verbs, and the Alternating Stress Rule (51) applies to the polysyllabic form *capitulate*. At the next stage we deal with the phrase *capitulation* and assign primary stress to the antepenultimate vowel /A/. The Stress Adjustment Rule then assigns primary stress to the last (and only) sonority peak, giving *capitulation*. In the third cycle, we consider the verb phrase as a whole and assign primary stress to the last sonority peak by the Nuclear Stress Rule. (See note 43.)

The other examples of the Nuclear Stress Rule discussed in Chapter Two now fall into place in the same way.

9. Compounds

Our informal discussion of the transformational cycle in Chapter Two dealt with Nuclear Stress and Compound Stress. We have accounted for the former, and must now add a rule for compound nouns, adjectives, and verbs such as those of (66) (the nouns, of course, being by far the richest and most productive category):

(66)

chemistry laboratory	*hard-headed*	*hedge-hop*
Christmas party	*hot-blooded*	*trouble-shoot*
venture capital	*rose-colored*	*air-condition*
toy factory	*heart-rending*	*boot-lick*
sugar cane	*mealy-mouthed*	*horse-whip*

As in the case of the Nuclear Stress Rule, we deal here with two constituents, each of which

has received a primary stress on the preceding cycle.[44] The Nuclear Stress Rule (63) assigns primary stress to the second sonority peak, reducing by one all other stress levels in the phrase under consideration; the Compound Rule, on the other hand, assigns primary stress to the first of the two peaks, reducing all other stress levels by one.

We can state the Compound Rule as (67):

$$(67) \qquad \mathrm{V} \rightarrow [1\ \text{stress}] \ / \ [\#\#X\left[\frac{\quad}{1\ \text{stress}}\right]Y\#\#Z\#\#]_{\mathbf{NAV}}$$

This rule will apply to a string of the form $\#\#X\overset{1}{\mathrm{V}}Y\#\#Z\#\#$ which is a noun, adjective, or verb with the two immediate constituents $X\overset{1}{\mathrm{V}}Y$ and Z. Its effect will be to weaken all stresses in the construction under consideration except that of the primary-stressed vowel of $X\overset{1}{\mathrm{V}}Y$. Thus $\#\#\overset{1}{chemistry}\#\#\overset{1}{laboratory}\overset{3}{}\#\#$ will become $\#\#\overset{1}{chemistry}\#\#\overset{2}{laboratory}\overset{4}{}\#\#$, etc. (See note 43.)

Clearly the Compound Rule (67) must apply prior to the Nuclear Stress Rule (63); furthermore, the ordering of these rules must be disjunctive or the Nuclear Stress Rule will reapply after the Compound Rule, weakening all but the primary stress. Now observe that our system of notations in fact requires (68) as the simplest formulation of the two rules (63) and (67):

$$(68) \qquad \mathrm{V} \rightarrow [1\ \text{stress}] \ / \ [\#\#X\left[\frac{\quad}{1\ \text{stress}}\right]Y\langle\#\#Z\rangle\#\#]_{\langle\mathbf{NAV}\rangle}$$

where Y contains no vowel with the feature [1 stress][45]

The formulation (68) expresses the disjunctive ordering (67), (63) in precisely the desired way. The two rules abbreviated as (68) determine the stress contours discussed in Chapter Two exactly as outlined there. With the material in angles, (68) is the Compound Rule; when the material in angles is omitted, (68) is the Nuclear Stress Rule. We will, as usual, continue to refer to these rules in their unabbreviated forms (67) and (63).

There is an ambiguity in the formulation of the Compound Rule in (67) and (68) for one particular construction, namely, a compound whose second member is again a compound, that is, a construction of the form:

$$(69) \qquad [_{\mathbf{N}}\#\#A\#\ [_{\mathbf{N}}\#B\#\#C\#]_{\mathbf{N}}\ \#]_{\mathbf{N}}$$

Such constructions are rare. Possible examples are *chemistry research-laboratory* (in the

[44] This remark is not quite correct. Although it is true that compounds are strictly limited to two immediate constituents, this is not necessarily true of the phrases to which the Nuclear Stress Rule applies. Thus the rule may apply to a noun phrase such as *an old, tired, disconsolate, retired teacher*, in which there is no internal structure among the coordinated items. It will assign main stress to the last sonority peak (namely, *teacher*) and reduce the stress on each of the adjectives to secondary.

The operation of the transformational cycle is guided by the surface structure produced by the syntax. The syntactic component must assign to each generated string a labeled bracketing that determines appropriately the sequence of applications of the rules. In the example of the last paragraph, it must assign no internal structure to the coordinated items (consistently with the sense, in this case). It is possible, however, that certain adjective sequences must be internally organized in the surface structure in order for the correct phonetic output to be produced (e.g., *tired old man* as distinct from *old, tired man*), though there may be a different basis for this phenomenon—see page 117. Just what the syntactic rules are that determine these surface structures is not known, and we have arbitrarily placed this problem, along with other syntactic problems, outside the scope of our study. We simply note here that various types of surface structure must be submitted to the phonological component, in particular, coordinate structures of arbitrary length with no internal organization.

[45] The condition on Y is irrelevant for the Compound Rule.

sense of "research laboratory for chemistry," not "laboratory for chemistry research"), *kitchen towel-rack* (in the sense of "towel rack in the kitchen," not "rack for kitchen towels"), *evening mathematics-class* (meaning "mathematics class held in the evening"), etc. Notice that the phrases *chemistry laboratory*, *research laboratory*, *kitchen rack*, *towel rack*, *evening class*, *mathematics class* all have primary stress on the first element, and the full phrases are of the form (69).

The early applications of the transformational cycle will assign a single primary stress to A, B, and C in (69). In the cycle, we consider the now innermost phrase $[_N \# \overset{1}{B} \# \# \overset{1}{C} \#]_N$. Primary stress is placed on B by the Compound Rule. Erasing innermost brackets, we have $[_N \# \# \overset{1}{A} \# \# \overset{1}{B} \# \# \overset{2}{C} \# \#]_N$. But the Compound Rule, as it stands, is ambiguous in its application to this form. We can take Z of (67), (68) to be C, or we can take it to be $B \# \# C$. If we take Z to be C, the primary stress will be placed on B (the last sonority peak), and we will have the stress contour 213 for the examples given above. If we take Z to be $B \# \# C$, the primary stress will be placed on A (the only sonority peak), and we will have the stress contour 123 for these examples.

To guarantee the contour 213, we can add the following qualification to (67) and (68):

(70) $$Z \neq \ldots \# \# \ldots$$

To guarantee the contour 123, we can add to (67) and (68) the qualification:

(71) Z contains [1 stress]

Our impression is that the normal stress contour in these cases is 213, and we will therefore give the Compound Rule with qualification (70) rather than (71) in subsequent formulations.[46]

Our formulation of the Compound Rule does not take account of a familiar convention for the representation of English stress contours, namely, that there is a distinction in stress contour between compounds such as $\overset{1}{elevator}\ \overset{3}{boy}$ or $\overset{1}{chemistry}\ \overset{3}{teacher}$, which are represented with tertiary stress on the second member of the compound, and those such as $\overset{1}{elevator}\ \overset{2}{operator}$ or $\overset{1}{chemistry}\ \overset{2}{laboratory}$, in which the second member of the compound retains secondary stress. With the system of rules that we have given so far, the second member of the compound will, in each case, have secondary stress. To account for this distinction, we must add an ad hoc rule providing that secondary stress in the rightmost member of a compound is reduced still further when this member has some property P. The property P might, for example, be the property of containing just a single vowel with the feature [+stress], or it might be formulated in a slightly different way, depending on how one wishes to assign a stress contour to compounds such as *soccer referee*, *UN attaché*, *land surveyor*, *pi-meson*, *car window*. It is not clear whether this is a question of fact or merely of convention. Whatever decision is made as to the appropriate property P (which might, for example, involve idiosyncratic features of particular lexical items, if we take the contours that have occasionally been described in the literature as factually accurate), the appropriate rule can be formulated in terms of it, with no effect on the rest of the system. We will therefore disregard this matter and tentatively assume that in all cases the stress contour is to appear as primary-secondary.

[46] We will also omit the string $\#\#X$ from the formulation of rules (68). This string plays no role; it was included only to bring out the domain of the rule more clearly.

To summarize, the rules that apply at the word level or beyond are the Compound and Nuclear Stress Rules, which apply in this order, disjunctively.[47] Each assigns primary stress to a vowel which already contains primary stress, weakening all other stresses in the string under consideration. Applying at the level of words, the Nuclear Stress Rule is what we called earlier the Stress Adjustment Rule; its effect is to reserve secondary stress for phrases that contain more than one word. The Nuclear Stress Rule assigns primary stress to the rightmost sonority peak in the string under consideration; with the possible exception of items of the form (69), the Compound Rule assigns primary stress to the leftmost sonority peak in the string under consideration.

10. Complex verbs

There are many verbs in English that are morphologically analyzable into one of the prefixes *trans-*, *per-*, *con-*, etc., followed by a stem such as *-fer*, *-mit*, *-cede*, *-cur*, or *-pel*. This analysis is strictly internal to the lexicon, playing no role in syntactic rules, so far as we know. The stress placement rules must assign primary stress to the final formative in these words, regardless of whether it contains a strong or weak cluster. Thus, even when such verbs end in a weak cluster, as in (72), stress is final:

(72) *permít, concúr, compél, detér, transfér*

Clearly, then, we must prevent case (i) of the Main Stress Rule (under condition (e)) from applying to these forms while still allowing it to apply to *fúrnish, wórship, cóvet* and other examples of the sort illustrated in column I of (18). That is, we must identify the complex verbs in some manner that will account for their exceptional behavior. The simplest way to do this is by a readjustment rule which adds an identifying feature to the internal boundary in verbs of the prefix-stem type (72). (See Section 1.3.1 for a discussion of the feature analysis of boundaries.) Since these stems and prefixes are not, in general, independent words or even separate lexical items, we do not expect to find # in this position. Rather, we expect to find the boundary which, in terms of feature analysis, is [−FB, −WB], that is, distinct from both + and #. We use the symbol = as an informal abbreviatory notation for the feature set [−segment, −FB, −WB]. Thus we assign to the examples of (72) the underlying representations (73), where /N/ is the archi-segment "nasal" and /Ɨ/ is the archi-segment "lax vowel" (which is, furthermore, back and high, at least in the case of *concur* in dialects which have the phonetic form [kənkə́rənt] for *concurrent*—see the next chapter for details). The features of the boundary are introduced into the representation by a readjustment rule.

(73) pƗr=mit, kəN=kƗr, kəN=pel, de=tƗr, træns=fƗr

When we now apply the Main Stress Rule to the forms in (73), conditions (a) and (b) are inapplicable and case (i) is blocked under condition (e) because of the = boundary. Case (ii) then assigns primary stress to the vowel in the final syllable, under condition (e).

This analysis of morphologically complex verbs accounts for several other peculiarities of such forms. Notice, in the first place, that trisyllabic verbs with prefixes are generally not subject to the Alternating Stress Rule (51), which assigns antepenultimate primary stress in

[47] One additional rule that may apply beyond the word level will be mentioned in Section 14.

words such as *éxercise*, *ánalyze*, *cómplicate*, *clárify*. That is, the final stress assigned by (50eii) is retained in verbs such as *comprehénd*, *apprehénd*, *intervéne*, *introspéct*, *introdúce*, *contradíct*, *controvért*. Introduction of an automatic = boundary after these prefixes will block the application of rule (51), thus accounting for this apparent violation of the Alternating Stress Rule. We will refine this observation directly.

A second peculiar feature of these constructions relates to segmental phonology. There are various positions in which /s/ becomes voiced in English, in particular, intervocalically when the preceding vowel belongs to one of the verb-forming prefixes that we are now considering. Thus we have voicing of /s/ in *resist*, *resemble*, *resolve*, *design*, *presume* (compare *consist*, *semblance*, *solve*, *consign*, *consume*—some apparent exceptions will be discussed in Section 16). We can now describe this phenomenon by a rule such as (74) (which, as we shall see, can be somewhat generalized):

$$(74) \qquad s \rightarrow [+\text{voice}] \;/\; V = \text{——} V$$

Notice that voicing of /s/ does not take place intervocalically when there is no boundary preceding /s/ (e.g., *misogynist*, *asylum*) or when there is a boundary but the element in question is not a morphologically complex verb (e.g., *para*+*site*, *para*+*sitic*, *chromo*+*somal*, *philo*+*sophical*, *meta*+*soma*). Hence the complex verbs must be distinguished from other forms for the purpose of rule (74); the obligatory = boundary makes the required distinction.

In short, the device proposed for determining the stress placement in morphologically complex forms such as (73) is not only the simplest, given the framework of rules that we have so far developed, but it is also independently motivated. We shall find still further support for this analysis.

Notice, incidentally, that rule (74) must, as indicated, be limited to the boundary [−FB, −WB]. We have given several examples to show why it is limited to boundaries which are marked [−FB]. To see that the boundary [+WB] (namely, #) must also be excluded, consider *parasynthesis*, *photosynthesis*, *proto-Siouan*, *resell*, *resettle*. In all of these prefix-stem constructions, the stem, which begins with /s/, is an independent word, and we therefore expect it, on general syntactic grounds, to be preceded by the boundary #.[48] Observe that rule (74) does not apply to the stem-initial /s/ in these cases. Thus we have contrasts such as *resolve* (/rE=sɔlv/, [rEz$\overset{1}{\text{ā}}$lv], "determine") versus *re-solve* (/rE#sɔlv/, [r$\overset{3}{\text{E}}$s$\overset{1}{\text{ā}}$lv], "solve anew"), and *reserve* (/rE=sɨrv/, [rEz$\overset{1}{\text{ə}}$rv], "withhold") versus *re-serve* (/rE#sɨrv/, [r$\overset{3}{\text{E}}$s$\overset{1}{\text{ə}}$rv], "serve anew").

The decision to identify prefix-stem forms by a = boundary necessitates a slight revision of the Alternating Stress Rule (51). The readjustment rule that introduces = should give representations such as /kɔN=kɨr/ for *concur*, /kɔN=pre=heNd/ for *comprehend*, /iNtɨr=sekt/ for *intersect*, /kɔN=teNplAt/ for *contemplate*, /kɔN=stitUt/[49] for *constitute*, /kɔN=peNsAt/ for *compensate*, etc. In the case of *concúr*, the Alternating Stress Rule is inapplicable; in the case of *comprehénd*, *interséct*, it is blocked by the boundary. But forms such as *cóntemplàte*, *cónstitùte*, *cómpensàte* show that it is the second, not the first, occurrence of = that blocks the rule in the case of *comprehénd*. We must therefore reformulate the Alternating Stress Rule so as to permit an occurrence of = before the penultimate syllable

[48] Additional phonological justification for the syntactically expected analysis will appear in Section 13.

[49] Actually, as we shall see, [kɔN=stitu+At].

because of forms like *cóntemplàte*. Accordingly we restate the rule as:

(75) $$V \rightarrow [1\ \text{stress}] \ / \ \text{——} C_0(=)C_0VC_0[1\ \text{stress}]C_0]_{NAV}$$

Formulated in this way, the Alternating Stress Rule will apply to representations such as *de=sign$\acute{A}$t*, *re=plic$\acute{A}$t*, *coN=plic$\acute{A}$t*, *iN=plic$\acute{A}$t*, *re=nov$\acute{A}$t*, *de=ton$\acute{A}$t*. It will not apply, however, to *coN=pre=h$\acute{e}$Nd*, *iNter=s$\acute{e}$ct*, *coNtra=d$\acute{i}$ct*, and other forms with a boundary before the final syllable, and primary stress will therefore remain on the final syllable in these forms.

There remain certain words (e.g., *persev$\acute{e}$re*) which seem to be true exceptions and must therefore be excluded from the domain of rule (75) by other means (see Chapter Four, Section 2.2).

11. Nouns derived from verbs

The preceding discussion leads naturally to the topic of stress patterns in the nouns that are derived from verbs with primary stress on the final syllable. The general rule is that the primary stress is nonfinal in these nouns. Thus we have nouns such as those in (76), all with primary stress on the first syllable:

(76) *tránsfèr, pérmìt, éxpòrt, súrvèy, prótèst, ínsèrt, prógrèss, cónvìct, súspèct, tórmènt, cómbìne*

It is important to note that the final syllable of these nouns has a tertiary stress. This is evident by comparison of noun pairs such as the following:

(77) *tránsfèr–dóctŏr, pérmìt–hérmĭt, éxpòrt–éffŏrt, súrvèy–scúrvў, prótèst–déntĭst, ínsèrt–cóncĕrt, prógrèss–tígrĕss, cónvìct–vérdĭct, tórmènt–tórrĕnt, cómbìne–érmĭne*

The nouns of (76) have the stress pattern 13; the items paired with them in (77) have the stress pattern 1–. Clearly this distinction is related to the fact that verbs with final stress underlie the forms in (76) but do not underlie the forms paired with them in (77). We can therefore account for the stress difference by means of the transformational cycle. The nouns of (76) will be derived from underlying verbs on the second cycle by a rule which shifts primary stress to the left, weakening the stress on the final syllable to secondary. The final stress then becomes tertiary by the Stress Adjustment Rule. The new rule, which we will refer to as the Stressed Syllable Rule, will be given below (see (80)) as cases (c) and (d) of the Main Stress Rule. Thus we will have derivations such as (78) for the examples of (76), and (79) for the items paired with these in (77):

(78)

$[_N\,[_V$pɫr=mit$]_V\,]_N$	$[_N\,[_V$tɔrment$]_V\,]_N$	$[_N\,[_V$sɫrvA$]_V\,]_N$	
1	1	1	RULE (50eii)
1 2	1 2	1 2	STRESSED SYLLABLE RULE
1 3	1 3	1 3	RULE (63)

(79)

$[_N$hɫrmɫt$]_N$	$[_N$tɔrent$]_N$	$[_N$skɫrvi$]_N$	
1	1	1	RULE (50bii)

The examples of (79) are straightforward. In each case the final syllable of the noun has a lax vowel so that condition (b) of the Main Stress Rule applies. Primary stress is therefore assigned to the vowel of the first syllable, the final cluster being excluded from consideration under condition (b). (Notice that the underlying vowel of the second syllable of *torrent* must be /e/—cf. *torrential.*) The final vowel of *scurvy* becomes tense in word-final position by rule (30), but only after the application of the Main Stress Rule. In each case the vowel of the second syllable retains [−stress] (and therefore reduces to [ə] nonfinally).

Consider now the derivations of (78), beginning with the noun $\overset{1}{s}\overset{3}{u}rvey$. In the first cycle, primary stress is assigned to the final tense vowel under condition (e) of the Main Stress Rule by case (ii), case (i) being inapplicable because of the final strong cluster. This completes the cycle, and innermost brackets are erased. On the next cycle, conditions (a) and (b) are inapplicable because the final vowel is tense, and condition (e) will apply vacuously. Thus the Main Stress Rule as formulated above has no effect in this cycle. But we need a rule which will shift the stress to the left. This rule, which we formulate as (80), asserts that in a noun with primary stress on the last syllable, cases (i) and (ii) of the Main Stress Rule apply to the string preceding this final stressed syllable.

$$(80) \qquad V \rightarrow [1\ \text{stress}] \Big/ \begin{cases} C_0 \begin{bmatrix} -\text{tense} \\ V \end{bmatrix} C_0^1 \begin{bmatrix} \alpha\text{voc} \\ \alpha\text{cons} \\ -\text{ant} \end{bmatrix} & \text{(i)} \\ C_0 & \text{(ii)} \end{cases}$$

$$/ \ \text{——}([-\text{seg}])\, C_0 \overset{1}{V} C_0]_N \qquad \text{(c), (d)}$$

For reasons which will appear as we proceed, we stipulate that rule (80) constitutes conditions (c) and (d) of the Main Stress Rule; it applies after condition (b) and before condition (e). We will refine and extend this rule in several stages as we proceed. First, however, let us see how it applies to the examples given above and how it interrelates with the other parts of the Main Stress Rule.

Returning to the derivation of *survey* in (78), we see that the new rule (80) is applicable in the second cycle. (Neither condition (a) nor condition (b) of the Main Stress Rule applies.) Rule (80) specifies that we exclude from consideration the final string $\text{-}\overset{1}{r}vA$ of $[_N s\text{ɪ}r\overset{1}{v}A]_N$ and assign primary stress to the vowel that immediately precedes it by (80ii) (which is simply case (ii) of the Main Stress Rule), thus reducing the stress on the final syllable to secondary. The stress is then further reduced to tertiary by the Stress Adjustment Rule. This completes the derivation of *súrvey* given in (78). Notice that condition (e) must not be applied in the second cycle of this derivation or stress will again be shifted, incorrectly, to the final syllable. Hence the ordering of rule (80) and condition (e) of the Main Stress Rule must be disjunctive. An apparent alternative, at this point, would be to have condition (e) precede (80). We shall see directly that this is not possible, however.

Consider now the derivation of the noun *torment* in (78). Clearly this should be precisely parallel to the derivation of $\overset{1}{s}\overset{3}{u}rvey$. In the first cycle primary stress is assigned to the final strong cluster under condition (e), case (ii), exactly as in the verb *survey*. In the second cycle, we expect the stress to be shifted left by rule (80), again as in the analogous case of $\overset{1}{s}\overset{3}{u}rvey$. However, as we have formulated the Main Stress Rule, condition (b) is applicable since the vowel of the final syllable happens to be lax in this case. Clearly this is not a relevant

distinction between *torment* and *survey*, and it indicates that the rules are in error.[50] Evidently we must prevent the application of condition (b) in this cycle. The simplest way to achieve this result is to require that under condition (b) (similarly, (a)) the vowel of the final syllable be not only lax but also nonstressed. This qualification admits all of the cases for which conditions (a) and (b) are appropriate and eliminates the unwanted applications.

With this modification of conditions (a) and (b), the derivation of *torment* proceeds in the second cycle in exact analogy to that of *survey*. In the very same way we also derive the noun *permit* from the underlying verb *permit*. Thus the contrasts *pérmìt–hérmĭt*, *tórmènt–tórrĕnt*, *súrvèy–scúrvў* are accounted for on the basis of the fact that the first member of each pair, but not the second, corresponds to a related verb.

Notice that the new rule (80) must precede condition (e), as we have assumed. If the order were reversed, a noun such as *machine*, which receives primary stress on the final syllable under condition (e), would have the stress shifted to the left under the subsequent rule (80), giving the incorrect form **machine*. Furthermore, we will see below that rule (80) must follow condition (a). Thus its position in the ordering is narrowly determined.

The examples of rule (80) given above all involved (80ii), that is, case (ii) of the Main Stress Rule. Case (i) is involved in the derivation of nouns such as *intercept* and *interlock* from the underlying verbs *intercept*, *interlock*. In the case of *interlock*, for example, we have the underlying representation (81):

(81) $[_N\,[_V \text{iNter}=\text{lɔk}]_V\,]_N$

In the first cycle case (ii) of the Main Stress Rule assigns final stress under condition (e) (case (i) being blocked by the = boundary, which also blocks an unwanted application of the Alternating Stress Rule). In the second cycle rule (80) is applicable and the string $=lock$ is omitted from consideration. Case (i) then assigns stress to the first syllable, giving finally the noun *interlock* after application of the Stress Adjustment Rule.

12. Revised version of the Main Stress Rule

Let us now consider how the Stressed Syllable Rule (80) can be introduced into the Main Stress Rule. Cases (i) and (ii) of rule (80) are identical to cases (i) and (ii) of the Main Stress Rule, so amalgamation causes no difficulty in this respect. We must, however, find a way to incorporate the outermost condition in (80) in such a way as to meet the following requirements: the condition (80) follows condition (a) and precedes condition (e); the ordering (80), (e) is disjunctive. It will be recalled that in the Main Stress Rule, as it now stands, the ordering (a), (b), (e) is disjunctive. This fact was made explicit in the formulation (53), which is the optimal representation for the conditions (a), (b), and (e).

[50] In fact, as we shall see, the Stressed Syllable Rule (80) applies when the stress on the syllable in the outermost context has [2 stress] as well as [1 stress]. When the rule is extended in this way, the error in the rules which was just noted will lead to an incorrect stress assignment, since under condition (b) the representation $[_N$tɔrment$]_N$ will be changed to $[_N$tɔrment$]_N$, and by rule (80) it will then be changed to $[_N$tɔrment$]_N$, becoming, finally, $[_N$tɔrment$]_N$ by the Stress Adjustment Rule. This consequence could be avoided if the ordering of (b) and rule (80) were specified as disjunctive, but this is impossible, given the empirical hypotheses we have proposed, since condition (b) is not related to rule (80) in a way expressible by angles or parentheses.

Within our framework, the sequence (a), (b), (80), (e) can be generalized in one of several ways which are, for the present, quite equivalent. Looking ahead to later refinements, we choose one of these and give the rule in the following form:

$$(82) \qquad V \rightarrow [1\ \text{stress}] \Big/ [X \text{——} C_0 \left(\begin{bmatrix} -\text{tense} \\ V \end{bmatrix} C_0^1 \begin{bmatrix} \alpha\text{voc} \\ \alpha\text{cons} \\ -\text{ant} \end{bmatrix}_0 \right)$$

$$\Big/ \text{——} \langle \left\{ \begin{array}{l} \langle +C_0 \rangle \begin{bmatrix} -\text{stress} \\ -\text{tense} \\ V \end{bmatrix} \\ \langle [-\text{seg}] \rangle C_0 \overset{1}{V} \end{array} \right\} C_0 \rangle]_{\langle N \langle A \rangle \rangle}$$

where X contains no internal occurrence of #

Expanding (82), we have the following sequence of rules:

$$(83) \qquad V \rightarrow [1\ \text{stress}] \Big/ [X \text{——} \left\{ \begin{array}{ll} C_0 \begin{bmatrix} -\text{tense} \\ V \end{bmatrix} C_0^1 \begin{bmatrix} \alpha\text{voc} \\ \alpha\text{cons} \\ -\text{ant} \end{bmatrix}_0 & \text{(i)} \\ C_0 & \text{(ii)} \end{array} \right.$$

$$\Big/ \text{——} \left\{ \begin{array}{ll} +C_0 \begin{bmatrix} -\text{stress} \\ -\text{tense} \\ V \end{bmatrix} C_0]_{NA} & \text{(a)} \\ \begin{bmatrix} -\text{stress} \\ -\text{tense} \\ V \end{bmatrix} C_0]_N & \text{(b)} \\ [-\text{seg}] C_0 \overset{1}{V} C_0]_{NA} & \text{(c)} \\ C_0 \overset{1}{V} C_0]_N & \text{(d)} \\ ] & \text{(e)} \end{array} \right.$$

where X contains no internal occurrence of #

The sequence (83) is uniquely determined by (82). By our general conventions, it follows that in (83) cases (i) and (ii) are disjunctively ordered and apply under conditions (a)–(e), taken in that order. Among the conditions (a) through (e), the permitted sequences within a single cycle are: (a), (c); (a), (d); (b), (c); (b), (d). Apart from these possibilities of successive application, the ordering is fully disjunctive. Conditions (a), (b), and (e) are exactly as described in our earlier formulation of the Main Stress Rule (50), (53). Conditions (c) and (d) are the two cases of the Stressed Syllable Rule (80), with and without the unit [−segment], the rule being extended automatically to adjectives in the case where the boundary is present. As we shall see directly, this extension is necessary. Notice that it was condition (c) that was applied in the derivation of the noun *pérmit*, and condition (d) in the derivation of the nouns *súrvèy* and *tórmènt*, where no internal boundary is present.

Summarizing, we have found evidence that the grammar contains the sequence of rules (83ai), (83aii), (83bi), (83bii), (83ci), (83cii), (83di), (83dii), (83ei), (83eii). Earlier we proposed an empirical hypothesis of a very general nature regarding disjunctive ordering. The hypothesis asserts that when certain formal relations hold between two rules of a linearly

ordered sequence of rules—namely, the relations expressed by the parenthesis and angled bracket notations, applied and reapplied consistently along with the other notational devices in the most complete manner possible—then these rules are disjunctively ordered with respect to each other. This empirical hypothesis implies that in the case of the sequence just listed, the relation of disjunctive ordering holds between each of (83*x*i) and (83*x*ii) (x = a, b, c, d, e); (83a*x*) and (83b*y*), (83a*x*) and (83e*y*), (83b*x*) and (83e*y*), (83c*x*) and (83d*y*), (83c*x*) and (83e*y*), (83d*x*) and (83e*y*) (x, y = i or ii). Thus the hypothesis concerning disjunctive ordering has precisely the effects required here on empirical grounds.

13. *Complex nouns and adjectives*

Many nouns consist of prefixes such as *mono-*, *tele-*, *photo-*, *bio-*, followed by stems or nouns. Thus the prefix *mono-* combines with the stem *-graph* to give *monograph*, and with the noun *genesis* to give *monogenesis*. The noun *genesis*, as distinct from the *-graph* of *telegraph*, happens to be an independent word with a specific semantic content that is carried over to the complex form. On syntactic grounds it is not clear what, if any, categorial structure should be assigned to the prefix. We will tentatively accept the weakest assumption and assign no categorization to it at all. Thus *monograph* will be represented $[_{N}$*mono* $[_{S}$*graph*$]_{S}\,]_{N}$ and *monogenesis* will be represented $[_{N}$*mono* $[_{N}$*#genesis#*$]_{N}\,]_{N}$. This underlying representation identifies *-graph* as a stem and *genesis* as a noun which is an independent word, and assigns *mono-* to no category at all.[51] This is the analysis that is most appropriate for the phonological rules; it is, furthermore, at least as well motivated on syntactic-lexical grounds as any other, as far as we can see, in that it assigns no categorization beyond what is independently motivated.

It is also a fact that prefixes can be formed fairly freely from other words (e.g., *politico-*, *parallelo-*) and in this case we will assign them to the syntactic category "prefix" instead of (rather than in addition to) the category to which the underlying form belongs in isolation. The word *parallelogram* will be represented $[_{N}\,[_{P}$*para* $[_{S}$*lel*$]_{S}$ *o*$]_{P}$ $[_{S}$*gram*$]_{S}\,]_{N}$, indicating that it is a noun of the form prefix-stem, where the prefix in turn consists of a stem with an uncategorized prefix *para-*, the latter being on a par with *mono-*, *tele-*, and so on. This analysis, once again, seems to be reasonably well motivated on syntactic-lexical grounds and is appropriate for the phonology.

Consideration of complex nouns and adjectives of this sort sheds additional light on the detailed form of the Main Stress Rule. Consider first the following examples:

(84)

$\overset{1}{}$*monograph*	$\overset{1}{}$*monogenesis*
$\overset{1}{}$*monotone*	$\overset{1}{}$*monomania*
$\overset{1}{}$*monolith*	$\overset{1}{}$*mononucleosis*
$\overset{1}{}$*monosyllable*	$\overset{1}{}$*monometalism*

The examples in the left-hand column of (84) have initial primary stress. Those in the right-hand column have primary stress on later syllables, as indicated.

We can account for most of these forms with our present rules. For example, the

[51] As Paul Postal has pointed out to us, the prefix might, in such cases, be regarded as a lexical feature of the stem or noun, syntactically on a par with other inherent features of a lexical entry.

items heading the two columns in (84) will have the following derivations:

(85)

$[_N mono\ [_S graph]_S\ ]_N$	$[_N mono\ [_N \#genes+is\#]_N\ ]_N$	
	1	RULE (83ai)
1		RULE (83eii)
1 2		RULE (83ci)
1 3		RULE (63)

In the first cycle, primary stress is assigned in the usual way. In the second cycle, condition (c) holds of *monograph*, which has a final stressed syllable, but not of *monogenesis*, which does not have a final stressed syllable. (The condition on *X* in (83) blocks (ai) in the second cycle of *monogenesis*.) In *monograph* the string *-graph* is omitted from consideration. Since the final vowel of the prefix is lax /ɔ/ phonologically (for reasons we shall discuss subsequently), case (i) then applies to the prefix. Thus the primary stress is shifted to the left under condition (c) in *monograph*, but not in *monogenesis*. The Stress Adjustment Rule (63) then gives the desired form. Except for *monosyllable*, the other examples of (84) are properly handled in exactly the same way.[52]

Putting aside the problem of *monosyllable* for the moment, we see that a great many words fall into the class illustrated in (84), such as the following:

(86)

télephòne	*tèlemechánics*
arístocràt	*elèctrophorésis*
áutogràph	*àutohypnósis*
áquaplàne	*àquamaríne*
bíoscòpe	*bìophýsics*
dodécagòn	*dodècahédron*
éndomòrph	*èndothélium*
thérmocòuple	*thèrmodynámics*
pàrallélogràm	*pàrallèlepíped*

To illustrate with a slightly more complex case than (85), consider the derivation of the final items in the two columns of (86), beginning with *parallelogram*:

(87)

$[_N [_P$pær$æ [_S$lel$]_S$ ɔ$]_P [_S$græm$]_S\ ]_N$	
1 1	RULE (83eii)
1 2	RULE (83ci)
1 3	RULE (63)

In the first cycle the monosyllabic internal elements receive primary stress in the usual way. Innermost brackets are erased, and we turn to the next largest phrase, the prefix *parallelo-*. Conditions (a)–(d) have so far been limited to nouns and adjectives, so they are not applicable. Under condition (e), case (i), primary stress is reassigned to the syllable *-lel-*.[53] The second cycle is therefore vacuous. Erasing innermost brackets, we proceed to the full form *parallelogram* on the third cycle. Conditions (a) and (b) are ruled out because the final

[52] We have not yet given the rule that puts various secondary (ultimately, tertiary) stresses in the items of the right-hand column of (84) (and in certain of the forms of (86), which follows). These omissions will be taken care of subsequently.

[53] We will see later that the vacuous application of the Main Stress Rule actually falls under (aii) rather than (ei).

syllable is stressed. We therefore turn to condition (c). This case of the Stressed Syllable Rule applies, excluding the primary-stressed syllable *-gram* from consideration. Primary stress is then placed on the penultimate syllable *-lel-* of the residue *parallelo-* by case (i) of the Main Stress Rule, the final cluster of the residue being weak.[54] This weakens the stress on *-gram* to secondary. Conditions (d) and (e) do not apply because of the disjunctive ordering. We terminate this cycle with the Stress Adjustment Rule (63), giving the final form *parallelogram* (after we have presented the rule assigning secondary, ultimately tertiary, stress on the first syllable—see note 52).

The derivation of *parallelepiped* is similar, but it suggests a slight modification of the rules. (We assume that phonologically the prefix *parallelo-* appears also in *parallelepiped* in spite of the obvious violation of the true etymology of the word.)

(88)

$[_N\,[_P$pærə$\,[_S$lel$]_S$ ə$]_P\,[_S$pIped$]_S\,]_N$		
	1	RULE (83bii)
1		RULE (83eii)
2	1	RULE (83bii)
3	1	RULE (63)

The top line of (88) is the underlying representation. In the first cycle we assign primary stress to the monosyllable *-lel-* as before, by rule (83eii); but we must also assign primary stress to the first syllable of *-pIped*. This effect is achieved by rule (83ei). However, if we were to extend condition (b) to stems, it would be achieved by (83bii). Without any very compelling reason (relevant forms being few), we will assume that condition (b) is the appropriate rule and will extend it to stems. This completes the first cycle. As in the case of (87), the second cycle (applying to *parallele-*) is vacuous, and we proceed to the third cycle and the noun *parallelepiped*. Condition (b) applies since the string in question is a noun with an unstressed lax vowel in the final syllable. Exactly as in the first cycle, primary stress is then placed on the strong cluster preceding the syllable excluded from consideration in accordance with condition (b). The effect at this stage of the derivation is to weaken the stress on the first of the two primary-stressed syllables (namely, the syllable *-lel-*) to secondary. The Stress Adjustment Rule then weakens this to tertiary, giving the final line of the derivation (88). Other rules, to which we will turn later, give the desired phonetic representation.

Notice that the Stressed Syllable Rule does not apply in the derivation (88), as it does at the comparable stage in the derivation (87), by virtue of the fact that the stressed syllable is not final. Thus the difference in stress contour between *parallélogram* and *parallelepíped*, as in the case of *mónograph* and *monogénesis*, is determined by the position of primary stress in the underlying final element of the compound.

There is another possible interpretation of forms such as *parallelepiped* that should be mentioned here. We have observed that case (ii) of the Main Stress Rule can, in a certain sense, be regarded as a special case of the Nuclear Stress Rule (see p. 91). Both rules assign primary stress to the rightmost sonority peak of the string under consideration. If these two rules are amalgamated, then one might reformulate the Main Stress Rule so that condition (b) becomes inapplicable in the final cycle of the derivation (88), primary stress now being

[54] For reasons that will appear below (p. 104), it is really case (ii) rather than case (i) that applies under condition (c), the affix *-o* being assigned to the string excluded from consideration under this condition.

placed on the rightmost of the two sonority peaks by the Nuclear Stress Rule, appropriately revised. This would require the imposition of several conditions on the Main Stress Rule. We have no evidence to suggest either that such a restatement of the rules is necessary or that it is ruled out conclusively. The extra conditions that must be added seem to us to rule against such an attempted generalization, but the possibility of this analysis should be kept in mind.

Notice that *párallèl*, in isolation, is assigned a stress contour as in the left-hand column of (86). Hence condition (c) must clearly be extended to adjectives, as indicated in (83), though examples are rather sparse. (Other relevant forms are those with *-dox*, e.g., *órthodòx*.)

Complex nouns and adjectives necessitate other slight modifications in the Main Stress Rule. Consider, for example, the word *politico-economic*. The first element, *politico*, is a prefix, and it must receive a primary stress on its antepenultimate syllable in the first cycle, where this form is considered in isolation. Within our framework, this stress can be assigned only by condition (a) or condition (b), which must therefore be extended to cover prefixes as well as nouns and stems. Thus conditions (a) and (b), in their abbreviated form (see (82)), will be as follows:

(89) $$\langle +C_0\rangle \begin{bmatrix} -\text{stress} \\ -\text{tense} \\ V \end{bmatrix} C_0]_{NSP\langle A\rangle} \qquad \begin{Bmatrix} \langle (a)\rangle \\ (b) \end{Bmatrix}$$

However, this quite natural extension of the Main Stress Rule leads to a difficulty in the derivations (87) and (88). In these derivations the second cycle, applying to $[_P$pærə$+$lel$+$ə$]_P$, was vacuous; but, with the extension to (89), condition (a) now holds of this form, and case (i) places primary stress in the syllable preceding the weak cluster *-lel-*. With condition (a) modified as indicated in note 54, the derivation will now result in the incorrect forms **parallelogram*, **parallelepiped* as the final phonetic representations. To prevent this, we clearly must restrict the notion "weak cluster" so as to exclude syllables which have primary stress, as does *-lel-* in these cases. Thus, we must adjust the feature composition of the nontense vowel specified in case (i) of the Main Stress Rule so as to guarantee that it have a stress weaker than primary.

One possibility would be to add the feature [−stress] to the specification of this vowel, just as we added the feature [−stress] to lax vowels specified in conditions (a) and (b) of the Main Stress Rule. This is incorrect, however, as we can see by considering words such as *telegraphy*. This is derived from *telegraph*, and must therefore have the underlying representation (90):

(90) $$[_N\,[_N\text{tele}\,[_S\text{græf}\,]_S\,]_N\,y]_N$$

In the first cycle the stem *-graph* receives primary stress on its sonority peak. In the second cycle condition (c) applies, shifting stress to the left and giving $[_N$tele$+$græf$+$y$]_N$ as we enter the third cycle. But in this cycle we must apply case (i) of the Main Stress Rule, assigning primary stress to the syllable immediately preceding the weak cluster *-graph*.[55] However, if the lax vowel specified in case (i) of the Main Stress Rule must have the feature [−stress], as just suggested, case (i) will not apply to *telegraph*$+y$, and case (ii) will apply

[55] Clearly this application of case (i) must fall under condition (a). That is, we exclude from consideration the final unit *-y* of the noun *telegraphy* and then assign primary stress by case (i). We return to a discussion of the affix *-y* in Section 15.

to give the incorrect phonetic form *$\overset{3}{telegr}\overset{1}{aphy}$. Clearly, then, we must require not that the lax vowel of the weak cluster of case (i) have the feature [−stress], but rather that it have a stress less than primary. Then case (ai) will apply, correctly, to $\overset{1}{telegr}\overset{2}{aph}$ in *telegraph*+*y*, but it will not apply to $\overset{1}{parallel}$ in *parallel*+*o*.

In summary, we must define a weak cluster as one containing a lax vowel with less than primary stress followed by no more than a single consonant followed by an optional *r*, *w*, or *y*.

A minor modification of condition (c) is dictated by consideration of examples such as $\overset{1}{praxin}\overset{3}{oscope}$, $\overset{1}{sider}\overset{3}{oscope}$, $\overset{1}{stere}\overset{3}{oscope}$, $\overset{1}{helio}\overset{3}{scope}$, $\overset{1}{platinotype}$, $\overset{1}{helicograph}$, $\overset{1}{mimeograph}$, $\overset{1}{cardiograph}$, $\overset{1}{hieroglyph}$, $\overset{1}{heteronym}$. In all of these items the first element is of the form $C_0\overset{1}{V}C_0V^*C_0o$, where the cluster V^*C_0 is weak in its underlying form and the stress on the first member of the compound is antepenultimate rather than penultimate, as required by our rule. Notice that if the cluster V^*C_0 is strong, the stress is penultimate, on V*, as expected. Thus we have $\overset{1}{kaleid}\overset{3}{oscope}$, $\overset{1}{laryngo}\overset{3}{scope}$, $\overset{1}{ophthalmo}\overset{3}{scope}$, $\overset{1}{electro}\overset{3}{scope}$, etc. Apparently the final *-o* of the first element of the complex form is acting as part of the context for cases (i) and (ii) of the rule, that is, as part of the string to be omitted from consideration in the application of cases (i) and (ii). Hence an optional *-o* (that is, /ə/, in the underlying representation) must be added to the statement of condition (c). We can therefore reformulate condition (c) as (91) and, correspondingly, abbreviate conditions (c) and (d) as (92):

(91) $(+ə)\,[-\text{seg}]\,C_0\overset{1}{V}C_0]_{\mathbf{NA}}$ (c)

(92) $\langle(+ə)\,[-\text{seg}]\rangle\,C_0\overset{1}{V}C_0]_{\mathbf{N}\langle\mathbf{A}\rangle}$ $\begin{Bmatrix}\langle(c)\rangle\\(d)\end{Bmatrix}$

Thus, if *helicograph*, for example, is represented after the first cycle in the form $[_{\mathbf{N}}\text{helic}+ə+\overset{1}{græf}\,]_{\mathbf{N}}$, then condition (c) will hold in the second cycle, excluding from consideration the sequence $[+ə+\overset{1}{græf}]$, which is of the required form $+ə\,[-\text{seg}]\,C_0\overset{1}{V}C_0$. Case (i) of the Main Stress Rule will now apply to the remaining sequence *helic-*, assigning primary stress to the first vowel.

We therefore reformulate the Main Stress Rule, replacing conditions (a), (b), (c), and (d) with (89) and (92).[56]

[56] In discussing disjunctive ordering we stipulated that the ordering by the use of parentheses is always disjunctive and that the rule that contains the parenthesized element always *precedes* the rule that omits this element. Thus the sequences enumerated by (92) are, in order, the following: (I)$+ə\,[-\text{seg}]\,C_0\overset{1}{V}C_0$; (II) $[-\text{seg}]\,C_0\overset{1}{V}C_0$; (III) $C_0\overset{1}{V}C_0$. Applying the Main Stress Rule to a hypothetical form *helic*+*o*+*scope*, on the second cycle we would find that condition (c) is applicable under interpretation (I), excluding from consideration the sequence $[+ə+\overset{1}{skOp}]$. Hence primary stress would be placed by case (i) on the first syllable, giving, ultimately, $\overset{1}{helicosc}\overset{3}{Op}$. Similarly, given *tele*+*scope*, in the second cycle we apply (II), excluding from consideration the sequence $[+\overset{1}{skOp}]$ and assigning primary stress to *tel-*.

Notice that there are some complex nouns with initial elements ending in *-o* which do not follow this rule. Thus, in $\overset{1}{galvano}\overset{3}{scope}$, $\overset{1}{chromato}\overset{3}{scope}$, $\overset{1}{daguerreotype}$ ([dəgerətIp]), $\overset{1}{hyalograph}$, $\overset{1}{cinematograph}$, etc., in order that primary stress be properly placed by case (i) of the rule, the *-o* must be regarded not as part of the context but as part of the string considered after the context of condition (c) is excluded. We can account for this simply by omitting the + boundary before *-o* in such cases. Thus *galvánoscope* will be represented [gælvæno+$\overset{1}{skOp}$] when it enters the second cycle, and primary stress will be properly

We must now return to the problem of the stress pattern of *monosyllable*, which we had put aside temporarily above. According to our rules, as so far established, the primary stress of this word should be on *syl-* rather than *mon-*. Thus, at the beginning of the second cycle we have the representation $[_{N}\text{mono}\#\text{sílæbl}]_{N}$. Since this form does not have a final stressed syllable, it is not subject to condition (c); it should, therefore, fall into the same stress class as *monogénesis* and *parallelepíped*. There are other similar examples, e.g., *métalanguage*, *ántibody*, *métaphysics* (in one pronunciation), *páralanguage*. Apparently, under certain circumstances condition (c) applies even though there is an extra nonstressed syllable on the extreme right. The circumstances are easy to detect. Recall that the complex forms that have been occupying us in this section consist of a prefix followed by an item which is either a stem or an independent noun. In each case in which the extra nonstressed syllable on the right is disregarded, the element filling the second position in the complex form is a noun rather than a stem, and it is this fact that permits condition (c) to be relaxed to allow this extra nonstressed syllable. Where we have an independent noun as the second element of a complex form, we naturally expect it to carry with it a # boundary. Using the angle notation, we can express the fact that the extra permitted syllable on the right is conditional on the presence of the # boundary, this being automatically associated with the incorporated lexical item in representations such as *mono#syllable*, *meta#language*. Thus we replace (91) by (93), as a more fully adequate version of condition (c):[57]

$$(93) \qquad (+\mathfrak{d})\begin{bmatrix}-\text{seg}\\ \langle -\text{FB}\rangle\end{bmatrix} C_0 \overset{1}{V} C_0 \langle V_0 C_0\rangle]_{NA}$$

Following our conventions for the use of parentheses and angles, we can list the sequence of rules abbreviated by (93) as (94):

$$(94) \qquad \text{(I)} \quad +\mathfrak{d}\begin{bmatrix}-\text{seg}\\ -\text{FB}\end{bmatrix} C_0 \overset{1}{V} C_0 V_0 C_0]_{NA}$$

$$\text{(II)} \quad +\mathfrak{d}\,[-\text{seg}]\, C_0 \overset{1}{V} C_0]_{NA}$$

$$\text{(III)} \quad \begin{bmatrix}-\text{seg}\\ -\text{FB}\end{bmatrix} C_0 \overset{1}{V} C_0 V_0 C_0]_{NA}$$

$$\text{(IV)} \quad [-\text{seg}]\, C_0 \overset{1}{V} C_0]_{NA}$$

Each of the above, of course, stands for a sequence of rules, one for each choice of allowed

---

placed under condition (cII) of the preceding paragraph (which omits from consideration the sequence $[+\overset{1}{\text{skOp}}]$ in this case) by case (i) of the Main Stress Rule.

Certain forms that seem to fall in the latter class actually may have $+o$, even though primary stress falls on a phonetically weak cluster. Thus, in *oscilloscope*, for example, the vowel with primary stress is phonetically lax but can be regarded as tense in the underlying representation, as we shall see in the next chapter; therefore the final *-o* of the prefix can be separated by a + boundary. Another possibility would be to assume a double *l* in the underlying form (see p. 148).

[57] The examples we have given so far leave open the question of whether the feature within angles in this rule should be [+WB] or, more generally, [−FB] (which includes [+WB]). We shall see later (p. 159) that the choice of [−FB] is correct.

Conventions to be discussed below (note 78) will require minor formal modifications in the statement of the rules abbreviated by (93) (see (94)) but will not affect their empirical content.

consonant and vowel string.[58] The sequence (94) is, by convention, pairwise disjunctively ordered. Case (94II) applies to examples such as *helic+o+graph*, giving *helicograph*. Case (94III) gives *monotone* from *mono#tOn*, *monosyllable* from *mono#syllable*, *metalanguage* from *meta#language*, as well as the nouns *intercept* from *inter=cept*, *permit* from *per=mit*, and *combat* from *coN=bat*. Case (IV) accounts for *telescope* from *tele+skOp* and *galvanoscope* from *galvano+skOp*. Case (I) would, for example, account for words such as *ornithofauna* from *ornith+o#fauna*.

In short, where the second element of a complex noun is itself a noun, stress is shifted to the left under condition (c) even if this incorporated noun is bisyllabic with initial stress.[59] We state this fact, in (93), by permitting an optional extra syllable in the second member of the complex form if this form is preceded by a boundary other than formative boundary, that is, if it is an independent noun instead of simply a stem.

We note, however, that there are many complex nouns with a bisyllabic second element which are not subject to condition (c) even though their second element exists as an independent word, e.g., *biophysics*, *monoacid*. In such a case we must drop the internal # boundary or primary stress will shift to the prefix. But there is no syntactic justification for dropping the boundary; it must be done ad hoc, simply to accommodate the phonetic facts. Such individual characteristics of particular formatives must be listed in the lexicon. They illustrate the marginally distinctive character of position of main stress placement in English.

Notice also that there are optional variants such as *meta(#)soma* or *meta(#)physics*, with initial or penultimate primary stress, depending on how the word is analyzed—that is, with or without the boundary, respectively. Here too the option is an idiosyncratic lexical matter.

The sharpening of the rules represented by (93) makes it necessary to extend slightly the system of notations that we have been presupposing. This becomes clear when we replace (91) by the revised form (93) in the more general frame (92). This replacement yields (95):

$$(95) \qquad \langle_1 (+\mathfrak{d}) \begin{bmatrix} -\text{seg} \\ \langle_2 -\text{FB} \rangle_2 \end{bmatrix} \rangle_1 \, C_0 \overset{1}{V} C_0 \langle_2 V_0 C_0 \rangle_2 \,]_{N \langle_1 A \rangle_1}$$

[58] We have not actually established a convention for the ordering of these subrules (see Chapter Eight). Furthermore, we have not given a convention to establish an ordering between (II) and (III) of (94). The ordering of (94) presupposes that parentheses are expanded before angles but we have no evidence for this arbitrary decision.

[59] Notice that *syllable* is phonologically bisyllabic, becoming phonetically trisyllabic by rule (56), so that *mono#syllable* is subject to condition (c).

Notice also that in forms such as *resell*, *mismanage*, *overprice*, *anti-tax*, *unwise*, *ultramodern*, which consist of a prefix that is syntactically and semantically functional, combined with a full lexical form, the incorporated lexical form must not undergo a separate application of the cycle. The extra cycle would cause a shift of stress to the left under condition (c) (that is, by (94III)). When there is an extra cycle (as in the nouns *mismatch*, *resale*), a shift to the left is precisely what we find. If we want to adopt representations with assignment of *sell*, *tax*, *wise*, etc., to their categories, we must limit condition (c) to nouns. Although this is not totally ruled out as a possibility (as we have noted, condition (c) is rather marginal for adjectives), it leads to some difficulties and does not seem highly motivated.

This matter is one that cannot be settled within the framework of the phonology in isolation. What is at issue is the problem of how fairly productive prefixes are to be described within the syntactic component of the grammar (including, in particular, its lexical subcomponent). There is little known about this question today, and therefore any decision that can be made within the phonology is necessarily quite tentative. It is not at all clear how this matter can be accommodated within our framework.

In the formulation (95), we have indexed angles in such a way as to show how they are paired. If the indices are dropped, (95) will be expanded, incorrectly, as:

(96) (I) $(+\text{ə})\begin{bmatrix} -\text{seg} \\ \langle -\text{FB}\rangle \end{bmatrix} C_0\overset{1}{V}C_0V_0C_0]_{NA}$

(II) $C_0\overset{1}{V}C_0]_N$

In (96), (I) abbreviates two rules, both of which incorrectly omit [−FB] (see note 24). Clearly we must enrich our notational system to permit indices on angles, adding the convention that angles with the same indices are expanded together. Thus we must replace the notational convention for angled brackets (pp. 76–77) by the convention that (97) is an abbreviation for the two rules of (98), in that order, where $Y_1 \ldots Y_{n+1}$ contain no angles $\langle_j \rangle_j$ for $j \leq i$:

(97) $Y_1 \langle_i X_1 \rangle_i Y_2 \langle_i X_2 \rangle_i \ldots Y_n \langle_i X_n \rangle_i Y_{n+1}$

(98) (a) $Y_1X_1Y_2X_2 \ldots Y_nX_nY_{n+1}$

(b) $Y_1Y_2 \ldots Y_nY_{n+1}$

Considering the intuitive meaning of the angled bracket notation, this is a very natural extension. We have already used it as an expository device in the formulation (53) above. We will henceforth use indices explicitly where they are necessary for determining the correct order of expansion; we will continue to omit them, however, where they are superfluous.[60]

Returning now to the Stressed Syllable Rule, we see that we can extend it to account for another well-known fact, namely, that words such as *advocate*, *delegate*, *precipitate*, *regiment*, *compliment*, which can be nouns or verbs, characteristically differ in stress contour in their nominal and verbal functions. The verbs, in each case, have tertiary stress and a nonreduced vowel in the final syllable; the nouns have zero stress and a reduced vowel.[61] Thus we have verb-noun contrasts such as [ædvəkA$\overset{1}{\text{t}}$]–[ædvəkət], [deləgA$\overset{1}{\text{t}}$]–[deləgət], [re$\overset{1}{\text{j}}$əm$\overset{3}{\text{e}}\overset{1}{\text{n}}$t]–[re$\overset{1}{\text{j}}$əmənt], [dā$\overset{1}{\text{k}}$yəm$\overset{3}{\text{e}}\overset{1}{\text{n}}$t]–[dā$\overset{1}{\text{k}}$yəmənt].

These forms can be explained by deriving the noun in each case from an underlying verb[62] and by modifying the Stressed Syllable Rule so that it permits secondary as well as primary stress on the final syllable. We will now be able to derive the noun *delegate*, for example, in the following way:

(99)

$[_N\,[_V$deleg+At$]_V\,]_N$		
	1	RULE (83eii)
1	2	RULE (51), (75)
1	3	RULE (83ci)
1	4	RULE (63)

[60] In case $n = 1$ in (97), we expand it simply as the single rule Y_1Y_2 (see note 24). This decision is crucial for the correct interpretation of (95).

As pointed out in note 24, it is important to show that a single set of notational devices underlies all descriptive grammar. In fact, the indexing of brackets has been utilized in earlier descriptive work in generative phonology, and such devices should be incorporated in a full and explicit account of linguistic theory. Specifications of a system of notational devices which require only slight modifications for our purposes have been presented in Chomsky (1951), (1955b); Postal (1962); Matthews (1964).

[61] At this level of phonetic detail, there is both stylistic and dialectal variation, particularly in the case of the forms with *-ment*. Here, as elsewhere, we adopt the phonetic representations of Kenyon and Knott, which agree with our own standard pronunciation. The derivation of nouns from such verbs is marginally productive, as is often the case in derivational systems of this sort.

[62] Notice that there are nouns of the form $C_0VC_0VC_0At$ with tertiary stress on the final nonreduced vowel

In the first cycle, stress is placed on the final strong cluster of the underlying verb and then shifted two syllables to the left, in the usual way, by the Alternating Stress Rule (51), now modified as (75). Thus the verb in isolation would have the form [dèlegÀt], after the Stress Adjustment Rule (63). For the noun there is a second cycle, in which condition (c), modified in a way which we discuss directly, places primary stress by case (i), weakening all other stresses by one. The Stress Adjustment Rule next weakens the final vowel to stress 4, and Vowel Reduction is then automatic because of the weakened stress.

Application of condition (c) in the second cycle of the derivation (99) will be permitted if we modify the Stressed Syllable Rule (conditions (c) and (d) of the Main Stress Rule, in their latest formulation, rule (95)), replacing it by (100):

$$(100) \qquad \langle_1 (+\text{ə}) \begin{bmatrix} -\text{seg} \\ \langle_2 -\text{FB} \rangle_2 \end{bmatrix} \rangle_1 \, C_0 \, [\beta\text{stress}] \, C_0 \, \langle_2 V_0 C_0 \rangle_2 \,]_{N \langle_1 A \rangle_1}$$

$$\beta = \begin{pmatrix} 2 \\ 1 \end{pmatrix}$$

In formulating this rule, we must specify that the stressed syllable may have either secondary or primary stress and that the two cases must be taken *in this order*. Thus (100) abbreviates

---

A of *-At*; for example, *cáliphàte, bíllingsgàte, súrrogàte, cándidàte, mágistràte* (some of which have stylistic or dialectal variants with final reduced vowel, in which case we represent them lexically with a final lax instead of final tense vowel). This fact supports the analysis we are presenting, since none of the nouns with final *-Ät* are paired with verbs. Thus the nouns with underlying verbs have a reduced vowel in the final syllable; the nouns with nonreduced, tertiary-stressed vowel in the final syllable do not have associated verbs.

Adjectives paired with verbs (e.g., *animate, approximate, articulate*) also have reduced vowels with zero stress in the final syllable, in forms of the sort we are considering here. These can be accounted for by the same mechanism proposed for the nouns *advocate, regiment*, etc. On the other hand, in adjectives such as *delicate, desperate*, which have a final reduced vowel but no underlying verb, there is no reason not to assume an underlying lax vowel in the final syllable. Derived forms such as *desperation* may seem to contradict this assumption, but we will see in the next chapter that they in fact do not.

As we have formulated the Stressed Syllable Rule, only condition (c) applies to adjectives. Therefore the adjectives discussed in the preceding paragraph must have a + boundary before *-ate*. Alternatively, it may be that condition (d) should also be extended to adjectives, in which case the + boundary is unnecessary. As we have noted previously, there are very few relevant examples involving adjectives, and therefore we are uncertain as to the correct decision. Neither alternative seems to us to pose any particular difficulty, and we will not go into the matter any further here.

Notice that where adjectives and nouns are paired with verbs, there are, very commonly, some syntactic reasons for regarding the noun phrase in which the noun appears as a transform of the verb phrase in which the corresponding verb appears, so that the noun is derived from the verb on syntactic grounds. In the same connection, note that phrases such as *... is (all, fully) dressed, ... is furnished, ... is sanded, ... is closed, ... is broken* cannot strictly be regarded as passives (and, in fact, contrast with passives). The syntactic analysis of these constructions is, at present, not clear. They are similar to passives at least in the grammatical relation between the grammatical subject and the underlying verb. It may be that they are in some way derived from passives or derived from underlying actives in a manner analogous to the transformational derivation of passives. If so, it may also be the case that the relation of *... is elaborate* to *... is elaborated*, etc., parallels this relation, in which case the adjective *elaborate* will in fact derive from the verb on syntactic grounds, as required by the phonological rules. There are many open syntactic questions here that make a more complete formulation of the phonological rules impossible. These considerations illustrate quite nicely the dependence of phonological rules on assumptions about syntactic structure. (See also note 64.)

There are certain other nouns which have variants with final [At] instead of final [ət], as they should if derived from verbs (e.g., *precipitate, concentrate*). Perhaps, in this case, these words are to be analyzed as containing the suffix *-ate* of *phosphate, manganate*, rather than as derived from the corresponding verb. For discussion of tense affixes, see Section 16.

two rules in this respect, the first of which has $\beta = 2$ and the second $\beta = 1$. If the ordering were inverted, both cases of the rule would apply in a form like *telegraph*. In the second cycle of the derivation, rule (100) would apply to $\overset{1}{tele}+\overset{1}{graph}$ with $\beta = 1$, giving $\overset{1}{tele}+\overset{2}{graph}$, and it would then reapply with $\beta = 2$, giving $\overset{1}{tele}+\overset{1}{graph}$, which would become, finally, *[$\overset{1}{\text{telə}}\overset{1}{\text{grəf}}$] by the Stress Adjustment and Vowel Reduction Rules, instead of the required [$\overset{1}{\text{telə}}\overset{3}{\text{græf}}$].

In discussing the Compound Rule in Section 9, we observed that in compounds such as *elevator boy*, *chemistry teacher*, it is customary to represent the second element with tertiary stress, rather than with the secondary stress that is retained in the second element of *elevator operator*, *chemistry laboratory*. The conditions under which this further weakening from secondary to tertiary is generally marked seem very much like the conditions under which the Stressed Syllable Rule applies. That is, when the second member of the compound is a monosyllable, with an optionally present extra syllable and perhaps some other slight modifications, primary stress is reassigned in the first element of the compound. This observation suggests that we seek a generalization that covers both the case of assignment of primary stress to the prefix in *mono# tOn* and *mono# syllable* and the case of reassignment of primary stress to the first element of *elevator# #boy*, *chemistry# #teacher*. Clearly all that is necessary is that (100) be modified to permit two successive boundaries where it is specified that a boundary may occur, and that a general convention be stated requiring that above the word level primary stress can be placed only on sonority peaks. We have observed several times that condition (e) of the Main Stress Rule can perhaps be amalgamated with the Nuclear Stress Rule, if a convention of this sort is established. With such modifications as these, we can explain the weakening of stress that is often noted in certain compounds. However, because of the marginal character of this problem and the dubious factual status of the observations in question, we will not develop this extension of the rules in any further detail.

With the various modifications that we have seen to be necessary, the Main Stress Rule (82) now takes the following form:

(101) MAIN STRESS RULE

$$\text{V} \rightarrow [1\ \text{stress}] \Big/ [X \text{---} \text{C}_0 \left(\begin{bmatrix} -\text{tense} \\ \gamma\text{stress} \\ \text{V} \end{bmatrix} \text{C}_0^1 \begin{bmatrix} \alpha\text{voc} \\ \alpha\text{cons} \\ -\text{ant} \end{bmatrix}_0\right)$$

$$\Big/ \text{---} \langle \left\{ \begin{array}{l} \langle_1 + \text{C}_0 \rangle_1 \begin{bmatrix} -\text{stress} \\ -\text{tense} \\ \text{V} \end{bmatrix} \text{C}_0 \\ (+\text{ə}) \langle_1 \begin{bmatrix} -\text{seg} \\ \langle_2 -\text{FB} \rangle_2 \end{bmatrix} \rangle_1 \text{C}_0 [\beta\text{stress}] \text{C}_0 \langle_2 \text{V}_0 \text{C}_0 \rangle_2 \end{array} \right\} \rangle]_{\langle \text{NSP} \langle_1 \text{VA} \rangle_1 \rangle}$$

where X contains no internal # boundary, $\gamma = 2$ or weaker, $\beta = \begin{Bmatrix} 2 \\ 1 \end{Bmatrix}$

Expanding the schema (101), we have the sequence of rules given in (102) (next page). The ordering conditions, once again, are the following: cases (i) and (ii) apply disjunctively, in that order, under the conditions (a)–(e); either (c) or (d) may follow either (a) or (b) within a single cycle; otherwise, the ordering is fully disjunctive.

We have slightly modified cases (c) and (d), shifting the position of the first occurrence of $\langle_1$ (compare (95) and (100)) for minor reasons that will be presented later.

(102)

$$\mathrm{V} \rightarrow [1\ \text{stress}] \Big/ [X \text{——} \left\{ \begin{array}{ll} \mathrm{C}_0 \begin{bmatrix} -\text{tense} \\ \gamma\text{stress} \\ \mathrm{V} \end{bmatrix} \mathrm{C}_0^1 \begin{bmatrix} \alpha\text{voc} \\ \alpha\text{cons} \\ -\text{ant} \end{bmatrix}_0 & \text{(i)} \\ \mathrm{C}_0 & \text{(ii)} \end{array} \right\}$$

$$\Big/ \text{——} \left\{ \begin{array}{ll} +\mathrm{C}_0 \begin{bmatrix} -\text{stress} \\ -\text{tense} \\ \mathrm{V} \end{bmatrix} \mathrm{C}_0]_{\mathbf{NSPVA}} & \text{(a)} \\ \begin{bmatrix} -\text{stress} \\ -\text{tense} \\ \mathrm{V} \end{bmatrix} \mathrm{C}_0]_{\mathbf{NSP}} & \text{(b)} \\ (+\text{ə}) \begin{bmatrix} -\text{seg} \\ \langle -\text{FB} \rangle \end{bmatrix} \mathrm{C}_0\, [\beta\text{stress}]\, \mathrm{C}_0\, \langle \mathrm{V}_0\mathrm{C}_0 \rangle\,]_{\mathbf{NSPVA}} & \text{(c)} \\ (+\text{ə})\, \mathrm{C}_0\, [\beta\text{stress}]\, \mathrm{C}_0]_{\mathbf{NSP}} & \text{(d)} \\ ] & \text{(e)} \end{array} \right\}$$

where X contains no internal # boundary, $\gamma = 2$ or weaker, $\beta = \begin{pmatrix} 2 \\ 1 \end{pmatrix}$

We have extended cases (a) and (c) to verbs for reasons that will appear in Sections 15 and 16. Actually, the only examples we have of verbs involve condition (c), but there is no harm in accepting the simplest solution, which extends condition (a) to verbs as well.

14. *Vowel reduction*

We have referred several times to the well-known fact that lax vowels reduce to a central, high, or mid unrounded "neutral" vowel in English when they are sufficiently weakly stressed, in some way that must be made explicit. We have been representing this neutral vowel as [ə]. The exact phonetic realization of [ə] does not concern us. For any particular dialect, the feature specifications and the appropriate phonetic rules can be established. For ease of exposition, we will simply make the assumption here that [ə] is distinguished from all other vocalic segments.

It is an open question to what extent vowel reduction is a matter of phonological rule. The distinction between a theory of competence (a grammar) and a performance model, which is crucial throughout, is particularly relevant in the discussion of vowel reduction.[63] In actual speech, the reduction of vowels is determined not only by the functioning of the underlying grammatical rules, but also by a variety of other factors (speed, casualness, frequency of use of the item, predictability in a particular context, etc.) These factors interact in complex and not very well-understood ways to determine the extent and place of vowel reduction, and they result, as well, in many other modifications of underlying grammatically determined forms (slurring, consonant elision, etc.) The grammar itself, here as always, generates only an idealized representation. A theory of performance will necessarily incorporate the grammar, but will also attempt to study the many other factors that determine the actual physical signal. Any investigation of grammar is, then, a contribution to the study of performance, but it does not exhaust this study.

[63] For discussion of the competence-performance distinction, see Chapter One, page 3, and Chomsky (1964, 1965), as well as many other references.

It must, incidentally, be borne in mind that the specific competence-performance delimitation provided by a grammar represents a hypothesis that might prove to be in error when other factors that play a role in performance and the interrelation of these various factors come under investigation. Although this is not usually a serious problem in grammatical study, it does become a real issue when we turn to low-level phonetic processes such as those we are now investigating. Since other aspects of performance have not been systematically studied, our attempt to delimit the boundary of underlying competence by providing specific rules for vowel reduction must be taken as quite tentative. When a theory of performance ultimately emerges, we may find that some of the facts we are attempting to explain do not really belong to grammar but instead fall under the theory of performance, and that certain facts that we neglect, believing them to be features of performance, should really have been incorporated in the system of grammatical rules.

In particular, we should like to point out that the distinction we draw between competence and performance is not invariably the same as that drawn implicitly by Kenyon and Knott in their choice of phonetic representation. That is, the output of our rules does not always agree with their phonetic notation with respect to the marking of reduced vowels, although it does agree for the mass of cases (in particular, for the examples that we cite here). In part the differences are systematic (for example, we mark reduced vowels in many positions where they retain an underlying /i/ as [i], and they mark lax [i] in certain positions where our representation is *E*—e.g., *rElax*, *dEnOt*); in part, the differences are idiosyncratic. Insofar as the differences are systematic, it is a fairly trivial matter to adjust the rules to give either phonetic output.

In short, we are formulating the rules so as to generate what we take to be the phonetic representation underlying our normal pronunciation, in agreement with Kenyon and Knott in crucial cases. Various modifications of these phonological rules would be needed to accommodate dialects differing in a systematic way from what we have here assumed. It should, incidentally, be expected that low-level phonetic rules such as those we are now considering will differ in detail across dialects.

Bearing these points in mind, we now turn to an examination of the set of processes that determine the reduction of vowels. We note, first, that nontense vowels specified as [−stress] reduce to [ə] fairly generally. Thus, as a first step, we can formulate the Vowel Reduction Rule as in (103):

$$(103) \qquad \begin{bmatrix} -\text{stress} \\ -\text{tense} \\ \text{V} \end{bmatrix} \rightarrow [\text{ə}]$$

In Section 3 it was noted that only unstressed low vowels reduce in final position; and it is clear that vowels never reduce prevocalically. Thus, the vowels in boldface in *fiasco*, *effigy*, *hind**u***, *annual*, *radiate* do not reduce even though they are minus-stressed, but the final vowels of *algebra*, *formula* do reduce. Furthermore, the vowels which do not reduce even though nontense and minus-stressed are phonetically tense. Clearly, then, the rule that tenses vowels in prevocalic and, when they are nonlow, in final position must precede the general Vowel Reduction Rule (103), as we have already noted in Section 4. For the case of nonstressed vowels, rule (30) of Section 4 has exactly the effect of (104):

$$(104) \qquad \begin{bmatrix} \text{V} \\ -\text{stress} \end{bmatrix} \rightarrow [+\text{tense}] \Big/ \left\{ \begin{array}{c} \text{V}\_\_ \\ \begin{bmatrix} \_\_ \\ -\text{low} \end{bmatrix} \# \end{array} \right\}$$

The vowels that undergo tensing by rule (104) are then immune from Vowel Reduction, despite their lack of stress.

An early rule of the phonology assigns to each vowel (in fact, to each unit, whether boundary, consonant, or vowel—see pp. 67–68) the feature [−stress]. A vowel belongs to the category [+stress], and thus is immune from Vowel Reduction, in the tentative formulation (103), only if it receives primary stress at some stage of the application of the cyclical rules. This stress may be weakened by successive applications of the stress placement rules in other positions of the utterance, but the vowel will still belong to the category [+stress] and hence will not be subject to Vowel Reduction.

Although (103), as we shall see, requires supplementation, it does express the central feature of the process of Vowel Reduction insofar as this is a grammatical phenomenon. We can give some idea of its wide range of applicability by a few selected examples.

Rule (103) accounts for the fact that the vowel reduces in the first syllable of *machíne*, but not the second, and in the second syllable of the verb *délegàte*, but not the first or third. In each case a vowel which has never received primary stress (and therefore retains the specification [−stress]) reduces, and a vowel which has at some point received primary stress (and thus belongs to the category [+stress]) is immune from phonological reduction. Similarly, consider the example ***theatricality*** analyzed in Section 7. The four vowels given in boldface do not reduce—the fourth because it has been tensed by rule (104), the second and third because they have at some stage of their derivation been assigned primary stress, and the first for both reasons. The other two vowels do reduce, never having been introduced into the category [+stress] in the course of the derivation.

As a further illustration, consider the nouns ***torrent*** and ***torment*** that were discussed in Section 11. The three vowels given in boldface in these examples are exempt from reduction, having been assigned primary stress at some stage of the derivation; but the final vowel of *torrent* does reduce, since it has the feature [−stress] when rule (103) applies.

As a last example, consider the *-ation* forms of bisyllabic final-stressed verbs such as *reláx*, *attést*, *depórt*, as compared with the superficially analogous forms *information*,[64] *illustration*, *demonstration*, *devastation*. The boldface vowel in ***relaxation***, ***attestation***, ***deportation*** is not subject to phonological reduction, whereas the antepenultimate vowel of the other *-ation* forms just given does reduce in each case. The reason is that the nominalized bisyllabic verbs have received stress in the antepenultimate syllable at an earlier stage of the cycle (namely, as verbs), whereas the other forms have never had stress assigned to this vowel. We will return to the details of the determination of stress contours in these cases. Although, as we shall see, the facts are not so clear-cut as these examples suggest, the general point does seem correct; that is, stress assignment in an early cycle can protect a vowel from phonological reduction, even when its actual stress, at the point when the Vowel Reduction Rule applies, is quite weak, and even though minus-stressed vowels in the same context do characteristically reduce. The important point is that rule (103) serves as a reasonably good tentative statement of the process of Vowel Reduction when this process is embedded within the general framework of the transformational cycle.

[64] Notice that *information* is not the nominalized form of *inform*, but rather a single noun presumably represented as /inform+At+iVn/. Thus we cannot have phrases such as **his information of my friend about the lecture* related to *he informed my friend about the lecture*, as we have *his relaxation of the conditions* related to *he relaxed the conditions*. Correspondingly, the meaning of *information* is not derivable from that of *inform* by any regular process.

We are not concerned here with the syntactic basis for these and other nominalized elements. For an approach that seems to us promising, see Chomsky (1965, pp. 219–20).

We see at once, incidentally, that the Vowel Reduction Rule cannot itself be cyclical. Once a vowel has been subject to rule (103), its original underlying form is unrecoverable. Therefore, if this rule were to apply at any point in the first cycle, for example, certain vowels will be reduced to [ə] even though in some later cycle they may receive primary stress. Evidently, rule (103) must apply only after the process of stress assignment within the word is complete. Within our framework, this means that the rule of Vowel Reduction is restricted to the level of word boundaries (see Section 1.1).

The tentative statement (103) is at best a first approximation to the description of vowel reduction; it does not specify the positions that are subject to this process with sufficient precision, although it is fundamental to such a specification. In fact, in certain positions a vowel will not reduce even though it has never received primary stress and thus remains in the category [−stress]; in certain other positions a stressed vowel will reduce if the stress is sufficiently weakened. Consequently, we must supplement the Vowel Reduction Rule (103) with certain auxiliary rules of the form (105a), (105b) which change the stress (and, sometimes, tenseness) category of vowels in certain positions before the application of (103).

(105)

(a) $V \rightarrow$ [2 stress] in certain contexts

(b) $V \rightarrow \begin{bmatrix} -\text{stress} \\ -\text{tense} \end{bmatrix}$ in certain contexts

Rule (105a) will apply to certain vowels that have never received primary stress and will assign them secondary stress, thus exempting them from reduction to [ə] by (103). The Stress Adjustment Rule will then weaken this stress to tertiary. (For reasons that are discussed on pages 118–19, we will not extend to rules of secondary stress placement the convention associated with placement of primary stress, namely, that other stresses in the domain under consideration are weakened by one.) Rule (105b) will apply to certain vowels which have received primary stress at some earlier stage of derivation and will switch them back to the category [−stress] so that they can undergo reduction by (103). Precise specification of the appropriate contexts for (105) is a complicated and, so it appears, relatively uninteresting matter,[65] and we will not attempt a detailed analysis. We will, however, give several cases of (105), illustrating some of the major conditions and accounting for examples discussed elsewhere in this chapter. We will continue to refer to (103) as the Vowel Reduction Rule and to the various cases of (105) as Auxiliary Reduction Rules.

Notice that rule (105b), like the Vowel Reduction Rule (103), cannot be permitted to apply cyclically beyond the level of word boundary. The reason is simple. As we proceed to apply the transformational cycle to more complex phrases, vowels are successively weakened in stress as more gradations and differentiations are introduced by successive applications of the cyclical rules. Above the word level even primary-stressed vowels may be weakened considerably in this process. However, this weakening of stress never leads to a shift of category with respect to stress or tenseness, nor does it lead to vowel reduction. In other words, although vowels that are weakened to stress 2 or stress 3 in certain positions within words may be subject to (105b), a vowel that is weakened to stress 2 or stress 3 in cycles beyond the word level will never, in these contexts, be subject to rule (105b); in

[65] In the sense that there are many details and special cases that do not seem to fall under any large-scale generalizations and that shed little light on general questions of phonological theory or on the structure of English.

particular, the sonority peak of a word will never be subject to this rule no matter how weak the stress on this word becomes by iteration of cyclic rules beyond the word level.

In short, neither rule (103) nor rule (105b) can be cyclical. Both must apply only once in the course of a derivation; within our framework this means that these must be noncyclical rules restricted to the level of word boundary.

To see the necessity for Auxiliary Reduction Rules of the form (105a), consider the following words:

(106) *rhododéndron, Oklahóma, Kalamazoo, Tatamagoúchi, Coriolánus, Winnipesáukee, Monongahéla, Conestóga, mulligatáwny*

The vowels that are not subject to reduction are given in boldface. Of these, the ones that are in final or prevocalic position and the ones with primary stress pose no problem so far as Vowel Reduction is concerned; and our rules also account for the reduction of the vowels not cited in boldface. The other boldface vowels, however, all of which have tertiary stress, are still not accounted for, for they have never received primary stress at any stage of their derivation. In each case, in fact, there is only a single cycle and a single application of a stress placement rule.

It seems, then, that to account for the unreduced tertiary-stressed vowels of these words, we need an Auxiliary Reduction Rule which will be a special case of (105a). We state this as (107):

(107)

$$\begin{bmatrix} -\text{stress} \\ \text{V} \end{bmatrix} \rightarrow [2\ \text{stress}] \Big/ \neq \begin{cases} [-\text{stress}]_0 \text{——} \begin{cases} C_0 \begin{bmatrix} -\text{tense} \\ \text{V} \end{bmatrix} C_0^1 \\ C_0 \end{cases} \overline{C}_0 \begin{bmatrix} \alpha\text{stress} \\ \text{V} \end{bmatrix} \overline{C}_0\,[1\ \text{stress}] & \text{(a)} \\ & \text{(b)} \\ C_0 \begin{cases} \text{——} C_2 \\ \begin{bmatrix} \text{——} \\ +\text{tense} \end{bmatrix} \end{cases} & \text{(c)} \\ & \text{(d)} \end{cases}$$

where α is weaker than 2[66] and $\overline{C}$ is an informal abbreviation for a unit which is a consonant or a boundary

Notice that the first two parts of this rule are strikingly similar to the rules of primary stress placement, particularly to condition (c) of the Main Stress Rule (102). Cases (a) and (b) of (107) assert that secondary stress is placed on a vowel preceding a weak cluster (case (a)) or on a strong cluster (case (b)) when the string under consideration falls under the condition ——$V^*C_0\overset{1}{V}$, V^* having stress weaker than two. The rule is closely analogous to the Main Stress Rule, the central difference being that secondary stress is assigned rather than primary stress. Thus, given the word *Monongah$\overset{1}{E}$la* (primary stress having been assigned by case (ii) of the Main Stress Rule (102) under condition (b)), rule (107) requires us to omit from consideration the final sequence *-ah$\overset{1}{E}$la* and to apply first case (a) and then, if case (a) is inapplicable, case (b) to the residual string *Monong-*.[67] Case (a) is inapplicable, since the

[66] That is, where α is an integer greater than 2, or has the value "minus" (−), which, by convention, is weaker than any value that belongs to the category [+*stress*], i.e., weaker than [*n*stress] for any integer *n*.

Notice that we cannot permit $\alpha = 2$ in this case, as we can see from words such as *ĕlèctrónic, ĕlèctrícity*, which at this stage have the stress contour −21 . . . , but do not, in the dialect in question, receive secondary stress in the first syllable by rule (107b).

[67] The ordering of cases (a) and (b) of (107) is disjunctive, just as the ordering of cases (i) and (ii) of the Main Stress Rule is disjunctive, and for exactly the same reason.

final cluster of this string is strong, so we turn to case (b) and assign secondary stress to the strong cluster, giving *Monongah^{2}É^{1}la*. The Vowel Reduction and Stress Adjustment Rules give, finally, [mənā^{3}ŋgəhÉ^{1}lə].

Consider now the word *Winnipesaukee* (primary stress again having been assigned by case (ii) of the Main Stress Rule under condition (b)). As before, rule (107) tells us to omit from consideration the final string *-esaukee* and to consider the residue *Winnip-*. But now case (a) of (107) applies, the final cluster of *Winnip-* being weak, and we derive *Winni^{2}pesaukee*. The Vowel Reduction and Stress Adjustment Rules give, finally, [wi^{3}nəpəsō^{1}kE].

In the word *Oklah^{1}Oma*, primary stress is again assigned by case (ii) of the Main Stress Rule under condition (b). In accordance with rule (107), we omit from consideration the string *-ah^{1}Oma* and consider the residual string *Okl-*. Case (b) assigns secondary stress to its only vowel. In the same way the other examples of (106) receive secondary stress in the appropriate place.

There are many other forms that are phonetically interpreted in this way, for example, verbs such as *òverthrów*, *èxtrapóse*, *ùnderstánd*, *còmprehénd*, all of which have tertiary-stressed nonreduced vowels in the first syllable. Since many of these forms contain = and # boundaries between the vowel that receives secondary stress and the following primary-stressed vowel, cases (a) and (b) of (107) must permit occurrences of [−segment], as indicated in (107). The word *comprehend*, for example, has the representation [kəN=pre=h^{1}end] at the point when rule (107) is to apply. Case (b) applies, with a boundary preceding and following the α-stressed vowel. The word *automobile* would have the representation *auto*+*mOb^{1}El*, and case (a) of (107), with the α-stressed vowel preceded by [−segment] C, assigns secondary stress to *au-*, so that we have the phonetic representation *au^{3}tomobile^{1}* ultimately. (Other variants require slightly different underlying representations.)

Notice, incidentally, that the similarity of cases (a) and (b) of (107) to cases (i) and (ii) of the Main Stress Rule is not a merit of this grammar but rather indicates a defect either in the analysis or in the underlying theory. As matters now stand, we are unable to formulate a generalization that covers both the rule of primary stress assignment and the rule of secondary stress assignment, despite the near identity of context in the two rules. We have, so far, been unable to find any way to overcome this defect without ad hoc extensions of the general framework for grammatical description or revisions of the rules which are unacceptable on other grounds. We are therefore forced to leave this as an open problem. In Chapter Five, note 3, we will come across another indication of this theoretical defect, in connection with a different sort of phenomenon.

Before turning to cases (c) and (d) of the Auxiliary Reduction Rule (107), let us consider a few more examples of the first two cases. Consider the nouns *relaxation*, *attestation*, *deportation*, etc., which we discussed above. Since these are derived from bisyllabic verbs with a final strong cluster, we enter the word-level cycle with representations such as [rE^{1}læks+At+iVn]. Primary stress is placed on [At], weakening the stress on [æ] to secondary, i.e., [rE^{2}læks+Á^{1}t+iVn]. We now turn to the phonological rules which are limited in applicability to the level of word boundary. Notice that the phonetic output must be [^{3}rĒ^{4}læksÁ^{1}šən]. Of the rules we are now considering, the final one to apply in this derivation is the Stress Adjustment Rule. Prior to the application of this rule, we must, therefore, have the representation [^{2}rĒ^{3}læksÁ^{1}šən]. Our problem, then, is to provide a rule that will carry the stress contour from –21–, which we now have, to 231–, which we need as the proper input to

the Stress Adjustment Rule. If we weaken the stress from 2 to 3 in the second syllable, then rule (107b) will assign [2 stress] in the first syllable, as we require. Therefore we must add a new rule (108) which weakens stress in the position immediately preceding primary stress.

(108) [2 stress] → [3 stress] / ——C_0 [1 stress]

We now have the following derivation for *relaxation*:

(109)

$[_N\,[_V$rElæks$]_V$ At+iV̆n$]_N$	
1	RULE (102eii)
2 1	RULE (102bi)
3 1	RULE (108)
2 3 1	RULE (107b)
3 4 1	RULE (63)

In the first cycle primary stress is placed on the strong final cluster of the underlying verb. In the second cycle the primary stress is shifted to the syllable preceding *-ion* in the usual way (see p. 87). Rule (108) then weakens the pretonic stress, and the Auxiliary Reduction Rule (107) assigns secondary stress in the first syllable. The Stress Adjustment Rule (63) then weakens all of the nonprimary stresses in the word. The vowel [æ], although it now has stress 4, is immune from reduction as the rules are formulated.[68]

In a similar way we derive analogous representations in the case of *attestation*, *deportation*, etc., as well as in many other cases (e.g., *connectivity*, *conductivity*, *objectivity*, *elasticity*). In each case the stress contour of the first three syllables is 341 and the vowel with [4 stress] remains unreduced. In contrast, words such as *information*, *demonstration*, *adjectival* all have the stress contour 3–1– and a reduced vowel in the second syllable, since in these words the second syllable has never received stress in an earlier cycle. We can even account, in this way, for such a fine distinction as is exhibited by the pairs *compensation* [$\overset{3}{\text{k}}\text{ăm}\overset{1}{\text{A}}$pənsšən], *condensation* [$\overset{3}{\text{k}}\text{ăn}\overset{4}{\text{d}}\overset{1}{\text{A}}$ensšən], from underlying $[_N\,[_V$kəN=peNsAt$]_V$+iV̆n$]_N$ (cf. *compensatory*), $[_N\,[_V$kəN=deNs$]_V$ At+iV̆n$]_N$ in exactly the same way.[69]

If, for some reason, rule (108) does not apply to a word with the stress contour –21 . . ., then cases (a) and (b) of the Auxiliary Reduction Rule (107) will not assign secondary stress to the initial minus-stressed vowel, since the rule (107), as formulated, requires that the pretonic vowel have a stress weaker than secondary. In fact, rule (108) is optional for certain classes of words, and when it does not apply, rule (107) is blocked. Thus, in the case of words such as *elasticity*, *electricity*, we may have either the contour –31–– or 341––. In the

[68] Because of these facts, it is easy to detect at least five degrees of stress in English. Thus, in forms such as *relaxation*, we have the stress contour 341–, [—stress] being numerically representable as [5 stress] in this case. Notice that we could not take the contour to be 2314, because of contrasts such as *either nation* (with 2–1–) versus *emendation* (with 341–).

[69] This is an accord with our pronunciation and also with a distinction between these forms noted in Kenyon and Knott. It is, however, unreasonable to expect cross-dialectal identity on a minute point such as this, particularly in the light of the problematic nature of phonetic representation at this level of fineness of detail.

Actually, to be even more precise, our grammar generates [$\overset{3}{\text{k}}\text{ăn}\overset{4}{\text{d}}\overset{1}{\text{A}}$ensšən] for the nominalized verb ("act of condensing") and [$\overset{3}{\text{k}}\text{ăndə}\overset{1}{\text{n}}$sšən] for the noun referring, e.g., to drops of water on the window pane (which, like *information*, does not have an underlying cycle for the contained verb).

The reason for assuming /kəN/ (N being the archi-segment [+nasal]) in the phonological representation is that the point of articulation of the nasal is determined by the following consonant.

former case, neither rule (108) nor rule (107) has applied; in the latter, both have applied. As we have formulated the rules, the option is restricted to rule (108), the subsequent applicability of (107) being completely determined in all cases.

As a further example of rule (107a, b), consider the nouns *instrumentality*, *complementarity*, *experimentation*, each of which has an unreduced vowel under [4 stress] immediately before a primary stress. Taking *instrumentality* as an example, we have the derivation (110), which is analogous to (109):[70]

(110)

$[_N\,[_A\,[_N$instrument$]_N$ æl$]_A$ i+ti$]_N$				
1				RULE (102bi)
2	1			RULE (102aii)
3	2	1		RULE (102ai)
3	3	1		RULE (108)
2	3	1		RULE (107a)
3	4	1		RULE (63)

In the first cycle we disregard the final lax syllable of the noun under condition (b) of the Main Stress Rule and assign primary stress by case (i). Thus in isolation we would have the phonetic representation [ɪnstrəmənt].[71] In the second cycle the affix *-al* causes primary stress to be assigned to the strong cluster that immediately precedes it. In the final, word-level cycle, the affix *-ty* causes primary stress to be placed on the syllable preceding the weak cluster that immediately precedes *-ty*, giving the third line of the derivation. Rule (108) then weakens the pretonic stress, and rule (107) raises the stress on the syllable before the weak cluster to secondary by case (a). The Stress Adjustment Rule next weakens the nonprimary stresses. The final affix becomes [tE] by rule (104), and the Vowel Reduction Rule gives, finally, [ɪnstrəmɛntælətE]. Again we have a nonreduced vowel under stress 4.

Before leaving this topic, we should make several further remarks about assignment of secondary stress by an Auxiliary Reduction Rule. First, it should be noted that this phonological process is considerably more general than we have indicated. The joint effect of rules (108) and (107a, b) is to convert a stress contour of the form *x*21 to 231 or *xy*21 to 2*y*31. We have given rules for this process within the scope of word boundaries only, but it also operates above the level of the word. Thus, in isolation *fifteen* or *abstract* (the adjective) has main stress on the final syllable, but, as has often been noted, in the construction *fifteen men* or *abstract art*, we have the stress contour 231 (see also note 26). The reason for this is perhaps the following. In the manner described in Section 8, the Nuclear Stress Rule converts *fifteen men* and *abstract art* to *fifteen men* and *abstract art*, respectively. Now, by a phenomenon superficially similar to the one we have formalized in terms of rules (108) and (107), the resulting *x*21 contour is converted to 231. Similarly, in a sequence such as *tired old men*, the 221 contour produced by the Nuclear Stress Rule is generally converted to 231, perhaps by the same process. We do not know precisely what the domain of this process is, or how it should be described in detail. We merely note here that our description, which is limited in scope to the word, is insufficiently general.

[70] On the analysis of *-ity*, see page 87 and note 90. On the stress contour of *experimentation*, see note 72. We modify (107) below (see (120)) so that it applies to vowels with other than primary stress and hence to the first vowel in *instrumentality*.

[71] Alternatively, this could be regarded as derived from an underlying verb, like the examples of page 96.

Actually, even within a word the process we have now been discussing has slightly wider scope than we have indicated. Consider, for example, *artificiality*. We enter the final, word-level cycle with the representation $[_N$ærtifikiæl+i+ti$]_N$. Primary stress is then placed on the antepenultimate syllable, giving $[_N$ærtifikiæliti$]_N$. Since the secondary-stressed vowel is not immediately followed by the primary-stressed vowel, the change of contour from 3–2–1 to 2–3–1 should not take place, as we have formulated rule (108), and the resulting contour should be 4–3–1; but, in fact, the correct contour is 3–4–1 rather than 4–3–1. Thus rule (108) must be slightly generalized to take account of this case and similar cases.[72]

Returning now to rule (107), we have still not given examples to illustrate cases (c) and (d). These cases of the rule assign secondary (ultimately, by the Stress Adjustment Rule, tertiary) stress to the vowel of a strong cluster in the initial syllable of a word. Thus, in *vòcátion, gèstátion, plàntátion, àsbéstos, àudácious*, etc., the vowel of the first syllable does not reduce and has [3 stress]. (Some would say [4 stress], in which case a slight revision of the rule becomes necessary.) Actually, the situation is a bit more complex in this position, but we omit any more precise specification of the relevant context here (see note 65).

Case (c) of rule (107) protects a vowel from reduction in the context ——CC, but not in the context C=C. Thus stress is introduced by (107c) in the first syllable of *Mòntána, pòntíficate, càntánkerous, làmpoón*, etc., but not in the verbs *com=bat, con=tend, con=vert, con=tinue*, and so on. This fact provides an additional justification for the decision to have a readjustment rule insert a boundary with the feature [–FB] in prefix-stem constructions (see Sections 10 and 13).

Given a stress contour of the form –21, rule (108) converts it to –31 and rule (107a) converts it to 231. A reasonable suggestion would be to drop rule (108) from the grammar altogether and to adopt a slightly different convention for assigning secondary stress. The convention for assignment of primary stress is as follows: when primary stress is assigned in a particular position, the stress value in every other position is weakened by one. Suppose that (following Kiparsky, 1966) we were to say, more generally, that when stress n is assigned in a particular position, then the stress value in any other position with stress not heavier than n is weakened by one. Under this convention, if rule (107a) applies to a contour –21, it assigns secondary stress to the minus-stressed vowel and automatically reduces the secondary stress already present to tertiary. Thus rule (107a) itself converts –21 to 231, and rule (108) is superfluous.

We do not accept this proposal, however, for several reasons. First, the suggested convention leads to technical difficulties. Consider, for example, the word *anticipate*. In the normal way, the stress assignment rules provide the stress contour *anticipÁt*. As matters

[72] As an additional example, yet to be covered, consider the word *Ticonderoga*. The Main Stress Rule assigns primary stress to the penultimate syllable. Rule (107b) then assigns secondary stress to the strong cluster preceding the primary stress by two syllables, giving *Ticonderoga*. Case (c) of rule (107), which we discuss directly, assigns secondary stress to the strong cluster in the first syllable, giving *Ticonderoga*. As our rules now stand, the Stress Adjustment Rule will give, finally, *Ticonderoga*. Actually, this should be modified to either of the two optional variants *Ticonderoga* or *Ticonderoga*. The first of these might be produced by a process similar to the one we have just been discussing. The second would require a subsidiary rule much like (108). Apparently what is needed is a variety of subsidiary rules to assign relative stress among weak stresses that are equal as our rules are now formulated. Such rules are needed, for example, to assign the contour 43–41– to *experimentation* (see p. 117). Rule (107c) should assign secondary stress in the first syllable, protecting the vowel from reduction. The Stress Adjustment Rule weakens this vowel to tertiary stress. A further weakening requires a rule of the sort just discussed.

now stand, rule (107c) will assign secondary stress in the first syllable and the Stress Adjustment Rule will then apply, giving *anticipÁt*, as desired. But if we were to adopt the suggested convention, then when secondary stress is assigned in the first syllable, the secondary stress of the final syllable will reduce to tertiary, giving *anticipÁt*. However, as we have seen in the discussion of verb-noun pairs such as [deləgAt]–[deləgət], [rĕjəment]–[rĕjəmənt], a tertiary-stressed vowel reduces in this position. Thus we derive the incorrect phonetic form *[æntisipət]. This fact seems to provide a compelling argument against the convention.

Apart from such technical considerations, there are others of a more general nature that lead us to question the proposed convention. It seems to us mistaken to regard the rules for assignment of secondary stress as forming a part of the system of stress assignment rules. Rather, they form a part of the system of vowel reduction. They are simply a device for preventing vowel reduction in certain positions, on a par with the other Auxiliary Reduction Rules that weaken stress as a device for permitting vowel reduction in other positions. If this conception of the role of the rules for assignment of secondary stress is correct, then the suggested generalization of the convention for stress assignment is a spurious one and inappropriate for the rules in question. There is, however, an interesting theoretical issue here, and we emphasize that our argument is far from conclusive. Thus, a generalization such as that proposed on page 117 for constructions beyond the word level would argue against our conclusion, as Kiparsky has correctly observed.

We have now given several examples of the first type of Auxiliary Reduction Rule, namely, the type (105a) that protects a vowel from reduction despite its lack of earlier stress. Let us now turn to the second type, that is, the type (105b) that makes a vowel subject to reduction despite its earlier stress. Such rules place a vowel in the category $\begin{bmatrix} -\text{stress} \\ -\text{tense} \end{bmatrix}$ in certain contexts, so that the Vowel Reduction Rule (103) will apply to them. Our problem now is to specify these contexts.

Consider first the words *solidity*, *telegraphy*. These are derived from the underlying forms *solid* and *telegraph*, and therefore enter the word-level cycle with the stress contours *solid*+*i*+*ty*, *telegraph*+*y*. Since the cluster preceding -(*t*)*y* is weak in both cases, primary stress is shifted to the antepenultimate syllable, giving *solidity* and *telegraphy*. However, the vowels in boldface must reduce, despite the fact that at this stage of derivation they belong to the category [+stress]. Therefore we must give an Auxiliary Reduction Rule of the form (105b) to shift them to the category [−stress] (all vowels in these examples are already lax) so that the Vowel Reduction Rule (103) can apply to them.

We have so far been assuming that all rules relating to Vowel Reduction precede the Stress Adjustment Rule (63), which, it will be recalled, is just a special case of the Nuclear Stress Rule. Continuing with this assumption, we must now formulate (105b) so as to convert the tertiary-stressed vowel of *-graph* and the secondary-stressed vowels of *tel-* and *sol-* to the category [−stress]. It seems that the relevant aspects of these contexts are essentially as given in (111):

(111)

(a) $\left[\overline{\qquad}_{3\ \text{stress}}\right]\,[-\text{stress}]_0\ \#$

(b) $\text{——}\,C_0^1\,[1\ \text{stress}]$

We shall have to revise and extend both cases slightly as we proceed. As (111) stands, it states that a tertiary-stressed vowel which is the final stressed segment in the word becomes

lax and nonstressed (case (a)), and that any vowel becomes lax and nonstressed if it is followed by no more than a single consonant followed by a primary-stressed vowel (case (b)). Case (a) will apply to the tertiary-stressed vowel in *telegraphy*. Case (b) applies to the vowel in the first syllable of *telegraphy* and *solidity*, assigning it, in each case, to the category [−stress]. Thus (111) accounts for the reduction of vowels in these words.

Notice that the Auxiliary Reduction Rule we are discussing does not apply to the pre-main-stress vowel of *mentality*, *sensation*, *gestation*, *instrumentality*, *relaxation*, etc.; it is blocked by the double consonant following the vowel. We have, however, formulated (111) so that it applies freely to tense vowels. We will see that certain restrictions are needed here.

Consider now the nouns *document*, *regiment*, *experiment*, *delegate*, *advocate*, etc., and adjectives such as *animate*, *elaborate*. As we have pointed out, these forms can be regarded as derived from underlying verbs. The additional cycle required for this derivation reduces the stress in the final syllable to tertiary, as compared with the corresponding verbs, which, with one less cycle in the derivation, have secondary stress in this position at this stage (see p. 107). In all cases the tertiary-stressed vowel in the final syllable becomes nonstressed and lax by the Auxiliary Reduction Rule (105b), applying in the context (111a), and then reduces to [ə] by (103). Thus we have now fully accounted for the contrast between the verbs *document*, *delegate*, *elaborate*, etc., with unreduced tertiary-stressed vowels in the final syllables, and the nouns and adjectives *document*, *delegate*, *elaborate*, with reduced minus-stressed vowels in the final syllable.

Notice that the Auxiliary Reduction Rule in question does not apply to a tertiary-stressed vowel followed by a double consonant if there is a stressed vowel later in the word. Thus consider the words *documentation*, *regimentation*, *experimentation*. Taking the first as an example, we derive the stress contour *document* in the first cycle. In the next cycle primary stress is placed on *-At-*, giving *documentation*. But the tertiary-stressed vowel of this word does not fall under case (a) of (111) because it is followed by a later stressed segment; and it does not fall under case (b) because it is protected by a double consonant. Thus the Auxiliary Reduction Rule gives, finally, *documentation*, with a nonreduced vowel under stress 4, as required for the dialect we are considering.

Consider now forms such as *explanation*, *provocation*, *defamation*, *divination*, all of which have reduction of the pretonic vowel. Taking the first as an example, we have the following derivation:

(112)

$[_N\,[_V$ekspl$A$n$]_V$ A$t+$iVn$]_N$			
	1		RULE (102eii)
	2	1	RULE (102bi)
	3	1	RULE (108)
2	3	1	RULE (107b)
2	–	1	RULE (111b)
3	–	1	RULE (63)

In the first cycle, *explain* receives primary stress on its final syllable. In the next cycle, the affix *-ion* causes primary stress to be shifted to the right by (102bi). Rule (108) weakens the pretonic secondary stress to tertiary; and the first Auxiliary Reduction Rule (107b) assigns

secondary stress in the initial syllable. But now the second Auxiliary Reduction Rule, operating in the context (111b), weakens the stress on the pretonic syllable to minus, at the same time specifying the vowel as [−tense] (see (105b)). The Vowel Reduction Rule (103) then reduces this segment to [ə], and the Stress Adjustment Rule (63) gives us the final phonetic representation [$\overset{3}{\text{e}}\text{ksplən}\overset{1}{\text{A}}$šən].

Notice that the forms *relaxation*, *attestation*, *connectivity*, etc., which we discussed above, are identical to forms such as *explanation* in their derivational history up to the point at which the word-level rules apply. But in the case of the former words, the Auxiliary Reduction Rule (105b) does not apply to the pretonic vowel, which is protected by the double consonant that follows it. Thus this vowel remains unreduced, with, finally, [4 stress].

The context (111b) is not formulated quite correctly, however. As given, it will lead to the reduction of any vowel, tense or lax, with or without stress, if this vowel is separated from a following primary stress by no more than a single consonant. As we have observed above, however, a strong cluster remains unreduced in pretonic position in word-initial syllables. Thus we have an unreduced vowel in the initial syllable of words such as *location*, *gradation*, *totality*, *iconic*, *baboon*, as well as in *asbestos*, *gestation*, *mentality*, etc. We must therefore restate the context (111b) so as to introduce this distinction between initial and noninitial positions in the case of tense vowels. We now replace (111b) by (113):

(113)
$$\left\{\begin{matrix}\left[\frac{\quad}{-\text{tense}}\right] \\ \text{VC}_0\left[\frac{\quad}{+\text{tense}}\right]\end{matrix}\right\} \text{C}_0^1\,[1\text{ stress}]$$

The necessity for still further emendation is clear from consideration of words such as *concéptual*, *contémplative*. These enter the word-level cycle with the representations $\overset{1}{con}=\overset{2}{cept}+u+al$, $\overset{1}{con}=templ\overset{2}{A}t+iv$. The affix *-al* causes primary stress to be shifted to *-cept-*, and, for reasons which we shall go into shortly, the affix *-ive* also causes a stress shift to the right in *contemplative*, as one option. In each case, then, the initial sequence is [$\overset{2}{\text{k}}$ə$\overset{1}{\text{N}}$=C$\overset{1}{\text{V}}$ . . .] after application of the Main Stress Rule in the word-level cycle. But now the pretonic vowel should reduce. Notice that in forms such as *cònchólogy*, *còmptómeter*, *bòmbárd*, the secondary stress (deriving from a primary stress assigned in the first cycle or, alternatively, assigned by (107c) if the forms are analyzed without an internal cycle) is protected from weakening to minus by the following double consonant, whereas in *concéptual*, *contémplative*, reduction does take place despite the double consonant. The difference is evidently the presence of the = boundary in the latter forms. Thus we extend (113) to (114):

(114)
$$\left\{\begin{matrix}\left[\frac{\quad}{-\text{tense}}\right] \\ \text{VC}_0\left[\frac{\quad}{+\text{tense}}\right]\end{matrix}\right\} \text{C}_0^1(=\text{C}_0)\,[1\text{ stress}]$$

Summarizing these remarks, consider a vowel V* that appears in the context ——C_m^n*Ation*. If $m = n = 0$, V* will be tensed by rule (104) and therefore will not reduce

to [ə] by (103) (e.g., the boldface vowels of *valuation* and *radiation*). Suppose that $m \neq 0$. If V* has never received primary stress and the syllable is noninitial, then it will reduce (e.g., *information*, *demonstration*). Suppose that V* has received primary stress at an earlier stage. In this case, if $n = 1$ (hence $m = n = 1$), V* will nevertheless reduce if it is lax (e.g., *allegation*), or if it is tense and not in an initial syllable (e.g., *explanation*, *provocation*, *justification*, *multiplication*). If it is tense and the syllable is initial, it will not reduce (e.g., *rotation*, *location*, *elation*). If $m = 2$ (hence $n \geq 2$), V* will not reduce (e.g., *relaxation*, *deportation*), although its final phonetic stress, after later rules apply, will be [4 stress]. With the usual margin of exceptions, these remarks appear to cover the facts.

Further consideration of tense stressed vowels in the context $\text{——}C_1^1$*Ation* sheds some additional light on vowel reduction. Such vowels will be reduced by (103) only if they are subject to the Auxiliary Reduction Rule (105b) that assigns them to the categories [−tense] and [−stress]. Thus reduction of a tense vowel is contingent on laxing. If, for some reason, a vowel is tense at the point where the Vowel Reduction Rule (103) applies, it will not be reduced. We have already made use of this fact to account for the nonreduction of unstressed nonlow vowels in prevocalic and final position. But there are two vocalic nuclei which are always tense in positions where others are lax, namely, [ɔ̄y] and [yūw]. Thus, in words such as *exploïtative*, *commútative*, the stressed vowel is not lax, as it is in the parallel forms *compárative*, *provócative*,[73] *rélative*, *conspírator*, *derívative*, *explánatory*. As we shall see in the next chapter, a rule of great generality makes vowels lax in the position where the main stress falls in all of these examples, and a subsequent rule causes the segments that underlie [ɔ̄y] and [yūw] to become tense.[74] (Other rules, not now relevant, account for the glides that appear in these vocalic nuclei.) Clearly the Auxiliary Reduction Rule (105b) should fall together with the other laxing rules. It will therefore precede the rule that tenses the segments underlying [ɔ̄y] and [yūw], so that when the Vowel Reduction Rule applies, these elements will be tense, hence not subject to vowel reduction. For this reason, we have an unreduced pretonic syllable in words such as *exploitation* and *commutation*,[75] which are otherwise parallel in their derivational history to *explanation*, *provocation*, etc. For just the same reason, we do not have reduction in the final syllable of the noun *constitute*, which is related to the verb *constitute* in exactly the way the noun *advocate*, with

[73] In American English, the primary-stressed vowel of *provócative*, which is originally /O/ (cf. *provoke*), is tensed in most dialects to phonetic [ā] by a later rule, after having been laxed by the general laxing rule. Thus the analog to the tense-lax pairs [A]–[æ], [I]–[i], [E]–[e] is actually [O]–[ā], and alongside of *sAn–sanity*, *divIn-divinity*, *obscEn–obscenity*, we have *verbOs–verbosity*. That a later tensing rule is involved in these cases is evident not only from the symmetry, but also from the fact that even an originally lax vowel becomes tense in this position. (Compare *cúrious–curiósity*, *frívolous–frivólity*, *recíprocal–reciprócity*, etc. We know that the vowel in boldface is phonologically lax in these cases because of the placement of primary stress in the first member of each pair.) Hence we see that despite the phonetic tenseness, the stressed vowel of words such as *provócative* has, in fact, undergone laxing along with the other examples just cited. We return to this matter in detail in the next chapter.

[74] Alternatively, the monophthong underlying [ɔ̄y] may be exempted from the laxing rules, but this matter is not relevant to the point here at issue. The same two options are available in the case of the formative *-note*, discussed below. See page 176 for further discussion.

As we shall see in the next chapter, the tensing rules must, in general, follow the laxing rules. See also Chapter Two, (79) and (80) (p. 52).

[75] The vocalic nucleus [yūw] can optionally be reduced to [yə] in various contexts when it is unstressed. An accurate description of this process involves questions concerning the phonological analysis of the vowel system to which we will turn in the next chapter. For the present, it is enough to observe that what is involved here is not simply the process of vowel reduction.

reduced final syllable, is related to the verb *advocate*, with unreduced final syllable. Furthermore, there are certain particular formatives which, as an idiosyncratic (lexically marked) feature, are exempt from laxing—for example, *-nOt*, as in *denOt*. Thus the word *denotative* is phonetically [dEn$\overset{1}{\text{O}}$tətəv],[76] instead of the expected [dEn$\overset{1}{\text{ā}}$tətəv] (analogous to *provócative*). But since this vowel is not subject to laxing, in general, it does not undergo (105b) and therefore is also not subject to Vowel Reduction, since (103) applies only to nontense vowels. Thus we have [d$\overset{3}{\text{E}}$n$\overset{4}{\text{O}}$t$\overset{1}{\text{A}}$šən], instead of the expected [d$\overset{3}{\text{e}}$nət$\overset{1}{\text{A}}$šən], which would be parallel to [$\overset{3}{\text{e}}$ksplən$\overset{1}{\text{A}}$šən], [pr$\overset{3}{\text{ā}}$vək$\overset{1}{\text{A}}$šən], [d$\overset{3}{\text{e}}$rəv$\overset{1}{\text{A}}$šən], etc.

Case (a) of (111) also must be somewhat extended. This is clear from a comparison of words such as *$\overset{1}{\text{advisory}}$–$\overset{1}{\text{promissory}}$* and variants such as [b$\overset{3}{\text{e}}$nəfiš$\overset{1}{\text{E}}$r$\overset{3}{\text{E}}$]–[b$\overset{3}{\text{e}}$nəfiš$\overset{1}{\text{ə}}$rE] (*beneficiary*—the basis for the alternation will be discussed in Chapter Four, Section 6). We will return below to the problem of how primary stress is assigned in words such as these. It is clear, however, that the secondary stress of *-Ory*, *-Ary* is weakened to minus in immediate poststress position, but it remains as secondary (ultimately being weakened to tertiary by the Stress Adjustment Rule) when it is separated from primary stress by a nonstressed syllable. The reduction, however, does not take place in word-final syllables, as in nouns such as *prótest*, *súrvey*, *tórment*. To account for this phenomenon, we extend (111a) to (115):

$$(115) \qquad \left\{ \begin{matrix} \left[\overline{\qquad}\right] \\ [1 \text{ stress}]\, C_0 \text{——} C_0 V \end{matrix} \right\} [-\text{stress}]_0 \#$$

Under this extended condition, then, a vowel will become lax and minus-stressed, subsequently reducing to [ə] by the Vowel Reduction Rule.

One final emendation is needed in the Auxiliary Reduction Rules (105), now formulated tentatively as (107), (115), and (114). As we have formulated (107a, b) and (114), secondary stress is inserted by (107) and [−stress] is introduced by (114) in positions determined by a subsequent primary stress. Recall, however, that these rules apply only at the level of word boundary. If the word is sufficiently complex in its internal structure, the stress that determines the positions in which the Auxiliary Reduction Rules apply may have itself been reduced from primary to secondary by the time the word-level stage of the transformational cycle is reached. In fact, what is required for the application of these rules is not an occurrence of primary stress (as in all the examples given above), but simply an occurrence of a stress greater than that of the position in which the rules apply; i.e., what is needed is a stress peak, regardless of its value. Thus we have relied on (114) to switch the first syllable of *solídity* to the category [−stress] before the primary-stressed vowel. The word *solídify* would undergo reduction of the first vowel in exactly the same way. But consider *$\overset{3}{\text{solidi}}fi\overset{1}{\text{cation}}$*. In this case, after the Main Stress Rule has applied in the word-level cycle, we have secondary, not primary, stress on the second syllable *-lid*, but this still causes reduction of the preceding vowel, exactly as in the case of *solidity*, *solidify*. Or, to take a slightly more complex example, consider the word *componentiality*, which has the following derivation:

[76] As we have pointed out on page 111, our conventions are systematically different from those of Kenyon and Knott in certain aspects. Thus their representation, in this case, is [dEnOtətiv]. As we have noted, in cases such as this only trivial modifications of the rules are needed to change the phonetic output to correspond to the Kenyon and Knott representations.

(116)

$$[_N\,[_A\,[_N k\text{ə}N = pOn + eNt]_N\,i + æl\,]_A\,i + ti\,]_N$$

		1		RULE (102aii)
	2	1		RULE (102ai)
	3	2	1	RULE (102ai)
2	3	2	1	RULE (107b)
2	–	2	1	RULE (114)
3	–	3	1	RULE (63)

In the first cycle, the affix *-ent* places stress on the preceding strong cluster, and in isolation we would have *component*. In the second cycle, the affix *-al* causes stress to be placed in the syllable that precedes it by two, the immediately preceding cluster being weak. In isolation the adjective would therefore be *componential*. The stress on the first syllable would be introduced by (107b) after (108) has weakened the second syllable to tertiary; the second syllable ultimately would reduce by (103) after application of the Auxiliary Reduction Rule (105b) in the context (114). But in the derivation of the noun *componentiality*, there is a third cycle, in which the stress is once again shifted to the right by the affix *-ty*. We must now introduce a secondary stress on the first syllable by rule (107b), exactly as in *componential* (or *explanation*, etc.), but the syllable that determines the position of stress placement now has not primary but secondary stress. Consequently (107) must be generalized to accommodate this case. After placement of the secondary stress by (107), suitably generalized, we next must weaken the stress on the second syllable to minus by (105b), applying in the context (114). Once again, the syllable that determines the position of reduction has not primary but secondary stress, and this is sufficient to allow the rule to apply. Finally, the Stress Adjustment and Vowel Reduction Rules (with others we have not yet discussed) give the phonetic form [kæ̃mpənenšiæləṭE].[77]

Let us now summarize the discussion of this section. We have discussed the Tensing Rule (104) which makes unstressed vowels tense before vowels or, when nonlow, before word boundary; rule (108) which converts a ... 21 ... contour to ... 31 ... ; Auxiliary Reduction Rules of the type (105a) which introduce secondary stress in certain positions; Auxiliary Reduction Rules of the type (105b) which place certain vowels in the category [−tense, −stress]; and the Vowel Reduction Rule (103) which converts lax unstressed vowels to [ə]. As far as ordering is concerned, it is clear that the Vowel Reduction Rule is the last of these, and that rule (108) must precede the Auxiliary Reduction Rules that introduce secondary stress, since it provides a relevant context for the latter. Furthermore, the Tensing Rule must follow the Auxiliary Reduction Rules of the type (105b), as we have noted in discussing words such as *exploitation*, *exploitative*, *commutation*, *commutative*, *denotation*, *denotative*. We will see in the next chapter (p. 183) that there is some reason to suppose that the Auxiliary Reduction Rules that assign secondary stress follow the Tensing Rules, since assignment of secondary stress to tense vowels applies also to vowels which are tensed only by the Tensing Rules. These facts suggest that we give the rules in the following order (adding slight qualifications that will be needed later on):

(117) (rule (108))

$$[2\text{ stress}] \rightarrow [3\text{ stress}] \;/\; \text{——}\, C_0\, [1\text{ stress}]$$

[77] In this case, as in the case of *artificiality*, discussed on page 118, we have omitted an application of (108). Here (108) should apply to the vowel of *ent*, so that the final stress contour is 3–4–1––.

(118) AUXILIARY REDUCTION RULE I (rules (105b), (114), (115))[78]

$$V \rightarrow \begin{bmatrix} -\text{stress} \\ -\text{tense} \end{bmatrix} \Big/ \left\{ \begin{array}{ll} \langle VC_0 \rangle \begin{bmatrix} \overline{} \\ \alpha\text{stress} \\ \langle +\text{tense} \rangle \end{bmatrix} C_0^1 (=C_0) \begin{bmatrix} \beta\text{stress} \\ V \end{bmatrix} & \langle (a) \rangle \\ & (b) \\ \left\{ \begin{bmatrix} \overline{} \\ \gamma\text{stress} \end{bmatrix} \right\} [-\text{stress}]_0 \; \# & (c) \\ \left\{ \begin{array}{l} [1\ \text{stress}]\, C_0 \text{——} C_0 V \end{array} \right\} & (d) \end{array} \right.$$

where β is 1, 2, or 3, α is weaker than β, γ is weaker than 2

(119) TENSING (rule (104), special case of (30))

$$V \rightarrow [+\text{tense}] \Big/ \left\{ \begin{array}{l} \text{——} V \\ \begin{bmatrix} \overline{} \\ -\text{low} \end{bmatrix} \# \end{array} \right\}$$

(120) AUXILIARY REDUCTION RULE II (rule (107))

$$\begin{bmatrix} \alpha\text{stress} \\ V \end{bmatrix} \rightarrow [2\ \text{stress}] \Big/ \# \left\{ \begin{array}{l} [-\text{stress}]_0 \text{——} C_0 \left(\begin{bmatrix} -\text{tense} \\ -\text{stress} \\ V \end{bmatrix} C_0^1 \right) \overline{C}_0 \begin{bmatrix} \beta\text{stress} \\ V \end{bmatrix} \overline{C}_0 \begin{bmatrix} \gamma\text{stress} \\ V \end{bmatrix} \overline{C}_0 \left\{ \begin{bmatrix} \# \\ \delta\text{stress} \\ V \end{bmatrix} \right\} \\ C_0 \left\{ \begin{array}{l} \text{——} C_2 \\ \left[\overline{} \right] \\ [+\text{tense}] \end{array} \right\} \end{array} \right\}$$

where $\overline{C}$ is a consonant or a boundary, $\alpha \neq 1$, β is weaker than 2, δ is weaker than γ.[79]

[78] We have reversed the ordering of cases (a) and (b) of (111) so as to account for forms such as the noun *correlate*, derived from the corresponding verb. In the manner described above, the vowel of the final syllable is subject to (118) and hence to Vowel Reduction in the noun (but not the verb). But the vowel of the medial syllable of *correlate* may be tense, as suggested by considerations raised on page 128. In this case, it, too, must be subject to (118), becoming lax and then reducing by (121). But only case (a) of (118) can apply to this vowel, and case (a) will not apply if the final vowel has already had its stress changed to minus.

We assume here that where F is a feature, the schema $Y\langle X\rangle Z \begin{bmatrix} W \\ \langle +\text{F} \rangle \end{bmatrix} Q$ is an abbreviation for the sequence $YXZ \begin{bmatrix} W \\ +\text{F} \end{bmatrix} Q$, $YZ \begin{bmatrix} W \\ -\text{F} \end{bmatrix} Q$. A generalization of the notations providing this interpretation will be presented in the Appendix to Chapter Eight.

We have changed $\gamma = 3$, as in (115), to $\gamma = 3$ or weaker, for reasons which will appear subsequently. Notice that this modification is entirely natural in this case.

Recall once again that a weaker stress is associated with a greater numerical value in our notation. Thus [2 stress] is weaker than [1 stress], [3 stress] is weaker than [2 stress], etc.

It is possible that we should have [δstress], $\delta \neq 1$, instead of [−stress] in (118c), (118d), but we have no crucial examples.

[79] The condition that δ is weaker than γ guarantees that the vowel with [γstress] is a stress peak in the required sense.

In most of the examples given so far, [αstress] has in fact been [−stress]. We give the slightly more general condition on α to accommodate such examples as *instrumentality* (see the derivation (110), p. 117) and *elementary* (derivation (143), p. 137).

(121) VOWEL REDUCTION (rule (103))

$$\begin{bmatrix} -\text{stress} \\ -\text{tense} \\ \text{V} \end{bmatrix} \rightarrow [\text{ə}]$$

Although these rules are not complete, they come sufficiently close to specifying the positions of vowel reduction for the purposes of our present discussion.

15. *Further investigation of derivational affixes*

We have now covered many of the major phonological processes that determine stress contours and vowel reduction, but there are still a number of refinements to be added. In this section we will sharpen and extend the rules of primary stress placement that involve derivational affixes.

Let us consider first the noun *ádvocacy*. This form has the underlying representation $[_{N}\,[_{V}\text{advocAt}]_{V}\,\text{y}]_{N}$. In the first cycle it follows the pattern we have outlined in the previous sections, and it enters the word-level cycle in the form $[_{N}\overset{1}{\text{a}}\text{dvoc}\overset{2}{\text{A}}\text{t}+\text{y}]_{N}$. As our rules now stand, condition (a) of the Main Stress Rule (102) is fulfilled, *-y* being the stress-determining affix,[80] and case (ii) will assign primary stress to *-At-*, giving $\overset{2}{a}dvoc\overset{1}{A}ty$, which becomes, finally, phonetic *[$\overset{3}{\text{æ}}$dvək$\overset{1}{\text{A}}$sE]. However, the correct phonetic representation is, rather, [$\overset{1}{\text{æ}}$dvəkəsE].

To account for this example, we must modify condition (a) (and, as we shall see directly, condition (c)) of the Main Stress Rule in such a way that the sequence *-At-* is regarded as part of the context omitted from consideration. We thus reformulate condition (a) as follows:

(122)
$$(At)+\text{C}_0\begin{bmatrix} -\text{stress} \\ -\text{tense} \\ \text{V} \end{bmatrix}\text{C}_0]_{\text{NSPVA}}$$

With this modification, we have the following derivation for *advocacy*:

(123)

$[_{N}\,[_{V}\text{advocAt}]_{V}\,\text{y}]_{N}$		
	1	RULE (102eii)
1	2	RULE (75)
1	3	RULE (102ai), (122)
1	–	RULE (118c)

In the first cycle primary stress is placed on the final strong cluster and is then shifted left two syllables by the Alternating Stress Rule (75). Thus, after application of the Stress Adjustment Rule, we would have the phonetic representation [$\overset{1}{\text{æ}}$dvək$\overset{3}{\text{A}}$t] for the verb *advocate* in isolation. But for the noun *advocacy*, there is a second cycle, in which condition (a) of the Main Stress Rule holds in its new formulation (122), with *-At+y* functioning as

[80] We are assuming here that the affix *-y* will place stress under condition (a) of the Main Stress Rule along with other affixes. This, of course, requires that the lexical representation for *-y* be compatible with condition (a). It is not immediately obvious that this is the case, but the assumption is in fact correct, as we shall see directly.

the stress-determining element of the context. Omitting *-At+y* from consideration, we apply case (i) to the remaining sequence *advoc-*, reassigning primary stress on the first syllable and weakening stress on *-At-* to tertiary. The tertiary-stressed vowel then becomes minus-stressed and lax by the Auxiliary Reduction Rule (118) and, finally, reduces by the Vowel Reduction Rule (121). We thus derive [ædvəkəsE] as the phonetic representation for the nominalized form of *advocate*, as required.

The modification proposed in (122) also accounts for adjectives derived from verbs that end in *-ate*. Thus consider the words in (124):

(124)

demónstrative	*génerative*
illústrative	*conféderative*
contémplative	*appréciative*
altérnative	*remúnerative*

Several of these words have variant pronunciations to which we return directly. However, it is immediately obvious from these examples that the position of primary stress is governed by cases (i) and (ii) of the Main Stress Rule applying to the string preceding *-ative* in the now familiar fashion: primary stress is assigned to the penultimate vowel of this string if the string ends with a weak cluster; otherwise it is assigned to the terminal strong cluster. We thus have the following typical derivations:[81]

(125)

$[_A\ [_V$demonstrAt$]_V$ ive$]_A$	$[_A\ [_V$generAt$]_V$ ive$]_A$	
1	1	RULE (102eii)
1 2	1 2	RULE (75)
2 1 3	1 3	RULE (102a), (122)
– 1 –	1 –	RULE (118b, c)

In the first cycle we derive *demonstrÁt*, *generÁt*, in the usual way. In the second cycle, condition (a) of the Main Stress Rule (102) holds in both cases, in its revised formulation (122), excluding the sequence *-Ative* from consideration. Case (i) of the Main Stress Rule applies in the case of *generative*, placing primary stress on the first syllable of *gener-* since the second syllable has a weak cluster. The effect here is not to shift the stress, which is already on this syllable, but to weaken the stress on *-At-* to tertiary. Case (ii) applies to *demonstrative*, shifting primary stress to the strong cluster. The Auxiliary Reduction Rule (118) then converts the tertiary-stressed vowels and the pretonic secondary-stressed vowel to [−stress] in the manner described in the preceding section. Finally the Vowel Reduction Rule (121) gives the phonetic representations [dəmānstrətəv], [ǰenərətəv].

It should be noted, incidentally, that the reformulation of condition (a) of the Main Stress Rule as (122) relies in an essential way on the general convention that parentheses imply disjunctive ordering. Thus (122) abbreviates two successive rules that assign primary

[81] As we shall see in the next chapter, the underlying representations for *demonstrate* and *generate* are actually /demɔNstrAt/ and /genVrAt/, respectively. The rules changing [ɔ] to [ā] and [g] to [j] will be discussed there, along with the phonological interpretation of the symbol *A*.

See note 76 on the divergence of our representation from Kenyon and Knott in the case of *-ive*. An obvious minor adjustment in the rules is needed to give the Kenyon and Knott representations.

stress in the contexts (126a) and (126b) (where $\check{V}$ is a lax, minus-stressed vowel), taken in that order:

(126)
(a) ——At+$C_0\check{V}C_0$
(b) ——+$C_0\check{V}C_0$

Suppose that the ordering of (126a) and (126b) were not disjunctive. Taking the word *demonstrative* as an example, we would first assign primary stress under condition (126a), giving *demonstrative*, and we would then proceed to (126b), which, in this case, would assign primary stress to the strong cluster *-At-*, giving *demonstrative*, ultimately **demonstrative*. The disjunctive ordering of (126a) and (126b) prevents this incorrect derivation.

There are words, such as *indicative*, *correlative*, that seem inconsistent with the analysis given, since the stress is shifted to a weak cluster. However, we have the means to deal with these forms. In fact, this can be done in either of two ways. One possibility is to represent these words phonologically as /iN=dikAt+iv/, /kəN=relAt+iv/, respectively, with the = boundary that appears in prefix-stem forms. This boundary will not block the correct derivation of the underlying verbs in the first cycle, since the Alternating Stress Rule (75), which shifts stress two syllables back from *-At-*, can apply to strings with = in this position. Case (i) of the Main Stress Rule, however, cannot. Thus, in the second cycle that is required for the derivation of the adjective, when the affix *-ative* places primary stress, this boundary will block case (i). Case (ii) will then apply, assigning primary stress to the syllable preceding *-ative*. Still another representation that would give the correct result is suggested by the laxing rule to which we have alluded several times, that is, the rule that converts *A* to æ, *E* to *e*, *I* to *i*, *O* to *ā* (see note 73) in certain contexts, among which are the contexts *-ative*, *-itiv*. Thus we have *comparative*, *repetitive*, *derivative*, *provocative* from *compAr*, *repEt*, *derIv*, *provOk*. This rule permits us to derive *indicative*, *correlative* from underlying representations with a tense vowel in the syllable that takes primary stress:

(127)

$[_A\,[_V$indIkAt$]_V$ iv$]_A$	
1	RULE (102eii)
1 2	RULE (75)
2 1 3	RULE (102aii), (122)
2 1 –	RULE (118c)
3 1 –	RULE (63)

In the first cycle we derive the stress pattern *indIkAt* in the usual way. If we were dealing with the verb in isolation, the Auxiliary Reduction Rule (118a), with $\beta = 2$, would now apply to the medial vowel, making it lax. This vowel would then be reduced by (121), giving [indəkÀt] after application of the Stress Adjustment Rule. To derive the adjective, there is a second cycle, in which the Main Stress Rule applies under condition (a) in its formulation (122). The sequence *-ative* is thus omitted from consideration, and primary stress is placed on the strong cluster immediately preceding this sequence. The Laxing Rule, which applies in the context *-ative*, then converts [I] to [i]. The Auxiliary Reduction Rule (118), the Vowel Reduction Rule (121), and the Stress Adjustment Rule (63) now give the phonetic representation [indikətəv].

We noted above that alongside of the examples of (124) there are, in several cases, variant phonetic forms. Thus we have the alternative forms [kəntemplətəv]–[kāntəmplÁtəv] and [ǰenərətəv]–[ǰenərÁtəv].[82] We have accounted in this section only for the first member of each pair. But it is clear that in the alternative form, *-ive* is simply acting as a neutral affix, leaving intact the phonetic representation of the underlying verb. We therefore provide for the option of affixing *-ive* with a # boundary that is not deleted by readjustment rules, for when an affix is preceded by #, the cycle in which it appears as a stress-determining element is vacuous (see p. 85). Summarizing, we see that where the underlying representation is as in the left-hand column in (128), the phonetic form will be the corresponding item of the right-hand column:

(128)

(a)	$[_A\ [_V$kəN=teNplAt$]_V$ iv$]_A$	[kəntemplətəv]
	$[_A\ [_V$kəN=teNplAt$]_V$ #iv$]_A$	[kāntəmplÁtəv]
(b)	$[_A\ [_V$generAt$]_V$ iv$]_A$	[ǰenərətəv]
	$[_A\ [_V$generAt$]_V$ #iv$]_A$	[ǰenərÁtəv]

These forms are of some interest since it is by no means obvious from superficial examination that the paired items are all related by the same system of phonological processes. However, as we have seen, it is precisely this pairing that is predicted by independently motivated phonological rules.

Let us turn next to a consideration of the derivational affix *-y* as in *aristocracy, telegraphy, synonymy, economy, galaxy, industry, melody*, etc. Notice that this is not to be confused with the *-y* variant of the nominalization element, as in *advocacy* (see p. 126) or with the affix *#y* of *shiny, stringy*, etc. (see p. 85). We review here some material presented in earlier sections, extending the scope and refining the content of our previous discussion.

Before considering the effect of *-y* on stress placement, let us investigate the question of its underlying representation. Since with regard to stress value it is phonetically identical with the final vowel of *effigy*, *Kennedy*, rather than the final vowel of *refugee*, *chickadee*, we see that it must be phonologically lax rather than tense, and subject to tensing by rule (119). Hence, at the stage of derivation prior to the application of (119), the affix *-y* is represented [i]. However, [i] cannot be the underlying representation. The reason is that the grammar must contain rule (129), which applies before the stress rules:

(129) $$i \rightarrow \phi \ / + \text{——} \#$$

This rule is necessary to account for forms such as *bile–bilious, reptile–reptilian, Arab–Arabian, professor–professorial, manager–managerial, matter–material, president–presidential.* The question of whether an item takes the ending *-ial, -ious, -ian*, with an *-i-*, or *-al, -ous, -an* (as in *peripheral, general, oriental*, etc.), without an *-i-*, is determined by the item itself, as an inherent property. Consequently, forms such as *bile, reptile, professor, president*

[82] Notice that in a case such as *legislative*, we will have the variants [leǰəslÁtəv]–[leǰəslətəv], instead of [leǰəslÁtəv]–[ləǰislətəv], provided that lax vowel followed by consonant followed by the liquid *l* constitutes a weak cluster. But see (49) and note 32 (p. 83).

must be represented as /bIl+i/, /reptIl+i/, /prə=fes+Or+i/, /pre=sId+ent+i/,[83] and so on, just as *habit*, *tempest*, etc., must be represented in the lexicon as /hæbit+u/, /tempest+u/.[84] In short, there are "stem-forming" vowels /i/ and /u/ which are deleted in final position by rule (129) but which remain before certain affixes.

Since final *-y* is not subject to deletion by rule (129), it must be represented in such a way as to differentiate it from the stem-forming vowels, if this method of analyzing *-i* and *-u* augments is correct. There are several possible ways of achieving this result. The simplest and most straightforward is to distinguish *-y* from stem-forming /i/ and /u/ by a single feature, and the natural choice is the feature [vocalic]. Since /i/ and /u/ are represented as [+vocalic, −consonantal], let us represent *-y* as [−vocalic, −consonantal], that is, as the glide /y/ (see p. 68), the other features remaining unchanged. We then add rule (130) to convert /y/ to [i]:

$$(130) \qquad y \rightarrow i \;/\; C\text{——}[-seg]$$

The position of rule (130) in the sequence of rules is a question to which we will return directly.

Recall that we found earlier that there is a rule (rule (57), p. 87) that converts [i] to [y] in certain contexts. Clearly, the case for rule (130) will be strengthened if it falls together with rule (57). As we shall see in the next chapter (Section 6), this is precisely what happens.

In short, we may represent *-y* as the glide /y/, converting it to [i] by (130) and finally to [E] by the Tensing Rule (119). Thus *industry*, for example, will be entered in the lexicon as /industr+y/,[85] whereas *reptile* will be entered /reptIl+i/. (In the case of such variants as *doctoral–doctorial*, we will have the lexical representation /dɔktər(+i)/ for *doctor*, with optional stem-forming /i/.) The stem-forming vowel /+i/ will drop in final position, but the glide /y/ will remain, become a vowel, and, finally, become tense.

Having determined the underlying representation for the affix *-y*, let us now turn to the question of how this affix affects stress placement. At first glance it appears that the *-y* affix assigns stress to the syllable preceding it by two, as in the examples *aristócracy*, *telégraphy*, *synónymy*, *ecónomy*, *gálaxy*, *índustry*, *mélody*, cited above. Notice, however, that many of these examples do not justify the assignment of any special status to *-y*. In any case in which the cluster immediately preceding the affix is weak, the placing of primary stress on the syllable preceding the affix by two can be perfectly well explained on the assumption that *-y* is a regular affix that assigns primary stress by the usual rule involving weak and strong clusters (i.e., cases (i) and (ii) of the Main Stress Rule). For example, the

[83] Notice that the representation could not be /bIli/, /reptIli/, etc. (or, in the cases we are considering, /industri/, etc.), without the + before the stem-forming vowel, since a vowel in the context C——# does not drop (cf. *pity*, *valley*, etc.), and, in the case of *industry*, would give the stress pattern **indústry*, like *attórney*, *inférno*, and so on. (See Section 3.)

[84] The forms with +*u* indicate that rule (129) is actually somewhat more general than given here. It must state that any high vowel (i.e., /u/ as well as /i/) is deleted in this position.

[85] We have as yet given no justification for representing the medial vowel as /u/. This will be done in the next chapter.

derivation of *aristocracy* would be as follows:[86]

(131)

[N [Nəristə [Skræt]S]N y]N			
		1	RULE (102eii)
	1	2	RULE (102ci)
2	1	3	RULE (102ai)
3	1	3	RULE (117)
3	1	–	RULE (118c)
2	3 1	–	RULE (120b)
3	4 1	–	RULE (63)

In the first cycle the stem *-crat* receives primary stress as a monosyllable. In the second cycle we are dealing with the noun *aristocrat*[1]. Conditions (a) and (b) of the Main Stress Rule are inapplicable, but condition (c) holds, and case (i) assigns primary stress to the syllable two away from the primary-stressed syllable *-crat*. If we were dealing with the word *aristocrat* in isolation, the Stress Adjustment Rule would then apply, giving *aristocrat*[3], the minus-stressed vowels finally reducing to [ə]. In the case of (131), however, we proceed to an additional cycle. Condition (a) of the Main Stress Rule holds, the stress-determining affix being *-y*.[87] Since the cluster preceding the affix is weak, primary stress is assigned two syllables back by case (i). Rules (117) and (120) then convert the –21 contour to 231, in the manner described in the preceding section. The Auxiliary Reduction Rule (118c) weakens the tertiary-stressed vowel of *-crat* to minus stress since it is not followed by any stressed vowel. This vowel then reduces to [ə] by rule (121), and we derive the phonetic representation [æristākrəsE] by the rules that tense the word-final vowel (that is, (119)), change [ə] to [ā], and change [t] to [s], under conditions that we describe in the next chapter.

Thus, most of the examples cited do not serve to show that *-y* is in any way distinct from the regular affixes *-ous*, *-al*, etc., which operate by the familiar rules. To demonstrate that *-y* actually belongs to an ad hoc category of affixes that assign stress to the syllable preceding the affix by two, it would be necessary to show that when the terminal cluster of the sequence preceding *-y* is strong, then it is still the case that *-y* always causes stress to be assigned to the syllable preceding this strong cluster. This assumption seems to be correct when we look at words such as *gálaxy*, *índustry*, *blásphEmy*. It no longer holds, however, when we come to other examples such as *órthodoxy*, *pólyandry*, *rhínoplasty*, *pédagOgy*, *állegOry*, *téstimOny*, *míscellAny*. All of these have a strong terminal cluster before *-y*, but primary stress is placed in the syllable preceding *-y* by three, not two.

Thus we have the following situation to account for. Along with the regular affixes such as *-al* and *-ous*, the affix *-y* assigns primary stress to the syllable two away when the immediately preceding cluster is weak (e.g., *polýgamous*, *polýgamy*). When the immediately preceding cluster is strong, then this syllable receives primary stress when the affix is *-ous*

[86] As has been becoming more and more obvious throughout this chapter, the underlying representations are in many cases very similar to conventional orthography, if we use the alphabetic symbols *a*, *o* for phonological /æ/, /ɔ/, respectively, as is quite natural for English. We shall see in the next chapter that there is a diacritic feature introduced by readjustment rules into segments of formatives that are subject to derivational processes. Using the alphabetical symbol *c* to represent /k/ with this redundant extra feature, the phonological representation of the word *aristocracy* will therefore be /aristo+crat+y/.

[87] This requires a slight modification (actually, simplification) of condition (a), to which we turn directly.

(e.g., *polyándrous*), but it receives only secondary (ultimately, tertiary) stress when the affix is *-y*, primary stress appearing on an earlier syllable (e.g., *polyándry*).

Actually, the facts are still more complex than this. Consider the ending *-Or+y*, as in the items of (132):

(132)

prómissory	*compúlsory*	*mémory*
állegory	*illúsory*	*ármory*
cátegory	*refráctory*	*cúrsory*
térritory	*advísory*	*sénsory*
áuditory	*introdúctory*	*réctory*
inhíbitory	*contradíctory*	*hístory*

In each case, the cluster preceding *-y* is strong.[88] In the first column the primary stress precedes this strong cluster by two syllables (as in the case of *órthodoxy*, *téstimony*, etc.) In the second and third columns, however, the primary stress immediately precedes this strong cluster. Notice that in the second column the cluster which takes the primary stress is itself strong, whereas in column one the cluster preceding *Or+y* is weak in each case.

Summarizing these various observations, we seem to have the following stress contours with final *-y*, where S stands for a syllable with a strong cluster, W for a syllable with a weak cluster, and A for an arbitrary syllable:

(133)

(a)	... ÁW+*y*	(*aristócracy*, *ecónomy*, *pólicy*)
(b)	ÁWS+*y*	(*órthodoxy*, *téstimony*, *prómissory*, *áuditory*)
(c)	AŚS+*y*	(*advísory*, *compúlsory*, *refráctory*)
(d)	#ÁS+*y*	(*mémory*, *sénsory*, *índustry*, *gálaxy*)

Evidently, whatever the correct explanation may be for stress distribution before *-y*, it will not do simply to assign *-y* to a special category of affixes that place primary stress two syllables away from the affix in question.

Actually, a closer look shows that the apparently aberrant behavior of *-y* can be explained on the assumption that it is a perfectly regular affix. It is precisely this behavior that is predicted for *-y* by the system of rules we have developed on independent grounds.

To see why this is so, let us turn back to the Main Stress Rule and give a somewhat more precise and, in fact, simpler account of it. We have stated the determining context for conditions (a) and (b) of the Main Stress Rule as (134), and for conditions (c) and (d) as (135), repeating here only the parts essential for this discussion:

(134)

$$\begin{bmatrix} -\text{stress} \\ -\text{tense} \\ \text{V} \end{bmatrix} \text{C}_0]$$

(135)

$$[\beta\text{stress}]\,\text{C}_0] \qquad \beta = 2 \text{ or } 1$$

Recall that the symbol V is an informal abbreviation for the feature complex [+vocalic, −consonantal] and that the symbol C is an informal abbreviation for the feature complex $\begin{Bmatrix}[-\text{vocalic}] \\ [+\text{consonantal}]\end{Bmatrix}$, that is, either [−vocalic] or [+consonantal]. Thus six features are

[88] The examples of the third column are not really crucial, since for most of them one might assume that the penultimate vowel is lax in the underlying forms. However, there are also more crucial examples illustrating the point now at issue, in particular, those of the form $\#\text{C}_0\acute{\text{V}}\text{C}_0\text{VC}_2+y$ listed in (133d).

actually mentioned in (134). We can simplify (134) to (136), eliminating two features:

(136)
$$\begin{bmatrix} -\text{stress} \\ -\text{tense} \\ -\text{cons} \end{bmatrix} [+\text{cons}]_0$$

This revision has no effect on any of our earlier discussion,[89] and the simplified formulation (136) is obviously to be preferred to (134) in terms of any reasonable evaluation measure, in particular, the one that we adopt throughout and will discuss in greater detail in Chapter Eight. We retain the formulation (135) for conditions (c) and (d) without change, listing it here only for ease of reference.

In the case of a form ending in *-y*—for example, *telegraphy*—we see that it falls under condition (a), reformulated as (136), with /y/ taken as the segment [−stress, −tense, −consonantal] and no consonants preceding or following it in the affix. Furthermore, this is the only way of interpreting $\overset{1}{\textit{telegr}}\overset{2}{\textit{aphy}}$ as an instance of condition (a).[90]

To complete the derivation of *telegraphy*, we now apply rule (130), converting the final glide to the vowel [i], which the Tensing Rule (119) will convert finally to [E].

With this simplification of the Main Stress Rule, let us now return to the problem of accounting for the four types of stress contours with final *-y* that we have noted in (133).

Case (a) of (133), namely, ÁW+*y*, is handled exactly as before. In the case of *aristocracy*, for example, we have the underlying lexical form $[_N\ [_N$ærist$\eth$ $[_S$kræt$]_S\ ]_N$ y$]_N$, and the derivation is as in (131). The other examples of case (133a) have analogous derivations.

Consider now the examples of (133b), which have the general form ÁWS+*y*. Taking *orthodoxy* as an example, we have the following derivation (using the notational conventions of note 86):

(137)

$[_N\ [_A$orθo $[_S$doks$]_S\ ]_A$ y$]_N$		
	1	RULE (102eii)
1	2	RULE (102ci)
2	1	RULE (102aii)
1	2	RULE (102ci)
1	3	RULE (63)

The first two cycles are as described earlier. In isolation we would have the form $\overset{1}{\textit{orthod}}\overset{3}{\textit{ox}}$, after Stress Adjustment. In the third cycle, we first apply case (ii) of the Main Stress Rule under condition (a), now formalized as (136), taking /y/ as the stress-placing affix. According to the disjunctive ordering, we skip condition (b) and turn to condition (c), which is conjunctively ordered with respect to (a). This condition, which is repeated in its essentials

[89] A fact that we have not yet dealt with systematically but that is important throughout this discussion is that phonetic [E], [A], [U], [O], [$\bar{o}$w], as well as the vocalic nuclei with centering glides and the "true" diphthongs [I], [$\bar{o}$y], and [$\bar{a}$w] (with their several dialectal variants), all derive from underlying monophthongs. Hence, at the stage of derivation when the Main Stress Rule applies, there are no terminal sequences of the form vowel-glide. We go into this matter in detail in the next chapter.

[90] Similarly, if we represent the affix *-ity* as /i+ty/ or /i+ti/, then a word of the form ——*ity* is uniquely interpretable under condition (a) with *-ty* taken as the affix. With this analysis, *-ity* behaves exactly like all regular affixes; without the assumption that it is morphologically complex, we would have to treat it as an exceptional element which always places stress on the final syllable of the item to which it is affixed. This assumption is independently well motivated, as noted earlier. For one thing, *-ty* is a common noun-forming affix (e.g., *royalty, loyalty, certainty*). Furthermore, forms with *-ity* frequently fall into a more general paradigm with *-ify* and *-itude* forms (e.g., *clarity–clarify, gratify–gratitude, infinity–infinitude, sanctity–sanctify–sanctitude*). Also, as we shall see in Section 6 of the next chapter, the analysis /it+y/ or /it+i/ is ruled out by the rules for spirantization. All these facts support the assumption that a stem-forming element *-i-* is involved.

as (135), excludes from consideration a stressed vowel followed by no vowels and then assigns primary stress to the residue in the usual way. In this example we do have a stressed vowel followed by no vowels, namely, the string *-doxy*, represented as [dɔ́ks+y] at this stage. Case (i) of the Main Stress Rule reassigns primary stress to the initial syllable, weakening the stress on *-dox-* to secondary. The Stress Adjustment Rule reduces the latter to tertiary, and other phonetic rules give, finally, [ɔ̄rθədā̆ksE]. The other examples of (133b) (including the examples of the first column of (132)) are derived in the same way.

We next turn to the examples of (133c), which have the structure AŚS+*y*. Taking *advisory* as an example, we have the following derivation:

(138)

$$[_A\,[_V \text{ad=vIs}]_V\ \text{Or+y}]_A$$

1		RULE (102eii)
2	1	RULE (102aii)
1	2	RULE (102cii)
1	–	RULE (118d)

In the first cycle primary stress is assigned to the tense vowel of the final syllable of the verb in the usual way. In the second cycle the affix *-y*, under condition (a) of the Main Stress Rule, causes primary stress to be shifted to the tense vowel of the syllable immediately preceding the affix. Then condition (c) holds, with *-Ory* as the final stressed syllable of (135) that causes primary stress to be assigned. In this instance the stress is assigned by case (ii) of the Main Stress Rule, the final cluster of *advis-* (the string that remains after the exclusion of *-Ory*) being strong. If this cluster were weak, as in *prómissory*, case (i) would have applied, assigning primary stress to the penultimate syllable of the residual string. The Auxiliary Reduction Rule then applies, converting the vowel [O] to the category [−tense, −stress] so that the Vowel Reduction Rule (121) can then reduce it to [ə].[91] Notice that for (118d) to apply in (138), either rule (130), which converts [y] to [i], must precede (118) or else the final V of (118d) must be simplified to [−consonantal]. Actually, both of these conditions hold, and there is therefore no problem here. Once again, had we been dealing with the otherwise analogous form *promissory*, rule (118) would have been inapplicable and the secondary stress would have remained on *O*, ultimately being reduced to tertiary by the Stress Adjustment Rule.

Finally, we turn to the examples of (133d) and the third column of (132). Taking *industry* as a typical case, we have the following derivation:

(139)

$$[_N\text{industr+y}]_N$$

1		RULE (102aii)
1	2	RULE (102dii)
1	–	RULE (118d)

[91] The initial vowel of *advise* and *advisory* reduces, despite the double consonant that follows it, because of the intervening = boundary. The underlying representation of *advisory*, dropping labeled brackets, should presumably be [æd =vIs≠Or+y]. However, the Main Stress Rule (102) will not apply as required in the second cycle of (138) unless ≠ is simplified to + (see the condition on *X* in (102)). We therefore assume that an ad hoc readjustment rule replaces ≠ by + before *-Ory* and *-Ary*. Alternatively, we might restrict the condition on *X* in rule (102) to condition (e) of the rule.

Notice, incidentally, that a rule replacing ≠ by + is needed to account for all cases where the distribution of ≠ does not accord with the syntactically derived surface structure. Thus, in the case of the affix *-ion*, the /y/ realization of the nominalization element in *advocacy*, and so on, we have + boundary instead of the ≠ which might be expected on syntactic grounds, the effect being that the affix in question is not neutral with respect to stress placement.

Primary stress is first assigned to the strong cluster by the affix rule. Then, under condition (d) of the Main Stress Rule, primary stress is assigned to the monosyllable preceding the sequence *-ustry*, which, being of the form $\overset{1}{V}C_0]$ specified in (135), is omitted from consideration for the purposes of stress assignment by condition (d). The secondary stress on *u* resulting from this operation is further reduced to minus by the Auxiliary Reduction Rule (118d). The other phonetic rules give, finally, the phonetic form [$\overset{1}{\text{i}}$ndəstrE].

It is important to observe that no new machinery is needed to account for the apparently idiosyncratic behavior of *-y* with respect to stress placement. The only assumption we have made, beyond the assumptions that were independently motivated in earlier discussions, is that rule (130) follows the Main Stress Rule. (We already knew that it had to precede the Tensing Rule (119) and follow (129), which drops stem-forming /+i/ when final.) In short, given this ordering, the independently motivated rules predict that *-y* will assign stress in the manner indicated in (133). Thus *-y* is a perfectly regular affix; it belongs to no special category. The fact that it differs so markedly from the other affixes in the superficial form of the stress contours that it provides is simply a consequence of its unique segmental constitution, *-y* being the only derivational affix that consists solely of nonvowels. It is this fact that allows a stressed syllable terminating in *-y* to fall under condition (c) or (d), giving rise to the phenomena in (133). As we noted, there is motivation for this analysis of *-y* apart from considerations of stress, though the latter would, in any event, suffice as justification.

This is an interesting demonstration of how a system of rules can cause a small difference in underlying representation to have large-scale and otherwise quite inexplicable phonetic effects. As noted in Chapter Two, the empirical hypothesis regarding disjunctive and conjunctive ordering is playing a particularly crucial role here.

We have so far come across lexical items that are represented in the four forms (1) /*X*E/, (2) /*X*i/, (3) /*X*+i/, and (4) /*X*+y/. Words such as *pedigree*, *chickadee* are of type (1); *attorney*, *macaroni* are of type (2); *president*, *professor* are of type (3); *economy*, *testimony* are of type (4). Thus we have underlying representations such as (1) /čikVdE/; (2) /mækVrOni/; (3) /prə=fes+Or+i/; (4) /testVmOn+y/. We will see in Chapter Five (note 6) that there is some slight evidence that words such as *city*, *pity* have the underlying representations /citee/, /pitee/, giving another source for phonetic final [E]. There is, furthermore, some justification (see pp. 225–26) for an underlying representation /colony/, rather than /colon+y/, for *colony* (continuing to use the notational conventions of note 86). We will also see that /y/ is otherwise restricted in distribution in lexical items to initial position. Therefore the range of contrast between /i/ and /y/ is extremely limited. In general, glides play a very marginal role in underlying representations in English.

Consider next the stress patterns of words ending in *-ary*:

(140)

(a)	*apóthecary*	*annivérsary*
	subsídiary	*exémplary*
	áncillary	*infírmary*
	cápillary	*dispénsary*
	córollary	*placéntary*
	órdinary	*eleméntary*
		compliméntary
		documéntary

(continued)

(140) *continued*

(b) *mómentary*
légendary
cómmentary
(c) *sédentary*
vóluntary
ádversary
(d) *véterinary*
dísciplinary

Among these are nouns and adjectives of various kinds, some based on an underlying independent form, some not. The general similarity between *-ary* forms and *-ory* forms suggests that we analyze the examples of (140) as containing a final sequence /+Ar+y/ which will then be parallel in its behavior to the /+Or+y/ ending discussed previously. Thus *apothecary* and *anniversary* would have the following derivations:

(141)

apothec+Ar+y			annivers+Ar+y			
	1				1	RULE (102aii)
1	2					RULE (102ci)
				1	2	RULE (102cii)
				1	–	RULE (118d)
			2	1	–	RULE (120b)
1	3		3	1	–	RULE (63)

In both cases, the *-y* affix first places primary stress on the strong cluster that directly precedes it, under condition (a) of the Main Stress Rule (102), now simplified as (136). Under condition (c), the final stressed syllable *-Ár*^{1}*y* is now omitted from consideration, and primary stress is shifted back two syllables in the case of *apothecary*, the final cluster of the residual sequence being weak, and shifted back one syllable in the case of *anniversary*, the final cluster of the sequence under consideration being strong. The Auxiliary Reduction Rule (118d) now weakens the stress on the immediately post-tonic syllable to minus, causing it to be reduced by the Vowel Reduction Rule. The second Auxiliary Reduction Rule (120) assigns secondary stress to the antepretonic syllable of *anniversary*. The Stress Adjustment Rule, rule (130), and the Tensing Rule give the final phonetic forms in both cases of (141), except that we must also add a subsidiary Laxing Rule to change [A] to [e] in *-ary*:

(142) A → e / in the affix *-ary*

We will formulate this rule properly in Section 4.3.5 of Chapter Four, incorporating it into the sequence of rules in the appropriate place. The rule will apply only to the element *-ary*, thus distinguishing the phonetically lax boldface vowel of *secret**a**ry*, *secret**a**rial*, *apothec**a**ry*, etc., from the phonetically tense boldface vowel of ***a**rea*, *v**a**rious*, *mal**a**ria*, and so on.

We will see in the next chapter that rule (142) is quite straightforward. Also, there is independent evidence in favor of the rule, quite apart from the necessity to analyze the underlying vowel of *-ary* as tense so as to account for the stress contours in (140). Thus consider alternations such as *solid**a**ry–solid**a**rity*, *capill**a**ry–capill**a**rity*. We have noted several times that *A*–æ is a regular alternation. There is, however, no other instance of an *e*–æ alternation.[92] Hence, if we were not to accept (142) as a rule, we would have to add a new

[92] There is a marginal rule converting [æ] to [e] in certain exceptional forms, but not under the circumstances here noted (see p. 202).

rule to account for the *e*–æ alternation in these words. Instead rule (142) explains this as a special case of the general *A*–æ alternation before *-ity*.[93]

We see, then, that with the single addition of rule (142), the rules that we already have account for examples such as *apothecary* and *anniversary* and, in fact, for all of the examples of (140a).

For some varieties of British English, the example *corollary* should be in the second rather than the first column of (140a). Its underlying representation should then be /kɔrOl+Ar+y/, rather than /kɔrV̆l+Ar+y/ (with V̆ an unspecified lax vowel) as in American English.

Some of the examples in the second column of (140a) have two cycles in their derivations. The word *elementary*, for example, will be derived as follows:[94]

(143)

$$[_{A}\,[_{N}\text{element}]_{N}\ \text{Ar}+\text{y}]_{A}$$

1			RULE (102bi)
2		1	RULE (102aii)
3	1	2	RULE (102cii)
3	1	–	RULE (118d)
2	1	–	RULE (120b)
3	1	–	RULE (63)

In the first cycle, primary stress is placed on the first syllable, the second having a weak cluster and the final one being excluded from consideration under condition (b). In the second cycle, the affix rule (a), with *-y* as the affix, places primary stress on the immediately preceding strong cluster, and condition (c) then causes primary stress to be shifted left to the strong cluster immediately preceding the final stressed syllable. The Auxiliary Reduction Rules readjust the nonprimary stresses, and Stress Adjustment gives the desired final form.

We observed earlier that the affix *-Ary* would be expected to be quite parallel to *-Ory* in its behavior, and derivation (143) illustrates that this is in fact the case. Thus the derivation of *elementary* in (143) is identical, in the second cycle, with the derivation of a word such as *supervisory*. The underlying representation for this form is $[_{A}\,[_{V}\ \text{supervIs}]_{V}\ \text{Or}+\text{y}]_{A}$. In the first cycle, primary stress is placed on the final strong cluster by (eii) of the Main Stress Rule, and is then shifted two syllables to the left by the Alternating Stress Rule (75). For the verb in isolation, then, we would have [sÚpərvĪz], when the Stress Adjustment Rule and other phonetic processes have applied. But in the case of the adjective *supervisory*, we have a second cycle exactly like (143). Primary stress is placed by (102aii) on the tense vowel of *-Or-* before the affix *-y*. Under condition (c), case (ii) of the Main Stress Rule (102) then shifts primary stress to the tense vowel of the syllable immediately preceding *-Ory*, giving [supervĪsÓry]. The Auxiliary Reduction and Stress Adjustment Rules then give the stress contour [supervĪsory], exactly as in the last three lines of (143).

Let us now turn to the other examples of (140), namely, those listed in (b), (c), and (d). Consider first the forms of (140b). Taking *momentary* as a typical example, we should

[93] It is interesting to note that Bloomfield took the phonological representation of *-ary* in *secretary* to be /ejri/, thus implicitly accepting (142) as a phonological rule. He is criticized for this by Kent (1934) and defended by Bolling (1934), in an exchange which is of some interest in the light of subsequent developments in phonological theory. For discussion see Chomsky (1964, Section 4.2, note 7).

[94] For reasons discussed in note 91, we assume that the # boundary which would be expected on syntactic grounds has been simplified to +.

expect the following derivation, in close analogy to (143):

(144)

$[_A\,[_N$mOment$]_N$ Ar+y$]_A$			
1			RULE (102bii)
2		1	RULE (102aii)
3	1	2	RULE (102cii)
3	1	–	RULE (118d)
2	1	–	RULE (120d)
3	1	–	RULE (63)

We thus derive *$\overset{3}{m}\overset{1}{o}mentary$, instead of $\overset{1}{m}o\overset{3}{m}entary$, as required. Evidently, *momentary* and the other examples of (140b) are different in that they are not subject to condition (c) of the Main Stress Rule in the second cycle. In these forms, when the stressed syllable $+\overset{1}{A}ry$ is excluded from consideration under condition (c), primary stress is not placed on the strong cluster that terminates the residual string, as it is in the second column of (140a); rather, it is placed on the syllable immediately preceding this strong cluster. The strong cluster in question is thus excluded from consideration along with the stressed syllable in this application of condition (c). In other words this strong cluster is treated exactly like the element /+ə/ discussed previously in connection with condition (c) (see p. 104). As far as we can see, the forms that behave in this way must be marked by some "diacritic" feature [D] that determines the appropriate application of condition (c). It seems that the most direct way to account for these facts is by assigning the diacritic marking [+D] to the final vowel of the underlying lexical items of (140b), then reformulating conditions (c) and (d) of the Main Stress Rule so that syllables marked [+D] are excluded from consideration, along with /+ə/, when these conditions are applied. We therefore restate conditions (c) and (d) of (102) as in (145):

(145)

$$([+\mathrm{D}]\,C_0)\begin{bmatrix}-\mathrm{seg}\\ \langle -\mathrm{FB}\rangle\end{bmatrix} C_0\,[\beta\mathrm{stress}]\,C_0\langle V_0C_0\rangle\,]_{\mathbf{NSP\,VA}} \quad \text{(c)}$$

$$([+\mathrm{D}]\,C_0)\,C_0\,[\beta\mathrm{stress}]\,C_0]_{\mathbf{NSP}} \quad \text{(d)}$$

$$\beta = \begin{pmatrix}2\\1\end{pmatrix}$$

We stipulate that the prefix-forming element /+ə/ and the second vowel of a lexical item of the form $\#C_0VC_0V$ [+sonorant] [+consonantal] ... automatically have the feature specification [+D], all other units being redundantly marked [−D].[95] We therefore have

[95] The feature [+sonorant] distinguishes nasals, glides, and liquids from other consonants. See note 34.

In note 56 we observed that some prefixes ending in *-o* depart from the regular rule in that the final *-o* is not excluded from consideration under condition (c) (e.g., *galvanoscope*, *hyalograph*), and we suggested that the final *-o* in this case not be separated by a + boundary from the string that precedes it. An alternative would now be to distinguish these instances of *-o* from others by the feature [+D]. This is a minor matter, and it makes little difference how it is resolved.

We can use the same device to extend our account of nouns and adjectives derived from verbs of the form ... $C_0\overset{1}{V}C_0VC_0\overset{2}{V}C_0$ (see p. 107). We noted that in such cases the derived form undergoes vowel reduction in the final syllable, though the underlying verb does not; and we explained this on the basis of an application of conditions (c) and (d) in the second cycle, as in the case of derivation (99) for the noun *delegate* ([$\overset{1}{d}$elɔgɔt]) from the verb *delegate* ([$\overset{1}{d}$elɔg$\overset{3}{A}$t]). But in the case of the derived forms *alternate*, *designate*, condition (c) should place primary stress on the penultimate syllable in the second cycle,

the derivation (146) instead of (144) for *momentary*:

(146)

$[_A\,[_N$mOment$]_N$ Ar+y$]_A$			
+D			(READJUSTMENT RULE)
1			RULE (102bii)
2		1	RULE (102aii)
1		2	RULE (102cii), (145c)
1		3	RULE (63)
		e	RULE (142)

There are analogous derivations for *legendary* and other similar examples of the form $\#X+Ary$, where X is a bisyllabic noun and terminates in a sonorant-consonant cluster. With this artifice, we now account for the examples of (140b). Notice that we have also accounted in this way for the examples of (140c), which differ from those of (140b) only in that *-Ary* is not added to an underlying noun. The readjustment rule of the preceding paragraph assigns [+D] in the second syllable of these forms as well, so that the derivations will be exactly like (146).

Once again we have closely analogous examples ending in *-Ory*. Thus consider the nouns *ínventòry*, *prómontòry*, *óffertòry*, *répertòry*. In these words we would expect primary stress to fall on the second rather than the first syllable, as it does in *refráctory*, *trajéctory*, *refféctory*, and so on, since the second syllable terminates with a strong cluster. However, the string preceding *-Ory* is of the form C_0VC_0V[+sonorant][+consonantal], exactly as in the case of the exceptions with *-Ary*. Notice that the exceptions with *-Ory* just given differ from those of (140b) in that they have no boundary before the string *-Ory*. However the absence of a boundary has no phonetic consequences here. It simply causes condition (d) to be applied at the point in the derivation where condition (c) applies in (146). Otherwise the derivations will be exactly as in the second cycle of (146). Similarly, in the case of *dýsentery* (see note 95), with no boundary before *-Ary*, condition (d) will apply. But in the case of an adjective like *desúltory*, condition (d), being restricted to nouns, is inapplicable. We must therefore assume a formative boundary before *-Ory* in this case to make condition (c) applicable. Such words as *dysentery* and *inventory* provide the reason for the modification of conditions (c) and (d) noted in the last paragraph of Section 13. The effect of this modification, restated in (145), is simply to permit [+D]C_0 to appear in condition (d) so that the Stressed Syllable Rule can apply to these words even though they contain no internal boundary.

By a similar artifice, we can account for the fact that in the examples of (140d),

---

since this terminates in a strong cluster. To avoid this consequence, we can assign the feature [+D] to the second syllable so that it is excluded from consideration along with the stressed final syllable when condition (c) is applied. In the case of *alternate*, assignment of [+D] in this position would be a special case of the readjustment rule dealing with strings of the form C_0VC_0V[+sonorant][+consonantal]. This will not preclude the assignment of primary stress to the second syllable by condition (a), as in *altérnative*. Notice that *sign*, as in *designate*, does not take primary stress, as expected, under other circumstances as well; thus there is no such form as **desígnative* (like *illústrative* or *altérnative*).

The same readjustment rule explains the stress contour of *dysentery* from the underlying representation /disVntAr+y/. Incidentally, because of the extension (136) of conditions (a) and (b) of the Main Stress Rule, the stress assignment in nouns such as *promontory*, *dysentery* would be unaffected if these nouns were represented without a + boundary before *-y*. There are so few relevant forms in this case that it is useless to carry the discussion any further.

primary stress is on the initial syllable rather than on the second syllable, as we would otherwise expect. These are apparently the only forms with more than two syllables before *-Ary* with a final weak cluster. We extend the readjustment rule for [D] so that it assigns [+D] in the syllable preceding *-Ary* in these words, this extension being entirely ad hoc. We now have the following derivation for *veterinary*:

(147)

$_{A}$[veterin+Ar+y]$_{A}$		
+D		(READJUSTMENT RULE)
	1	RULE (102aii)
1	2	RULE (102ci), (145c)
1	3	RULE (63)

The derivation of *disciplinary* has an additional cycle but is the same as (147) in its second cycle. Under condition (c), in both cases, an extra syllable is excluded from consideration along with the following stressed syllable, and primary stress is placed by case (i) of the Main Stress Rule in the syllable preceding the weak cluster of the residue. (Note that in *disciplinary* we must regard *pl* as a weak cluster—see p. 83, p. 197, and note 82.)

The examples of (140) therefore appear to require a rather general readjustment rule and a slight revision of condition (c). Apart from this they are accommodated by independently motivated rules.

The example *commentary* in (140b) deserves some further discussion. Notice that in the underlying form *comment*, the second syllable is unreduced; whereas in *legend* and *moment*, the second syllable reduces as expected. A further peculiarity of the underlying form is that *comment* has the same phonetic shape as a noun and as a verb, whereas we would expect [kəment] as the verb and [kāment] as the noun derived from it. Another example sharing this exceptional behavior of *comment* is *triumph*, which has the phonetic realization [trIʌmf] both as a noun and as a verb, whereas we would expect [trIʌmf] as the verb and [trIʌmf] as the noun derived from it.

The items *comment* and *triumph* clearly depart from the regular patterns, and we must enter them in the lexicon in such a way as to indicate this. One possible analysis, which does little violence to the grammar as already constituted, is to add an extra cycle, quite artificially, to the verb in each case, and to assume that the nouns *comment* and *triumph* and the corresponding verbs are independently derived from underlying stems of a new class S. With this artifice, we then have the following derivation for *commentary*:

(148)

[$_{N}$ [$_{V}$ [$_{S}$kəment]$_{S}$]$_{V}$ Ar+y]$_{N}$		
+D		(READJUSTMENT RULE)
1		RULE (102eii)
1 2		RULE (102dii), (145d)
2 3	1	RULE (102aii)
1 4	2	RULE (102cii), (145c)
1 –	2	RULE (118d)
1 –	3	RULE (63)

In the first cycle, the feature [+D] is introduced by the readjustment rule just discussed and primary stress is placed on the final strong cluster so that, were it not for the exceptional

behavior of the verb in this case, we would have the isolated form [kəment]. In the second, artificially introduced cycle, condition (d) applies (or condition (c) if we take the form to derive from underlying /kəN=meNt/) and requires us to exclude the final stressed syllable from consideration, assigning primary stress by case (ii) to the remaining monosyllable. Thus in isolation we have the verb [kāment] after the application of other familiar rules. (Notice that this application of condition (c) requires its extension to verbs, as provided in (102) and (145); if condition (d) is to be applied, then it too must be extended to verbs, a rather minor matter concerning which we have insufficient evidence to motivate a decision.) In the next cycle the affix *-y* causes primary stress to be shifted to the syllable preceding it. Condition (c) then holds, requiring us to omit from consideration the final stressed syllable and the syllable marked [+D] that precedes it, and to place primary stress on the monosyllabic residue. The Auxiliary Reduction Rule (118d) weakens the occurrence of [4 stress] to [−stress] so that the Vowel Reduction Rule reduces the vowel to [ə]. The Stress Adjustment Rule (63) then weakens the secondary stress on *-Ary* to tertiary. Rules (142), (130), and (119), along with the rule that changes [ɔ] to [ā], give, finally, the phonetic representation [kāmənterE]. The vowel of the syllable *-ment* does not reduce in *comment* but does reduce in *commentary* because of the extra cycle. Similarly, it would reduce in *commentator* (from /kɔment+At+ər/), by a derivation analogous to (148).

There are a few other examples that do not appear to follow the general rules for items ending in *-ary* and *-ory*, namely, words such as *medúllary*, *centénary* (both of which, incidentally, have variants with the expected initial stress). We return to these on page 151.

We should also mention that throughout this discussion we have been assuming that the phonetic representation of *-Ory* is [*OrE*] when the vowel [O] is not reduced. Actually, in many dialects this vowel is phonetically low, as a result of phonetic rules that apply to [A] and [O] before liquids.

Summarizing, we have been led to modify conditions (c) and (d) slightly, reformulating them as (145), to add the marginal phonetic rule (142), and to postulate a readjustment rule that inserts the diacritic feature [+D] in various positions, in particular, in forms with sonorant-consonant clusters in the second syllable followed by *-Ary* or *-Ory* (and perhaps /At/—see note 95) and in trisyllabic forms terminating in a weak cluster followed by /Ary/. We stress that this readjustment rule is introduced ad hoc to account for what appears to be exceptional behavior. Perhaps there is a deeper explanation of the facts that can eliminate the rule; however, even as it stands there are clear subregularities that can be exploited to account for the exceptions in a fairly simple way.

Let us now turn our attention to complex forms ending in *-Ory*, such as the following:

(149)

(a)	*compénsatòry*	*antícipatòry*
	confíscatòry	*artículatòry*
	expúrgatòry	*revérberatòry*
	derógatòry	*hallúcinatòry*
	oscíllatòry	*manípulatòry*
(b)	*inflámmatòry*	
	comméndatòry	
	prepáratòry	

For the examples of the first column of (149a), we must have derivations such as the following:

(150)

$[_A\,[_V$kəN=peNsAt$]_V$ Or+y$]_A$				
		1		RULE (102eii)
1		2		RULE (75)
2		3	1	RULE (102aii)
3	1	4	2	RULE (102cii)
–	1	–	2	RULE (118b, d)
–	1	–	3	RULE (63)

In the first cycle primary stress is placed on the final strong cluster and then shifted back two syllables by the Alternating Stress Rule (75). Thus in isolation we would have the verb *compensate*. In the second cycle the affix *-y* places primary stress on the preceding strong cluster in the usual way. We turn next to condition (c). As our rules are now formulated, condition (c) requires us to omit from consideration the final stressed syllable and to place stress in the residual string *compensAt-*. Since the final cluster of this residual string is strong, primary stress will fall on this final syllable by case (ii) of the Main Stress Rule, giving *compensAtOry* at this stage of the derivation. This is incorrect, however, for American English. Instead we want primary stress to be placed on the syllable *-pens-* at this point. Clearly what is required is that the sequence *-At* be omitted from consideration under condition (c), along with the sequence that follows it, precisely as in the case of condition (a). In other words we must extend condition (c) exactly as we extended condition (a) in (122). We therefore stipulate that the string *-At* be considered part of the omitted context, rather than part of the residual form, under conditions (a) and (c) (and, irrelevantly, (b) and (d)). Combining this with the modification of condition (c) given as (145c), we now replace condition (c) of (102) by (151).[96]

(151)

$$\left(\begin{Bmatrix} At \\ [+\mathrm{D}]\,\mathrm{C}_0 \end{Bmatrix}\right)\begin{bmatrix} -\mathrm{seg} \\ \langle -\mathrm{FB}\rangle \end{bmatrix}\mathrm{C}_0[\beta\mathrm{stress}]\mathrm{C}_0\langle \mathrm{V}_0\mathrm{C}_0\rangle]_{\mathbf{NSPVA}}$$

$$\beta = \begin{pmatrix} 2 \\ 1 \end{pmatrix}$$

We have now replaced condition (a) of (102) by (122) and condition (c) of (102) by (151). In each case the modification assigns the string *-At* to the omitted context. When the rules

[96] Actually, our examples illustrating the assignment of *-At* to the external context all involve conditions (a), (c), and (d). In fact, under condition (b) the element *-At* is not treated in this way (cf. *ultimátum, potáto*). Precise statement of this fact requires the use of a generalization of the angled bracket notation, which we develop in Chapter Eight but have not made full use of in the body of the text.

Not only /At/ but also /fIk+At/ is treated in this way. This accounts for the fact that we have words such as *jústificatory* and *clássificatory*, with five syllables after the primary stress, as contrasted with *multiplicative* (with [I] becoming [i] for reasons that will be discussed in the next chapter).

It should also be mentioned that there are apparently some marginal subsidiary rules that prevent long sequences of unstressed syllables after primary stress in many cases. Thus, on syntactic grounds we should expect the affix *-ly*, for example, to appear with a # boundary and to be neutral with respect to stress placement for this reason (see p. 85). Under certain conditions, however, the # boundary is simplified to +, so that *-ly* places stress by the affix rule (102a). We thus have forms such as *ordinárily, obligatórily*, and, as an optional variant, *evidéntly*, where stress is shifted to the right by *-ly* regarded as a regular affix. When affixed to words such as *satisfáctory* or *perfúnctory*, however, *-ly* does not cause stress to be shifted to the right and thus remains a neutral affix preceded by #. The conditions for replacement of # by + before *-ly* are fairly clear; the basic point seems to be that a barrier is placed against long strings of unstressed syllables following primary stress. (See also note 91, p. 134.)

are given in their optimal representation (cf. (101)), the condition involving *-At* need be stated only once. Thus the modification of condition (c) just proposed is actually a generalization of (122) to condition (c).

Assuming this modification of the Main Stress Rule, we can now return to the derivation (150). We have reached the second line of the second cycle. Applying condition (c), modified as (151), we omit from consideration the string *-At+Or+y* and use case (ii) of (102) to place primary stress on the final syllable of the residual string *compens-*, case (i) being blocked by the final strong cluster. The Auxiliary Reduction Rules (118b) and (118d) apply to the vowels of the first and third syllables, respectively, and these are then subject to Vowel Reduction. By other familiar rules, we derive, finally, the phonetic representation [kəmpensətOrE].

In a similar manner we derive the other examples of the left-hand column of (149a). Notice that in the case of *dérogate*, *óscillate*, we might postulate a tense vowel in the second syllable, just as suggested in the case of *indicate*, *correlate* (see p. 128).

The examples of the second column of (149a) are now straightforward. Thus *anticipatory* will have the derivation (152), and the other examples will be quite parallel.

(152)

$[_A\ [_V$aNticipAt$]_V$ Or+y$]_A$					
		1			RULE (102eii)
	1	2			RULE (75)
	2	3	1		RULE (102aii)
	1	4	2		RULE (102ci), (151)
	1	–	2		RULE (118d)
2	1	–	2		RULE (120c)
3	1	–	3		RULE (63)

The first cycle is much like that of (150), and the underlying verb in isolation would be *anticipAt*. In the second cycle primary stress is placed by *-y* exactly as in (150). We turn next to condition (c), reformulated as (151). Excluding the string *-AtOry* from consideration, we assign primary stress in the residual string *anticip-* by case (i), the final cluster of this string being weak. In other words, we reassign primary stress to the syllable that contained primary stress in the first cycle, weakening all other stresses in the word by one. The vowel [A] becomes [−tense] and [−stress] by the Auxiliary Reduction Rule (118d), then undergoing reduction to [ə] in the usual way, and secondary stress is placed on the first syllable by the Auxiliary Reduction Rule (120c). Other familiar rules give, finally, the phonetic representation [æntisəpətOrE].

Notice the parallel between the examples of (149a) and the examples of (124), with the affix *-ive*. Thus *demonstrative* is related to *generative* exactly as *compensatory* is related to *anticipatory*. The only difference between the examples with *-ive* and those with *-ory* is that there are no forms such as **compensatory*, **anticipatory*, paralleling *contemplative*, *generative*, respectively. The reason is that the elements *-Ary*, *-Ory* take primary stress, at one stage of the derivation, by the Affix Rule, and then shift stress to the left by the Stressed Syllable Rule (102c) (now formulated as (151)). Syntactically *-ive* and *-ory* are quite parallel. The few differences between them in their phonetic effects are, we see, simply a reflection of the difference in their underlying representations. (See also note 91.)

Returning to (149), the examples of (149b) now raise no difficulties. The derivation (153) is typical.[97]

(153)

$[_A\,[_V$in=fiAm$]_V$ At+Or+y$]_A$		
1		RULE (102eii)
2	1	RULE (102aii)
1	2	RULE (102cii), (151)
1	3	RULE (63)

In the first cycle primary stress falls on the final strong cluster. Matters then proceed exactly as before. (The *A*–æ alternation is automatic in this position, as we shall see in the next chapter.) Thus the difference in structure between the underlying verbs of (149a) and (149b) does not affect the phonetic forms.

Examples such as *prédatory*, *gústatory*, and *mígratory* are derived as required from the underlying representations $[_A$pred+At+Or+y$]_A$, $[_A$gust+At+Or+y$]_A$, $[_A\,[_V$mIgr+At$]_V$ Or+y$]_A$, respectively.

We still have not given the rules for deriving the phonetic representation [m$\overset{1}{\text{I}}$gr$\overset{3}{\text{A}}$t] or for deriving the variants [r$\overset{1}{\text{O}}$t$\overset{3}{\text{A}}$t], [r$\overset{3}{\text{O}}$t$\overset{1}{\text{A}}$t], and so on. We return to this question on page 155. Notice, however, that whether primary stress is on the first or the second syllable in such words, the derived form with *-ory* has primary stress on the first syllable. Thus we have *mígratory*, *óratory*, *rótatory*, *rótatory* from *mígrate*, *oráte*, *rótate*, *rotáte*, respectively. This apparent anomaly is accounted for by the rules already given. For example, the word *rótatory* is derived either from *rótate* or *rotáte* by the derivations (154):

(154)

$[_A\,[_V$rOt+At$]_V$ Or+y$]_A$				$[_A\,[_V$rOtAt$]_V$ Or+y$]_A$			
	1				1		RULE (102cii)
1	2						(RULE TO BE GIVEN)
2	3	1			2	1	RULE (102aii)
1	4	2		1	3	2	RULE (102cii), (151)
1	–	2		1	–	2	RULE (118d)
1	–	3		1	–	3	RULE (63)

In the first cycle, primary stress is assigned to the final strong cluster in both cases, and, for reasons we have not yet discussed, it is then shifted left in the left-hand derivation of (154). The second cycle operates exactly as in the cases dealt with above, and, as we see, it gives the same final form in both cases despite the difference between them at the end of the first cycle.

In this section we have been concerned with the affixes *-y*, *-Ary*, *-(At)Ory*, and *-(At)ive* and their diverse phonetic effects. We have seen that these can be accounted for quite simply, largely on the basis of rules established independently. The only modification of any significance in the Main Stress Rule (102) is the requirement that *-At* be considered as part of the element omitted from consideration, along with the string that follows it, under conditions (a)–(d). This change and other minor modifications are expressed in (122) and

[97] In this case the element /At/ is lexically part of the underlying verb, just as the stem-forming elements /i/, /u/ of *componential*, *habitual* are lexically part of the underlying forms (see pp. 129–30). Thus *inflame* differs from *compel*, for example, in that the former takes an *-At-* augment before the affixes *-Ory* and *-ion*. However, as we have already noted (see p. 116), these augments are assigned to the exterior rather than the interior cycle.

(151), which replace conditions (a)–(d) of rule (102). At the same time, we have seen that conditions (a) and (b) can be simplified to (136). Beyond this, we have introduced only minor modifications. Thus we have seen how a collection of complex and superficially quite exceptional phonetic facts can be explained on the basis of a fairly simple system of rules which are, for the most part, independently motivated on other grounds.

The reader who has followed the exposition carefully will have noticed the crucial role played by the conditions on ordering determined by the relations among the successive parts of the Main Stress Rule (102). We have relied in an essential way on the fact that condition (c) or (d) can follow (a) or (b), whereas no other sequences are allowed within a single cycle. This is an important fact, for it provides evidence in support of the extremely strong hypothesis regarding conjunctive and disjunctive ordering tentatively suggested on page 30.

16. Stress as a lexical category

We have now described most of the processes known to us that determine stress contours and related phenomena. It may be useful at this point to reconsider briefly the general problem to which this investigation has been addressed.

We have presupposed a syntactic component of the grammar that generates a surface structure for each utterance. This surface structure is a string with labeled bracketing. The string consists of lexical and grammatical formatives represented in matrix form. Each string, then, consists of matrices with labeled bracketing, the columns of the matrices standing for segments and boundaries, the rows standing for various phonological categories. Everything in the surface structure except the representation of the formatives is determined by the nonlexical syntactic rules. The matrix representation of the lexical formatives is given in the lexicon as part of the entry for these formatives. Each lexical formative has a single entry in which is represented all information relevant to the item's phonetic form in various positions.

This syntactic surface structure is further modified by the readjustment rules, which, however, change only specific elements in the representation and do not affect its general character. It is this modified surface structure that is subject to the rules of the phonological component and is converted by them into a phonetic representation.

Corresponding to each surface structure there is a phonetic representation consisting of a matrix in which columns stand for phonetic segments and rows are labeled by distinctive features provided by a universal phonetic theory. This representation stands in a direct relationship with particular elements of the complex array of stress contours, reduced and nonreduced vowels, etc., that are found in the phonetic record. The rules of the phonological component of a grammar apply to the surface structure representation of an utterance as modified by the readjustment rules and convert it into a phonetic representation, using the information that is present in the surface structure representation and that ultimately derives, therefore, from the lexical entries and the syntactic rules.

In a phonetic representation, each square of the matrix is filled by an entry indicating the specification of a particular unit in terms of a particular feature. In their phonetic function, many of the features—in particular, the feature of stress—are scales, and the entries are integers indicating position along these scales in a conventional way. In the underlying lexical representation, only those specifications that are not determined by general rule are indicated. The entry in a particular square of the lexical matrix indicates membership of

the unit in question in one or another of two disjoint categories which are, furthermore, exhaustive in the domain in which membership is not determined by rule.[98]

The feature composition of a particular lexical entry is not a matter of choice but rather one of fact. In the case of the examples we have discussed so far, the facts seem to be that stress is not a category that is specified in lexical entries. That is, lexical matrices are not distinguished from one another in terms of the categorial feature [±stress] in certain positions, as they are distinguished in terms of the categorial features [±vocalic], [±voice], [±strident], etc. Instead, the contours of stress and the arrangement of reduced and unreduced vowels are determined by general rule.

It is important to recognize that this conclusion would not be affected by the discovery (supposing this to be a fact, for the sake of illustration) that there is a class of items for which stress or reducibility is a category that is distinctive in their lexical entries. The situation here is quite analogous to the more familiar and far more trivial one of regular and irregular verbs. Monosyllabic verbs must be categorized as regular or nonregular in their lexical entries.[99] Only the nonregular verbs require further lexical specification; the inflected forms of the other verbs are determined by general rule. Among the verbs marked as nonregular, there are subgeneralizations involving rules that limit the extent of lexical specification; apart from these subregularities, each nonregular lexical entry must indicate exactly which rules do or do not apply to the item in question. The discovery of nonregular verbs, however, does not force us to provide such additional specification for the regular verbs, in particular, the polysyllabic verbs. Similarly, the discovery of lexical items that are irregular with respect to stress placement or vowel reduction would not, in itself, show that the mass of regular items need be specified in terms of a lexical feature of stress or reducibility.

We repeat this rather obvious point in preparation for an investigation of some cases in which stress might appear to be marginally distinctive on the lexical level. We will attempt to determine whether stress is, in fact, a distinctive lexical category for any of these items or whether, alternatively, their irregularity must be marked by a different sort of categorial feature or complex of features. But whatever the results of this investigation may be, it is important to realize that it may have no effect at all on what has been presented so far, just as an investigation of irregular verbs may have little or no effect on the rules for the regular paradigms. In either case, investigation of exceptions to rules will affect the statement of these rules only if it leads to the discovery of still deeper regularities that replace them.

In the course of the discussion of regular cases, we have several times made note of examples that do not fall under the general rules that were developed. One such case was on page 73, in connection with condition (b) of the Main Stress Rule (102), which determines the position of primary stress in nouns ending in a syllable with a nontense vowel. The general rule is to omit the final syllable from consideration and then to place primary stress in the residue by case (i) or case (ii) of the Main Stress Rule. Typical examples are *aspáragus*, *arÓma*, *uténsil*, *clÍmax*.[100] We also listed several examples that do not fall under this generalization, such as *cemént*, *giráffe*, *burlésque*, *Mississíppi*, *ellípse*.

[98] The exact meaning of this rather vague remark will be discussed in Chapter Eight.

[99] The few nonregular polysyllabic verbs can be identified by their internal structure. There is little doubt that within the category of monosyllables there are identifiable subcategories that need not be specified with respect to regularity. We have made no attempt to investigate the exact domain of the categorial feature in detail.

[100] The final vowel of *climax* is immune from reduction because of the tense vowel of the preceding syllable. Thus we find variants such as [ærəb], [Áræb] for *Arab*. This minor regularity was pointed out to us by J. Fidelholtz. There are further conditions and complications which we shall not elaborate.

In the face of such apparent exceptions, there are three paths open to us: (1) giving up the general rule for stress placement in nouns with a lax vowel in the final syllable and assigning to each such noun a lexical feature determining its category with respect to the position of primary stress; (2) specifying nouns of the lax final-syllable class as [±regular] in the lexicon and then further categorizing those that are [−regular] in terms of stress placement; (3) assigning a representation in terms of segments and boundaries to each apparently nonregular noun in such a way that the correct phonetic form is predicted by rules that are needed on independent grounds.

Of these alternatives, the first is ruled out at once. Condition (b) would have to be dropped from the grammar and each noun of the type to which condition (b) applied would have to have an additional feature specification in its lexical entry, thus greatly increasing the complexity of the lexicon. Furthermore, it is important to notice that by dropping condition (b) from the grammar we do not reduce the complexity of the grammar *at all.* To see this, consider the fully formalized grammar containing rule (101) (p. 109) as an abbreviation for conditions (a)–(e). Notice that to exclude condition (b) from (101) is simply to drop occurrences of angled brackets in this rule. Under any reasonable evaluation measure—in particular, that which we shall discuss—the notations used in abbreviating rules do not count in determining the value of the system of rules. These notations provide a measure of the extent to which a system of rules expresses generalizations that are, by hypothesis, linguistically significant. The measure that we propose is in terms of number of feature specifications after certain notational transformations of a well-defined class have applied. These notational transformations are part of the definition of simplicity, and therefore it would be senseless to "count them" in some way in measuring simplicity.

In short, even if the language contained no nouns of the sort we are now discussing, there would be no more highly valued grammar than the one that contains condition (b), as formulated above. Consequently, we gain nothing in simplicity by excluding condition (b). But we lose a great deal under the first alternative by having to complicate the lexicon, not to mention the new phonological rules needed to interpret this lexical categorization in terms of phonetic stress.

The only plausible alternatives, then, are the second and third. The second requires adding a new feature [+regular] to the lexical entry for each regular noun. The third alternative involves no such complication and is therefore preferable, if it can be realized. It is, then, interesting to observe that there are certain "phonological gaps" which, when filled, lead to just the phonetic representations that we require.

To begin with, notice that nouns such as *burlésque*, *ellípse*, *cemént* would receive the proper stress contour by case (bii) of the Main Stress Rule if the lexical representation in each case were to terminate in a lax vowel. In discussing lax final vowels, we noticed a certain phonological gap (see note 22). Of the six expected lax vowel segments, we found in final position examples only for underlying /i/, /u/, /o/, /æ/, /ə/; there was no example to illustrate final /e/. These observations suggest that we add to the grammar a rule of *e*-Elision such as (155):

$$(155) \qquad e \rightarrow \phi \; / \; \text{——} [-\text{seg}]$$

The exact position of this rule in the sequence of rules will concern us later. For the moment we note merely that it must apply after the Main Stress Rule.

We can now represent *burlesque*, *ellipse*, *cement* in the underlying forms /bVrleske/,

/Elipse/, /sEmente/, respectively.[101] Primary stress, in each case, will be placed on the penultimate vowel under condition (b) of the Main Stress Rule (102), by case (ii). The final vowel will then be elided by rule (155). Words such as *climax*, *sérpent*, on the other hand, will be represented with no word-final vowel. In this way the "phonological gap" in the lexicon is filled; the class of lexical items is more symmetrical in that all possibilities are realized, and we need not provide a categorial specification, with respect to stress placement, for nouns terminating in syllables containing lax vowels.

We shall see that rule (155) plays a role in explaining many other phonetic facts and is therefore quite essential to English phonology. For the present, however, we simply observe that it allows us to make use of a phonological gap to avoid introducing a new and ad hoc lexical categorization and the new phonological rules of stress placement that would be required to interpret this ad hoc categorization in phonetic terms.

Consider now words such as *Mississíppi*, *Kentúcky*, *confétti*, *abscíssa*, *Philíppa*. In each item the final vowel is lax in the underlying form (see pp. 74–75). Thus condition (b) holds, omitting the final syllable from consideration. Case (i) of the Main Stress Rule will apply to the residual string, giving an incorrect antepenultimate stress in each case. To derive the correct stress contour, we must somehow block the application of case (i) so that case (ii) will assign primary stress to the final syllable of the residual string, that is, to the penultimate syllable of the word.

A simple device for blocking case (i) in each case would be to represent these words with a double consonant before the final vowel, as in conventional orthography. Thus the lexical representations would be /misisippi/, /kVntukki/, /kVnfetti/, /æb=cissæ/, /filippæ/.[102] This artifice accomplishes our purpose. Case (i) is blocked because of the double consonant, and case (ii) then correctly assigns primary stress to the penultimate syllable. We must then add to the grammar a rule of consonant simplification which we state informally as (156):

$$(156) \qquad C \rightarrow \phi \ / \text{ before an identical } C$$

Thus the word *Mississippi*, for example, terminating with the phonological segments /. . . ippi/, will receive primary stress on the penultimate syllable because of the strong cluster, and the consonant string will then simplify to [. . . ípi].

There is quite a bit of empirical evidence supporting the postulation of rule (156). We noted in Section 10 that there are rules voicing the segment [s] in many positions. One such case is rule (74), which voices [s] in the context V= ——V. Thus we have intervocalic [z] in *resist*, *resemble*, *design*, *presume*; but the corresponding segment remains nonvoiced in *consist*, *semblance*, *consign*, *consume*. Notice, however, that in *assist*, *assemble*, *assign*, *assume*, the segment [s] remains unvoiced, in apparent violation of rule (74). This contradiction can be avoided by the assumption that the prefix in these examples is not *a-* but rather *as-*, so that when rule (74) applies, the representations will be [æs=sist], [æs=sembl], etc. Further analysis of the prefix-stem construction shows that the prefix is not *as-* but is rather

[101] Notice that these apparently optimal lexical representations depart in an important way from conventional orthography only in the case of *cement*. If *cement* were represented as /sEment/, it would become [sEment] in the phonetic representation. This is, in fact, a dialectal variant.

The first vowel of *burlesque* is actually the archi-segment "lax vowel." The first vowel of *ellipse* is subject to dialectal variation in its phonetic form.

[102] On the interpretation of the symbol *c*, see notes 86 and 103.

of the form aC-, where C is a consonant which assimilates to the following consonant under conditions which we describe in more detail in the next chapter. In any event, this analysis requires postulation of a rule such as (156) to simplify the [ss] cluster that would otherwise appear in the phonetic representation.

Such pairs as *potassium–gymnasium* give further justification for the postulation of [ss] strings which are simplified phonetically by rule (156). We have discussed several cases of the tense-lax vowel alternations that involve the pairs *A–æ*, *E–e*, *O–ā*, etc. As we shall see in the next chapter, [æ] is replaced by [A], [e] by [E], and [ɔ] (which underlies [ā]) by [O] in the context ——$C_1^1 iV$, as in *gymnasium*, *magnesium*. A double consonant blocks this rule, as in *calcium*, *compendium*, where the vowel given in boldface remains lax. But in *potassium* the boldface vowel is lax, indicating that it is followed by a double consonant in the underlying form, which then simplifies by rule (156). In further support of this assumption, notice that in the cases where the vowel tenses (e.g., *gymnasium*, *magnesium*, *cesium*), the [s] segment voices, obviously by a generalization of the rule (74) that voices [s] in intervocalic position. But in *potassium* we have phonetic [s], not phonetic [z], in this position, indicating that the rule voicing intervocalic [s] must somehow be blocked. Postulation of [ss] in the underlying phonological representation thus accounts for the fact that in the phonetic form [pətæsEəm] the antepenultimate vowel is lax and the following consonant is unvoiced, thereby eliminating two independent exceptions. Once again, this is possible only by virtue of rule (156).

Deeper analysis of English sound structure provides still further justification for these assumptions. Consider, for example, the words *music*, *Pusey*, *Russell*, *russet*. The first two have intervocalic [z] following [U] in the phonetic representation; the last two have intervocalic [s] following [ʌ] in the phonetic representation. In fact, these configurations are characteristic. There is no relevant case with the phonetic form [CÚsVC];[103] a form [mÚsək] or [pÚsE], for example, would deviate from the regular sound patterns of English. The explanation for this is provided by the rules of [ʌ]–[U] alternation that we shall discuss in detail in the next chapter. Of relevance to our present discussion is the fact that of the two segments [ʌ], [U], only [ʌ] appears freely in strong clusters, as in *musket*, *mustard*. On the other hand, the lax, high, back vowel which, as we shall see, underlies [ʌ] in strong clusters becomes [U] in underlying weak clusters followed by vowels, as in *futile*, *pewter*, *putrid*, *cutaneous*, *cupola*. In conformity with this rule, we must assume the medial cluster in *Russell*, *russet*, and so on to be [ss]. This assumption then automatically accounts for the fact that the cluster is not affected by the rule that voices the medial [s] of *music*, *Pusey*. Once again, two independent phonetic facts follow from the postulation of [ss], namely, the voiceless-voiced opposition in the consonant and the corresponding [ʌ]–[U] opposition in the preceding syllable. Again, this explanation presupposes that rule (156) is in the grammar.

Combining these observations with what we have discovered about *e*-Elision, we can now account for the stress pattern of otherwise exceptional forms such as *Neptune*, which is phonetically [néptUn] (or, in some dialects, [néptūwn], [néptšūwn], [néptšUn], etc., after the application of late phonetic rules that we will discuss in the next chapter). If we were to take the underlying vowel of the second syllable to be tense, it should have primary stress, as in *machine*, *career*, etc. (See (37), p. 78.) If we were to take it to be lax, we would have the

[103] A word such as *lucid* is only an apparent exception. We can derive this from the underlying representation /luc+id/, where /c/ (as the variant of /k/ in forms that undergo Romance derivational processes) becomes [s] when followed by a nonlow, nonback vowel, *after* the intervocalic [s]-voicing rule has applied. Actually, the remark in the text needs some qualification (cf. *fuselage*, *grue+some*, *dOs+age*, *Osage*, *Caruso*), but it is essentially correct. See page 228 for a somewhat more careful statement.

problem of accounting for its phonetic tenseness. We can now solve this by taking the underlying lexical representation to be /neptune/. Under condition (b) of the Main Stress Rule, the final lax vowel is omitted from consideration and primary stress is placed, by case (i), on the initial syllable of the residual string /neptun/, the final cluster of this string being weak. By the rule just mentioned which determines the [ʌ]–[U] alternation, the underlying segment /u/ of the medial syllable of [ˈneptune] then becomes [U]. Rule (155) then elides the final vowel, giving [ˈneptUn]. The Vowel Reduction Rule does not apply to the vowel of the now final syllable because of its tenseness. Furthermore, as we have noted, the Auxiliary Reduction Rule that makes segments nontense and nonstressed does not apply to [U] (see p. 122 and note 75).

Notice, incidentally, that the rules determining the choice of [ʌ] or [U] as a reflex of underlying /u/ provide additional justification for rule (156), quite apart from the question of [s]-voicing. Thus, to preserve the general rule that determines the choice of [ʌ] in a strong cluster and [U] in a weak cluster followed by a vowel, we must represent words such as *bucket*, *Kentucky*, *putty* with doubled consonants that become simplified by rule (156).

With the postulation of doubled consonants, just as with the postulation of final /e/, we fill a gap in underlying structures (a " phonological gap ") and extend the symmetry of the system of lexical entries. Strings of consonants appear intervocalically with considerable freedom. The restriction that they may not be doubled would be difficult to formulate within our framework.[104] It is therefore interesting that we now have good reason to assume that doubled consonants do in fact appear in underlying representations. Notice further that obstruent clusters are, with rare exceptions, unvoiced in English. Correspondingly, almost without exception, where a double consonant must be postulated to account for stress placement or vowel quality, this cluster either involves a sonorant or is unvoiced.[105] Hence, not only do double consonants fill a phonological gap in general but they do so in a way which is in accord with the general rules of consonant combination in English.

From the considerations just outlined, we conclude that rule (156) is quite well motivated, and another class of apparent irregularities disappears.

Rules (155) and (156) now permit us to derive the phonetic representation of *giraffe* from the underlying representation /giræffe/ (or, as far as the phonetic evidence goes, /ǰVræffe/). Primary stress is placed on the penultimate syllable under condition (b) of the Main Stress Rule (102), by case (ii), the strong cluster /æff/ preventing case (i) from applying. After the stress is placed, the final /e/ is elided by rule (155) and the cluster is simplified by rule (156). By rules that we discuss in detail later, /g/ becomes [ǰ] before certain vowels. By the general Vowel Reduction Rule discussed previously, the vowel of the first syllable becomes [ə]. We therefore derive, finally, the phonetic representation [ǰəræf]. In just the same way we can derive the phonetic forms of words such as *coquette*, *marionette* from the underlying representations /kOkette/, /mæriVnette/. Notice that in the latter case, the final [e] also serves to block the application of the Alternating Stress Rule (75).

[104] To put the same thing in somewhat different terms, there would be no simple way, within our framework, to explain the fact that forms with phonetically doubled true consonants depart in an extreme way from the normal phonetic structure of English. We return to the problem of phonological admissibility and lexical redundancy in Chapters Eight and Nine.

[105] There are a few marginal exceptions, such as *Passamaquoddy*, for which we must postulate the underlying representation /pasVmVkwɔddi/, with /dd/. (We discuss the /kw/ string in Chapter Four, observing that it is, perhaps, a new phonological segment /kʷ/.) This word will, therefore, be an exception to the devoicing of obstruent clusters, along with exceptions such as *adze*, *smaragd*, *rugby*, *abdomen*, *afghan*, *anecdote*, *asbestos*, *husband*, *Lisbon*, *Presbyterian*, *tidbit*, *lobster*.

These observations show one way in which a marginal phonetic opposition between stress contours may arise. For example, a person who is given the "segmental" phonetic representation for the name of the Massachusetts town *Assinippi* would not be able to determine whether the stress contour should be *Assínippi* or *Assiníppi*, although he would know that these are the only possibilities. The former presupposes the underlying representation /æsinipi/; the latter, the representation /æsinippi/.

The rule of cluster simplification accounts for several other apparent exceptions that we have noted in the course of this chapter. Consider the phonetic variants [$_{1}$sentən$_{3}$erE], [$_{3}$sent$_{1}$enərE] for *centenary*. The first form derives from the underlying representation /centen+Ar+y/ in the manner described in detail in Section 15; the latter can be derived from /centenn+Ar+y/ by the same rules along with the rule of cluster simplification. In support of the latter representation, we observe that double /n/ must be postulated in *centennial* (/centenn+i+æl/) to account for the fact that the $e \rightarrow E$ rule, which should apply in the context ——$C_1^1 iV$ (see p. 47), does not apply in this case.

Similarly, we can now account for verbs such as *caress*, *acquiesce*, and adjectives such as *remiss*, *quiescent*, and so on. We might derive *caress*, *remiss*, *quiescent* from the lexical representations /kVress/, /rEmiss/, /kwiess+ent/, respectively, in the familiar way, simplifying the cluster after it plays its role in stress placement.[106] The verb *acquiesce* requires both rules (155) and (156), since an underlying final *e* is needed to prevent application of the Alternating Stress Rule (75). We can derive it from /æckwiesse/, or, perhaps, /æckwiesce/, in which case the second occurrence of /c/ becomes [s] before [e], in the usual way, or even from /æC=kwiesce/, by the processes mentioned on page 149. Assuming the last as the underlying form, we would have the following derivation:

(157)

æC = kwiesce			
	1		RULE (102ei)
2			RULE (120b)
3	1		RULE (63)
	E		RULE (119)
		s	($c \rightarrow s$ RULE)
		ϕ	RULE (155)
k			ASSIMILATION (see p. 149)
ϕ	ϕ		RULE (156)

Primary stress is placed on the penultimate syllable under condition (e) of the Main Stress Rule by case (i), the final cluster being weak. (As mentioned, the final [e] prevents application of the Alternating Stress Rule (75), which would incorrectly give *[$_{1}$ækwE$_{3}$es] as the final phonetic form. The Auxiliary Reduction Rule (120b) assigns secondary stress in the first syllable, this becoming tertiary by the Stress Adjustment Rule (63). The vowel of this syllable is barred from the $æ \rightarrow A$ rule that applies in the context ——$C_1^1 iV$ (see p. 47) by virtue of the fact that it is followed by the consonant cluster [Ckw]. The vowel [i] tenses prevocalically by rule (119); the occurrence of /c/ before [e] becomes [s]; the final [e] elides; and the [ss] cluster is simplified by rule (156). Similarly, the medial cluster assimilates to [kkw] and then simplifies to [kw] by rule (156). We derive, finally, the phonetic form [$_{3}$ækwE$_{1}$es].

Words such as *pellágra*, *candelábra* also appear to be exceptions to the rules of stress

[106] Some modifications of these representations are required by considerations developed in the next chapter.

placement since the weak cluster [æCr] receives primary stress.[107] Investigating the situation more closely, we note many other cases where a weak cluster containing the vowel [æ] is treated as strong. Furthermore, in these cases there is apparently no contrast between [æ] and [ā] within a single idiolect. This observation suggests that we represent these clusters as /āCr/, with a tense vowel, and add a rule converting [ā] to [æ] in certain positions. There are, as we shall see, other examples of [ā]–[æ] alternation. This rule would enable us to account for words such as *pellágra*, *Alabáma*, *Koála*, and *panoráma* with the phonological representations /pVlāgræ/, /ælVbāmæ/, /koālæ/, /pænVrāmæ/. A more extensive study would undoubtedly reveal much heavier constraints on the occurrence of /ā/ and /æ/. Notice, incidentally, that these observations suggest another analysis for the word *giraffe*, namely, as derived from /jVrāf/.

Consider now words such as *álabàster*, *sálamànder*, *póetàster*. The phonetically penultimate syllable contains a strong cluster and therefore receives primary stress in the usual way. But then stress is shifted back two syllables, presumably by the Alternating Stress Rule (75). For this rule to apply, however, the primary stress must fall on the final syllable, rather than on the penultimate syllable. It follows, then, that the underlying representation must be not /ælVbæstVr/ but /ælVbæstr/, etc., the final sonorant later becoming syllabic by rule (56) (p. 85).[108] This decision, however, faces the difficulty that condition (b) requires the final syllables /æstr/, /ændr/ to be omitted from consideration when primary stress is assigned. These syllables will therefore not be protected from vowel reduction, never having received stress. To avoid this consequence we may make use, once again, of the rule converting [ā] to [æ]. The words in question can be represented as /ælVbāstr/, /sælVmāndr/, /pəVtāstr/. Primary stress is placed on the final syllable by case (ii) of the Main Stress Rule (102) under condition (e); condition (b) is now inapplicable because of the tense vowel in the final syllable. The Alternating Stress Rule assigns primary stress to the antepenultimate syllable, weakening the stress on the last syllable to secondary, ultimately, tertiary. The final [r] then becomes syllabic, and [ā] becomes [æ]. The word *tabernacle* is now analyzed in the same way, from underlying /tæbVrnākl/.

We have not yet accounted for words with tense affixes such as *-oid*, *-ine*, *-ize*. The vowels of these affixes have a tertiary stress and do not reduce; and, furthermore, these affixes sometimes determine the placement of stress by the rules involving strong clusters. These observations suggest that tense affixes receive a primary stress before the application of the Main Stress Rule (102) so that they place stress under condition (c).[109] One possibility, then, would be to add to the grammar the rule (158), which precedes the Main Stress Rule in the ordering.

(158) $$\begin{bmatrix} +\text{tense} \\ \text{V} \end{bmatrix} \rightarrow [1\ \text{stress}] \ / \ +\text{——}C_0\#$$

[107] The word *allegro* is regular in the pronunciation [əlÁgrO] but deviant in the alternative form [əlégrO]. One might consider extending rule (142), which converts [A] to [e], to this context, the *A–e* opposition being very marginal here, but there are too few examples to allow the question to be decided in any satisfactory way.

[108] Support is provided for this analysis by the fact that the adjective derived from *alabaster* is *alabastrine* [æləbæstrEn], rather than [æləbæstərÈn].

[109] As we shall see in the next chapter, the affix *-oid* is of the underlying form /VC/, as are the others under discussion here. Recall that condition (c) of the Main Stress Rule has now been reformulated as (151), but the modifications are not pertinent to the examples we consider here. Notice that many of the examples with tense affixes are verbs. It is for this reason that we extended condition (c) to verbs. (See (102), p. 110.)

We will now have typical derivations such as the following:

(159)

$[_A\,[_N mollusc]_N + oid]_A$	$[_A amygdal + oid]_A$	
1		RULE (102bii)
2 1		RULE (158)
3 1 2	1 2	RULE (102ci)
		RULE (102cii)

In the case of *mollúscoid* (similarly, *arách*noid, *cylín*droid, *salamán*droid, etc.), stress is assigned in the internal cycle in the usual way. In the word-level cycle, primary stress is first assigned to the affix by rule (158). Turning next to the Main Stress Rule, we see that conditions (a) and (b) are inapplicable because of the final tense stressed vowel, but condition (c) does apply since the final syllable of the form under consideration has primary stress. In the case of *amygdaloid*, primary stress is assigned to the penultimate syllable of the residual string *amygdal-* by case (i), since the final syllable of this string has a weak cluster. In the case of *molluscoid*, primary stress is assigned to the final syllable of the residual string *mollusc-* by case (ii) since this syllable has a strong cluster. The familiar rules of Stress Adjustment and Vowel Reduction now apply to give the phonetic representations.

There is, in fact, another approach that might be explored, namely, to extend the Alternating Stress Rule (75) so that it assigns stress to the immediately preceding syllable under certain circumstances, now permitting primary stress to fall on the affix in the usual way under condition (e) of the Main Stress Rule. The approach in terms of (158) seems to us preferable, and we will postulate this as the correct rule. (See, however, pp. 236–38.)

The exact role of rule (158) can be brought out clearly by a comparison of the two derivations of (160), for the variant pronunciations [rəkǎ^{1}ndɪ^{3}t], [re^{1}kəndɪ^{3}t] for *recondite*:

(160)

$[_A$recɔnd + It$]_A$	$[_A$recɔndIt$]_A$	
1		RULE (158)
1 2		RULE (102cii)
	1	RULE (102eii)
	1 2	RULE (75)
1 3	1 3	RULE (63)

In the left-hand derivation, we analyze the adjective as containing the affix *-ite*, which, being tense, receives primary stress by rule (158) before application of the Main Stress Rule. Since the final syllable is now stressed, condition (c) of the Main Stress Rule is in force and stress is shifted to the preceding strong cluster by case (ii) of (102). Other rules that we have already discussed give, finally, [rəkǎ^{1}ndɪ^{3}t]. In the right-hand derivation rule (158) does not apply since the form is not analyzed as containing an affix. Consequently, condition (c) of rule (102) is inapplicable and only condition (e) applies, assigning primary stress to the final syllable of the word by case (ii). At this point, the Alternating Stress Rule (75) shifts primary stress two syllables to the left. (Recall that for application of the Alternating Stress Rule, it is immaterial whether the cluster preceding the primary-stressed final syllable is strong or weak.) Other familiar rules give, finally, the phonetic representation [re^{1}kəndɪ^{3}t]. Thus the effect of rule (158) is to make condition (c) of the Main Stress Rule applicable so that primary stress is assigned by the rules involving strong and weak clusters.

The full range of possibilities allowed by rule (158) is evident from a consideration of polysyllabic words ending in *-ize* (or *-ise*). If the ending is not subject to rule (158), we have

derivations analogous to the right-hand derivation of (160), as in the case of *éxorcise, éxercise, mérchandise, ádvertise, súpervise, jéopardize, stándardize, díphthongize, énergize, sólemnize, módernize, fráternize, wésternize, sólipsize.* Since in each case primary stress falls on the antepenultimate syllable despite the strong medial cluster, it must be that final primary stress is assigned under condition (e) of the Main Stress Rule and then shifted to the left by the Alternating Stress Rule. On the other hand, if the ending is subject to rule (158), then condition (c) of the Main Stress Rule will apply to the string preceding *-Iz*. If this residual string terminates in a strong cluster, then this will receive primary stress by case (ii), as in *enfránchise, anthropomórphize, etérnize, sycophántize, propagándize, metamórphize.* If this residual string terminates in a weak cluster, then its penultimate syllable will receive primary stress by case (i), as in *cathólicize, grammáticize, políticize, platitúdinize, gelátinize, diplómatize, demócratize, anésthetize.* Actually, however, in such cases with a weak cluster preceding *-Iz*, it makes no difference whether rule (158) is in effect or not. Certain words have variant forms, depending on whether or not rule (158) is in effect, as in the case of *recondite.* Thus we have the variants *aggrándize–ággrandize, amórtize–ámortize.*

There is another category of examples with *-ize*, illustrated by words such as *skéletonize, álphabetize, prótestantize.* In these cases *-ize* acts as a neutral affix, and we must therefore assume that it is preceded by #, like the inflectional affixes in general (see p. 85). As we have seen, in this case the cycle involving the affix will be vacuous.[110]

We find, in fact, several options for the ending *-Iz*. If the form to which it is added is an independent word, then we expect it, on syntactic grounds, to be preceded by # and to be neutral with respect to stress placement. We see, however, that the expected # boundary is sometimes replaced by +, as in *cathólicize, demócratize, gelátinize.* Where *-Iz* is preceded by + rather than #, there is the further option of applicability of rule (158), which assigns it primary stress. Rule (158) applies in the case of *propagándize, enfránchise*, and so on, but not in the case of *éxercise, jéopardize*, and the other forms with antepenultimate primary stress and a strong cluster in the penultimate syllable. It appears to be the case, then, that words containing the affix *-Iz* must be specified by two ad hoc features, the first determining whether or not # is replaced by +, the second determining whether or not rule (158) applies to *-Iz*. Though there are certain redundancies, the examples given above suggest that these two classificatory features are not entirely predictable. Here, then, is an example of a range of possible phonetic forms determined by two partially free lexical features.

The verbal affix *-At* provides another example, though a somewhat marginal one, of the optionality of rule (158). Among bisyllabic verbs terminating with *-At* we have such

[110] A slight problem arises here in connection with reduction of the vowel of the neutral affix *-Iz*. Since it is nonstressed, as matters now stand it is subject to the Auxiliary Reduction Rule (118c), which makes it lax and subjects it to the Vowel Reduction Rule. We can exclude it from the domain of (118) by modifying that rule slightly in one of two ways: we can add the requirement that γ is stronger than minus, or we can restrict the segment marked [γstress] to the context $[-\text{WB}]_0$ —— in various ways.

In either case, it should be noted that the vowels of neutral affixes (*-ing, -Iz*, etc.) are not subject to vowel reduction even if lax, and the formulation of the process of reduction must somehow take account of this fact.

In the case of the word *próselytize*, the affix *-Iz* is neutral with respect to stress, but leads to the reduction of the penultimate vowel, although with *-ism, -ist*, it seems that there is no reduction in this position in general. According to our rules, the penultimate vowel should not reduce. Thus the Auxiliary Reduction Rule (118) must be complicated slightly to permit reduction of this vowel where it does take place.

Notice also that in a word such as *systematize*, where the affix *-Iz* is preceded by *-At*, the segment *-AtIz* is excluded from consideration as a whole when the Stressed Syllable Rule (condition (c) of the Main Stress Rule) is applied, in accordance with formulation (151).

stress variants as *locáte–lócate*. We can derive the former from the representation /lOcAt/ and the latter from the representation /lOc+At/. Rule (158) will be inapplicable in the first form, which will therefore receive primary stress under condition (e) of the Main Stress Rule by case (ii). Rule (158) will, however, apply automatically to the representation /lOc+At/, assigning primary stress in the final syllable; under condition (c) of the Main Stress Rule, case (ii) will then assign primary stress to the first syllable, giving $[\overset{1}{\text{l}}\text{Oc}+\overset{2}{\text{A}}\text{t}]$. We then proceed, by the usual rules, to derive the phonetic representations $[\overset{3}{\text{l}}\text{O}\overset{1}{\text{k}}\text{A}\overset{3}{\text{t}}]$, $[\overset{1}{\text{l}}\text{O}\overset{3}{\text{k}}\text{A}\overset{3}{\text{t}}]$, respectively. The presence or absence of the + boundary is not otherwise motivated, however; it therefore plays the role of a classificatory feature in the lexicon, determining, in effect, whether or not rule (158) applies. If a bisyllabic form in *-At* has only the variant with initial stress, it will appear in the lexicon only with the + boundary (e.g., *vácate*, /vAc+At/); if such a form has only the variant with final stress, it will appear in the lexicon only without the + boundary (e.g., *creáte*, /creAt/). To some extent such an analysis is independently motivated, as in the case of *vácate–creáte*; but in part it is an arbitrary lexical classification, imposed so as to determine the phonetic form correctly and for this reason alone.

The same property can be observed in the case of trisyllabic verbs ending in *-At*. Thus consider such variants as *íllustràte–illústràte*, *ádumbràte–adúmbràte*. We can derive *íllustràte* from the phonological representation /ilustrAt/, primary stress being assigned to the final syllable by case (ii) of the Main Stress Rule under condition (e) and then shifted two syllables to the left by the Alternating Stress Rule. The form *illústràte*, on the other hand, will be derived from the phonological representation /ilustr+At/. In this case, rule (158) applies to assign primary stress to the affix. The stress is then shifted to the preceding strong cluster by case (ii) of the Main Stress Rule under condition (c). Again, the presence or absence of + boundary before *-At* in these polysyllabic forms is largely unmotivated on independent grounds and therefore functions as a classificatory principle in the lexicon. Notice that, as with forms in *-Iz*, where the penultimate syllable has a weak cluster (for example, in the verbs *ánimate*, *extrápolate*), there is no way to determine whether or not a + boundary appears before *-At*; either decision will lead to the same phonetic form.

This framework suffices to resolve most of the problems that arise in connection with final syllables with tense vowels. There are still a few minor points to be made, however. Consider words such as *ádjective*, *infínitive*. These have several peculiarities that require discussion. First, note that in the derived forms we have *adjectÍval*, *infinitÍval*, with tense primary-stressed [I]. This indicates that the underlying vowel of the final syllable must be tense /I/ rather than lax /i/; otherwise there is no way to account for the position of primary stress. Furthermore, the stress contour of *ádjective* is sufficient to show that in any event the final *-ive* of the underlying forms cannot be identified with the affix of *colléct+ive*, *prospéct+ive*, *detéct+ive* or the final syllable of *invéctive*. In fact, primary stress can fall on the antepenultimate syllable of *ádjective* only by an application of the Alternating Stress Rule to the form *adjectíve*; and the latter form can arise only from case (e) of the Main Stress Rule, the form being analyzed as a stem with a tense vowel in the final syllable. These observations show that the underlying forms must be *adjectIv*, *infinitIv*, and the grammar must contain the very special rule:

$$(161) \qquad \text{I} \rightarrow \text{i} \;/\; \acute{\text{V}}\text{C}_0\text{VC}_0 \text{——} \text{v}\#$$

The form *adjectIv* now receives primary stress on the final syllable under condition (e), case

(ii), of the Main Stress Rule (102), and the phonetic form [æ̆jəktiv] results from the Alternating Stress Rule (75), the Stress Adjustment and Vowel Reduction Rules, and rule (161). The form *adjectíval* is derived in a second cycle in the usual way, rule (161) being inapplicable in nonfinal position.

Rule (161) is actually of somewhat greater generality, for the affixes *-ile* and *-ine* are subject to a similar process. Thus we find variant pronunciations for single words (e.g., *júvenÌl–júvenil*, *BýzantIn–Byzántin*, in some dialects); or, within a single dialect, forms such as *quártÌl* in contrast to [hắstəl] (*hostile*); or such dialectal variants as British *hóstÌl* and American [hắstəl]; etc. Additional rules must be stated, depending on the facts of dialect and style, to account for the *-El*, *-En* variants of these affixes (e.g., *mercantEl*, *ByzantEn*).

Let us now turn to another matter. Primary stress tends to be shifted to the right in successive cycles, both within the word, as new affixes are taken into account, and within the phrase, by successive applications of the Nuclear Stress Rule. However, we have come across three processes that shift primary stress to the left: the Compound Rule (67) of Section 9, conditions (c) and (d) of the Main Stress Rule (102), and the Alternating Stress Rule (75). Of these, only the latter two operate within the word. All three processes are subject to certain exceptions, and we must now consider these briefly.

The exceptions to the Compound Rule are of various sorts. There is considerable dialectal variation in connection with the placement of primary stress in items such as *chocolate cake*, *apple pie*, and many others. There are also widely maintained but syntactically unmotivated contrasts such as *Fifth Ávenue*, with nuclear stress on the second element, versus *Fifth Street*, with compound stress on the first element. Furthermore, proper nouns (e.g., *John Smíth*, *John Paul Jónes*) and names with titles (*President Ý*, *Senator Ý*, etc.) typically have the nuclear stress of phrases rather than the initial stress of compounds, as do also such noun-noun constructions as *stone flóor* and *iron bóx*. Many examples of such contrasts have been mentioned in the literature, in one connection or another, although there is, to our knowledge, no general treatment of the question.[111] The fact that a phrase is not subject to the Compound Rule might be formally indicated in various ways: for example, by a feature specification of the boundary between the constituents, in which case the rule can be limited to boundaries not containing this feature. This, obviously, does not solve the general problem, but serves only to eliminate it from the domain of phonology. The problem remains of determining under what syntactic conditions this feature is or is not present. Alternatively, we might provide for an ad hoc deletion of the node N dominating such compounds. In fact, the general problem certainly belongs in part to syntax, in part to the readjustment component, rather than to phonology proper, and it can be clarified and resolved only by an investigation of the conditions, syntactic and other, under which the Compound Rule is applicable. For this reason, we will make no attempt to go more deeply into the question here. We have throughout been limiting ourselves arbitrarily to problems of phonological interpretation, and are making no attempt in the present study to investigate the processes by which the syntactic component of the grammar forms the surface structures that are phonetically interpreted by the rules we have been discussing here. Because of this limitation of scope, we will simply leave this question in its present unsatisfactory state.

Conditions (c) and (d) of the Main Stress Rule (102) and the Alternating Stress Rule (75) also have certain exceptions, as we have noted in the course of the exposition. Consider

[111] A serious and extensive investigation of phrases that fall under the Compound Rule and their syntactic structure is presented in Lees (1960, Chapter 4).

first conditions (c) and (d), which we have been calling the Stressed Syllable Rule. One of the many roles of this aspect of the Main Stress Rule is to shift the final primary stress of bisyllabic prefix-stem verbs to the initial syllable in the related nouns (see Section 11). Thus we have the noun-verb pairs *pérmit–permít*, *súrvey–survéy*, and so on. There are, however, certain nouns of this form that do not undergo stress placement under condition (c) or (d) in the second cycle and retain stress on the second syllable. To some extent these exceptions are systematic; for example, nouns with the prefix *de-* (e.g., *demand*, *delay*, *desire*, *decay*, *defeat*, *despair*) fall into this class quite generally.[112] Such items must be lexically marked in a way that prevents condition (c) or (d) from applying to them in the second cycle. Within the present range of our formal means, we can represent lexical items that are not subject to the Stressed Syllable Rule with a special internal boundary or with a final /e/. The latter would have no effect on the first cycle but would block this rule on the second cycle, after which the *e*-Elision Rule (155) would eliminate the final vowel. Where there are subregularities among the exceptions, as in the case of the prefix *de-*, we can specify the boundary or add the final /e/ by a readjustment rule. A different method for expressing the fact that a certain class of items is excepted from a rule will be discussed in the next chapter. Formalism apart, any such device simply adds a new classification of lexical items, a classification analogous to the subdivision of verbs into strong and weak.

Consider now the Alternating Stress Rule (75). This places primary stress in the context $\_\_ C_0VC_0\overset{1}{V}C_0$, reducing the final stress to secondary. We have made note of certain exceptions to this rule, such as *Tennessée*, *attaché*, *chandelíer*, *kangaróo*, *chimpanzée*, all of which retain primary stress in the final syllable. Evidently, these items must be exempted from the Alternating Stress Rule by some sort of lexical classification. Again, there are several mechanisms by which such a classification can be expressed, and, without an exhaustive analysis of cases, it is not clear which is optimal. We have already observed that the Alternating Stress Rule does not apply if the final syllable is preceded by or contains a = boundary (see pp. 95–96). We might, then, insert this boundary before the final VC_0 sequence of these forms. This seems an appropriate device insofar as exemption from the Alternating Stress Rule is associated with certain specific endings, such as *-oo*, *-ee*, *-eer*, *-ier*, *-é*, *-ese*.[113] Such affixes can be supplied with a preceding = boundary as part of their feature composition; or, if the association is sufficiently general, the boundary can be inserted by a readjustment rule.[114] An alternative would be to provide the items that are exempt from

[112] If we take words such as *décoy* and the optional variant *détail* to be derived from the corresponding verbs, then to preserve this generalization these forms must be represented phonologically without =, that is, as monomorphemic rather than as of a prefix-stem construction.

[113] Notice, incidentally, that forms such as *Japanese* and *Siamese* are correctly derived in the second cycle from $\overset{1}{Japan}$, $\overset{1}{Siam}$, by rules (158), (117), (118b), (120b), and (121). The underlying representations are presumably /jæpān/, /siām/, the rule of *ā*–æ alternation discussed on page 152 applying when these forms are in isolation. The appearance of [I] in [sÌæm] is normal, as we shall see in the next chapter.

[114] If the affixes in question here are assigned a = boundary, they will be exempt from rule (158) and will receive primary stress under condition (e) of the Main Stress Rule. If they are supplied with a final /e/, to be elided later on, they will be assigned primary stress under condition (b). In either case, both the Stressed Syllable and Alternating Stress Rules will be inapplicable. If, on the other hand, an affix that retains primary stress is assigned this stress prior to the Main Stress Rule—for example, by rule (158)—then it cannot have been assigned = or final /e/. It must, then, be lexically specified as exempt not only from the Alternating Stress Rule (if the form to which it is affixed contains two or more syllables), but also from the Stressed Syllable Rule, that is, from conditions (c) and (d) of the Main Stress Rule.

There are other examples that are excepted from the Alternating Stress Rule beyond those that have characteristic endings such as those cited. For example, the word *Alexánder*, as contrasted with *sálamànder*, does not undergo this rule. We might express this fact by entering *Alexander* in the lexicon

rule (75) with a final /e/ (to be elided by rule (155)), either as part of each lexical entry or, if the class of exceptions under consideration is specifiable, by rule. This would be necessary for nouns in *-esque* and *-ette*, for example, as this is the only way in which primary stress can be placed on these syllables. A third possibility, which we discuss in the next chapter, is to use a general device for specifying exceptions to rules. In any event, it is fairly clear, details aside, how to deal with these marginal contrasts within the lexicon.

Verbs ending in *-ute* have certain properties that deserve special mention. Consider first the verb *cónstitùte*, with the derived form *constítutive*. A natural phonological representation would be /kɔN=stitUt/. This will give the phonetic representation [$\overset{1}{\text{k}}\bar{\text{a}}\text{nst}\overset{3}{\text{ə}}\text{tUt}$] in the usual way. But now consider the derived form *constítutive*.[115] As our rules now stand, primary stress should be shifted from the first syllable (which is the sonority peak at the end of the first cycle) to the strong cluster immediately preceding *-ive*, by case (ii) of the Main Stress Rule (102) under condition (a). But this is incorrect. Apparently, the ending *-Ut*, like *-At*, must be considered part of the string omitted from consideration under condition (a) rather than part of the residual string, and we must generalize the formulation of condition (a) in (122) (and of (c) in (145)) to permit this. With this modification, the string omitted from consideration under condition (a) in the second cycle is *-Ut+iv*, and the residual string is $\overset{1}{k}$*ɔN=stit-*. Case (i) of the rule is blocked by the = boundary, and case (ii) shifts primary stress to the second syllable. The representation [kɔnst$\overset{1}{\text{i}}$tUtəv] is then derived in the usual manner.

In just the same way we can derive forms such as *consecutive*, *execute–executive*, and so on. The word *execute*, for example, might receive the phonological representation /eks=secUt/.[116]

---

with the representation /ælVksændre/, with a final /e/. Primary stress will be placed on the penultimate strong cluster under condition (b), and the final /e/ will be elided by rule (155) after blocking application of the Alternating Stress Rule. In final position, the postconsonantal [r] becomes syllabic (see p. 85); if there is another cycle, as in *Alexandrian*, it remains nonsyllabic before the following vowel.

Several of the words that are exceptions to the Alternating Stress Rule are exceptional in other ways as well. For example, *chimpanzée* is in conflict with the Vowel Reduction Rule in that its medial vowel does not reduce. If we were to attempt to extend coverage to borrowed words and proper nouns more fully, the number of exceptions to be listed in the lexicon would, of course, mount considerably. Notice, however, that this extension of the lexicon would not affect the system of rules or lexical entries that account for the other, regular cases.

[115] Recall that the # boundary is generally optional before *-ive* (see p. 129). If it were present in this case, we would derive the form *$\overset{1}{\text{con}}\overset{3}{\text{stitutive}}$*.

[116] The resulting [ss] sequence is simplified by rule (156). Notice that the modification of the prefix /eks/ to [ek] before stems beginning in [s] provides an additional reason for incorporating the Cluster Simplification Rule (156) in the grammar. Notice also that in *executive* the [ks] cluster voices, although it remains unvoiced in *exceed*, *excite*, etc. This matter will be discussed in the next chapter.

An argument might be made for extracting the morpheme /sEk^{w}/ (see note 105) of *sequence*, *consequence* from words such as *consecutive* and *execute*. Thus we might enter these words with the representations /cɔn=sEk^{w}+At+iv/, /eks=sEk^{w}+At/, respectively (dropping internal brackets). An early rule would convert /k^{w}+At/ to /kUt/. The derivations would then proceed in the usual way. In the same manner, we could account for the relations between *location*, *elocution*, *loquacious*, *interlocutor*, *eloquent*.

This analysis can be extended to the word *constitute*, which can be derived from the representation /cɔN=stitu+At/. The rule converting /k^{w}+At/ to /Ut/ can be extended to /tu+At/. In favor of this proposal is the fact that it would account automatically for the derived form *constituent*.

A further advantage of the analysis suggested here is that it dovetails properly with the analysis of [U] presented in Chapter Four. As we will see there, [U] does not appear in the context ——C_0# in phonological representations. A verb such as *attribute* (see (162)) may be a unique, lexically marked exception to this generalization.

Consider now the somewhat different form *attríbute*, with the derived nominalized form *áttribute*. We have, for the latter, the derivation (162):

(162)

$[_N\,[_V$æC=trib+Ut$]_V\,]_N$			
		1	RULE (158)
	1	2	RULE (102cii)
1	2	3	RULE (102cii)
1	–	3	RULE (118d)
1	–	4	RULE (63)

In the first cycle, primary stress is first placed on the tense affix by rule (158). Under condition (c), it is then shifted back one syllable by case (ii), case (i) being inapplicable because of the = boundary separating the prefix from the stem. In isolation, then, we would derive the verb *attríbute* after the Stress Adjustment Rule (63).[117] In the second cycle, condition (c) entitles us to omit the string *-tribÚt* from consideration. Note that the = boundary after the prefix /æC/ permits a second syllable in this omitted form, as well as preventing application of (ci) in the first cycle. The residual string is now simply /æC=/, and this receives its primary stress under condition (c). The Auxiliary Reduction Rule (118) and the Vowel Reduction Rule (121) reduce the vowel of the medial syllable, and the Stress Adjustment Rule, along with the rules of assimilation and simplification of clusters, gives the form [ætrəbÚt].

Our rules therefore account for the verb *attríbute* and the noun *áttribùte* on the assumption that they are related in the same way as the verb *délegàte* and the noun *délegate*, or, for that matter, the verb *convért* and the noun *cónvert*. Once again, it is by no means obvious, on superficial examination of the phonetic facts, that these pairs are lexically related in exactly the same way. It is therefore interesting to discover that an independently motivated system of rules does account for the phonetic forms of lexically related items.

A similar pattern of explanation can be used to account for the well-known fact that stress is shifted to the left in words such as *réferent*, *cónfident*, *résident*, *éxcellent*, *pértinent*, *déferent*, *réverent*, which derive from underlying verbs with primary stress on the second syllable. In contrast, we have forms such as *depéndent*, *repéllent*, *inhérent*, *abhórrent*, *insístent*, *recúrrent*, in which the stress remains on the stress peak of the underlying verb. The second class is the more productive; members of the first class in many cases have a less simple semantic relation to the form that underlies them. This suggests that we distinguish these classes in terms of the presence or absence of the # boundary before the affix *-ent*. If this is freely added, by a syntactic process, we have forms such as /de=pend#ent/, /re=pel#ent/; if, on the other hand, the component formatives are more closely amalgamated and the # boundary is weakened to +, we have [re=fer+ent], [cɔN=fId+ent], etc. In the productive class that retains #, the affix is neutral with respect to stress placement (see p. 85), and the stress contour of the underlying form remains in the derived word. Where # is weakened to +, we still derive forms with stress on the final syllable in the first cycle (e.g., [re=fer], [cɔn=fId]), but in the second cycle the stressed syllable followed by *-ent* is omitted from

[117] Recall that the vowel [U] is immune to laxing by the Auxiliary Reduction Rule (118) and, consequently, does not reduce (see p. 122). Notice that the proposal of the preceding footnote would explain the difference in the position of stress in *attríbute*, on the one hand, and *éxecute*, *cónstitute*, on the other, by the fact that there is no independent formative /tribu/ (though there is motivation for /stitu/ by virtue of the form *constituent*, and for /sEk^w/ as noted above) and that there is no phonological segment /b^w/ analogous to /k^w/. Thus there is no basis for analyzing *attribute* as /æC=tribu+At/ and then dropping the + boundary, as in *execute*, *constitute*.

consideration under condition (c) (inclusion of the extra syllable *-ent* in this omitted string being permitted because of the = boundary between the prefix and the stem), and stress is placed on the residual string. This gives [$\overset{1}{\text{re}}=\overset{2}{\text{fer}}+\text{ent}$], [$\overset{1}{\text{cɔN}}=\overset{2}{\text{fI}}\text{d}+\text{ent}$], etc. By the Auxiliary Reduction Rule (118d), the vowel of the medial syllable becomes nontense and nonstressed, so that it reduces to [ə] by the Vowel Reduction Rule. In this way the phonetic representations of all of these forms are derived.[118]

In precisely the same way, we can account for the position of primary stress in words such as *ádmirable*, *irrévocable*, *réparable*, *cómparable*, *préferable*, *réputable*, as opposed to *remóvable*, *enjóyable*, etc. The elements of the second class will either retain the # boundary before the freely added affix *-able* or, as in the case of *allówable*, *emplóyable*, they will contain no internal = boundary, so that condition (c) is inapplicable in the second cycle. Such words as *ádmirable*, *irrévocable* will be derived exactly along the lines of *réferent*, *cónfident*.[119] A few items will require ad hoc adjustments, but many fall directly into place under this analysis. Once again, it would be expected, and appears very largely to be the case, that the examples without # are the more ossified forms that have been reanalyzed, in effect, as single lexical items.[120]

Notice that examples such as *áttribute*, *cónfident*, *préferable* require that the extra syllable permitted in the Stressed Syllable Rule be contingent on the presence of a boundary with the feature [−FB], not simply the boundary [+WB] (see note 57).

Forms derived from words ending in *-ent* are more of a problem. Thus consider the words *présidency*, *mílitancy*. Our rules would predict the phonetic forms [prəz$\overset{1}{\text{I}}$dənsE] and [$\overset{1}{\text{mil}}$ə$\overset{3}{\text{t}}$ænsE], respectively, analogous to *advísory*, *órthodòxy* (see Section 15). The simplest way to avoid this problem and to produce the correct phonetic output is to extend rules (122) and

[118] Other vowel alternations that are observed in these forms (e.g., *E–e*, as in *refer–referent*, and ɔ–*ā*, as in *confide–confident*, are automatic, as we shall see in the next chapter.

[119] The affix *-able* seems to pose a unique problem because of the following facts. Forms such as *ability*, *preferability*, etc., seem to indicate that the form is bisyllabic in its underlying representation, i.e., /Abil/. But the forms *ably*, *preferably* apparently require that the underlying form be monosyllabic, namely, /Abl/. Similarly, we presuppose a monosyllabic analysis in the interpretation of stress placement in words such as *préferable*, *ádmirable*; if the form is bisyllabic, condition (c) will not hold. However, as J. Ross has pointed out to us, the point at issue does not involve only *-able* but also forms such as *nobly–nobility*, *possibly–possibility*, *humbly–humility*; and the problem can be solved by accepting the monosyllabic analysis as /Abl/ and postulating a rule that converts [Blity] to [Bility], where B is a labial consonant. Thus *preferability* derives from /preferabl+ity/, *nobility* from /nobl+ity/, *humility* from /huml+ity/. To derive [hʌmbəl], we make use of an obvious rule of epenthesis. The [ʌ]–[U] alternation of *humbly–humility* is now explained in the normal way, as developed in the next chapter. Since *-able* is phonologically monosyllabic, the analysis of stress placement proceeds in the intended way.

[120] Deletion of # is to be expected as a word is intuitively reanalyzed from a syntactically generated member of a productive class to a derived element based on independent formatives that merge to form a single lexical item, the semantic content of which is no longer completely predictable by general rules from that of its parts. A similar phenomenon can be observed above the word level. Thus a noun phrase such as *mâin##lánd* can be reanalyzed as a single noun *maín##lànd*, and may even lose word boundaries completely, becoming *maínland*, with a reduced vowel in the second syllable. Similarly, a phrase such as *old##maid* or *Long##Island* may be reanalyzed as a single word *old+maid*, *Long+island*, in which case the secondary stress on the first element (assigned by the Auxiliary Reduction Rule (120)) is reduced to tertiary by the Stress Adjustment Rule (63). Thus we have $\overset{3}{\text{old}}$-$\overset{1}{\text{maid}}$ ("spinster") contrasting with $\overset{2}{\text{old}}$##$\overset{1}{\text{maid}}$ ("maid who is not young"); $\overset{3}{\text{Long}}$ $\overset{1}{\text{Island}}$ (the place name) contrasting with $\overset{2}{\text{long}}$ $\overset{1}{\text{island}}$ ("island that is long"), etc.

The problem of semantic representation in the lexicon for forms such as these, which preserve their underlying structure only partially and in an unsystematic way, is far from settled. But it seems clear that any solution must meet the conditions that we require here to explain the phonetic form.

(151) so that the affix *-ent* (along with *-At* and *-Ut*) is omitted from consideration under condition (a), along with an affix that follows it. This modification produces the desired effects.[121] Thus, in the final cycle, the string which acts as stress-placing affix under condition (a) is not *-y* but *-ent*+*y* and *-ant*+*y*, so that we derive [pre=sɪ$\overset{1}{\text{d}}$+ent+y] and [m$\overset{1}{\text{i}}$lit+ant+y], the former becoming [pr$\overset{1}{\text{e}}$=sɪ$\overset{2}{\text{d}}$+ent+y] under condition (c) (/ent+y/ being monosyllabic), and the final phonetic forms then resulting in the familiar way.

Notice that alongside of the *-ency* and *-ancy* forms, and often in free variation with them, we have *-ence* and *-ance* forms such as *residence*, *confidence*, *tolerance*. These forms are perfectly parallel to the *-ency*, *-ancy* forms in their behavior. What we clearly need, for these cases, is a noun-forming affix that will cause [t] to become [s], just as *-y* does, but that will differ from *-y* in that it is deleted after having had its effects on stress placement and consonant alternation. The $t \rightarrow s$ alternation is one of several that take place before nonlow front vowels and glides in certain positions, in particular, before [i] or [y] and [e]. Since we already have an *e*-Elision Rule (namely, rule (155)), it seems obvious that the final affix in the *-ence* forms must be the glide which is related to /e/ as /y/ is related to /i/, that is, the glide with the features "nonhigh," "nonlow," "nonback." Let us designate it as /ɛ/. Then *residence*, *tolerance* will be represented /rE=sId+ent+ɛ/, /tɔlVr+ænt+ɛ/[122] in the lexicon. The glide /ɛ/ will have precisely the same effects as /y/ with respect to stress placement and consonant alternations, and will then be deleted by a simplified version of the *e*-Elision Rule (155) which omits reference to the feature [+vocalic].

In Section 14 we showed that the distinction in patterns of stress and reduced vowels between forms such as *relaxation*, *deportation*, *condensation*, with unreduced 4-stressed vowels in the second syllable, and *demonstration*, *information*, *compensation*, etc., with reduced minus-stressed vowels in the analogous position, is directly determined by their syntactic structure. Matters are not always this straightforward, however, and the *-ation* forms of certain bisyllabic verbs undergo anomalous derivations. Consider, for example, the phonetic alternatives [pr$\overset{3}{\text{E}}$z$\overset{4}{\text{e}}$nt$\overset{1}{\text{A}}$šən]–[prez$\overset{3}{\text{ə}}$nt$\overset{1}{\text{A}}$šən] for *presentation*. The first is derived in the normal way from *présent*. The second must be derived without a first cycle for the underlying verb, or with an artificial analysis $[_{N}\,[_{V}present+At]_{V}\ ion]_{N}$.[123] The same artificiality is necessary for a word such as *transformation*, which, even as a nominalized verb, has a reduced vowel in the second syllable instead of the expected 4-stressed nonreduced vowel. In each such case an ad hoc lexical analysis must be given for the underlying forms, specifying that they undergo the necessary reanalysis before the application of the phonological rules. Such examples, then, are true exceptions.

Other apparent exceptions are forms such as *modern*, *honest*, *haggard*, mentioned above in the discussion of adjectives. Our rules predict that final stress should fall on the final syllable in these examples. We can provide the correct phonetic form only by analyzing these elements as *mod*+*ern*, *hon*+*est*, *hagg*+*ard*, so that stress is assigned under condition (a) to the penultimate syllable, instead of under condition (e) to the vowel of the final strong cluster. There is some justification for this (cf. *mode*, *Western*, *honor*, *lag*–*laggard*, etc.), but

[121] Notice that the question can be regarded as one of where to assign the diacritic feature [+D] discussed on page 138, once conditions (a) and (c) have been amalgamated as indicated on page 142. As we noted there, [+D] is quite generally assigned to the vowel of a vowel-sonorant-consonant cluster such as *-ent*, *-ant*.

[122] Notice that verbs in *-At* delete the ending *-At* before the affix *-ent* or *-ant*.

[123] As we shall see in the next chapter, the choice of [E] or [e] in the first syllable of *presentation* is determined by the stress on the following vowel, by a rule of great generality.

in some cases the analysis is ad hoc. A more serious exception is the adjective *pérfect*. In this case, not only the position of primary stress is contrary to rule but the reduction of the vowel of the final syllable as well.[124]

Although we have not yet exhausted the material, we have reached the point where no further insight into stress contours and vowel reduction can be achieved from application of the rules and phonological principles that we have so far been able to discover and formulate. There are still many examples that resist analysis and that must, so far as we can see, be treated by ad hoc lexical classification and special rules. So far as we can determine, these examples have no bearing on what we have presented so far; but one must keep in mind the fact that they might turn out to be relevant, if it can be shown that deeper generalizations or alternative principles can account for the remaining problems only by revising the analysis presented above.

Within the framework of this book, there would be no point in our going on to present ad hoc analyses of particular examples. As we stated in the Preface, we are interested in an analysis of the facts of English insofar as this analysis serves to reveal general principles of linguistic structure. Thus we have been concerned with details of stress contour and vowel reduction because of the way they bear on such general notions as the principle of the transformational cycle. We are not, in this book, interested in these details for their own sake. We have tried to show that quite a variety of phenomena can be explained on the basis of the general principles of phonological structure that we have been developing in the course of the exposition. Insofar as this attempt is successful, it provides empirical justification for these principles. Since the residue of unexplained phenomena do not, so far as we can see, bear on these principles one way or the other, we deal with them no further here.

[124] We might account for the position of primary stress by deriving the adjective from the underlying verb *perféct*, in the familiar way, but this would still leave unexplained the vowel reduction in the final syllable.

Chapter four

WORD-LEVEL PHONOLOGY

1. *Introductory remarks*

We have seen in the preceding chapter how a variety of stress contours and a complex interplay of stress level and vowel reduction are determined by a small number of transformational rules that apply in a cyclical manner, beginning with the smallest constituents of the surface structure and proceeding systematically to larger and larger constituents. In this chapter we turn our attention to the phonological rules that do not reapply in this cyclic fashion. Among these, the ones that concern us most directly are the rules of word phonology.

We have been assuming that each terminal string that enters the phonological component is uniquely and exhaustively analyzed as a sequence of words, and that each of these words is a constituent of the surface structure. Thus the surface structure specifies that each word constitutes a stage of the transformational cycle. By a word, we mean an element of the form # # ... # #, where ... contains no occurrence of # #. (See Chapter Eight, Section 6.2, for a more careful formulation.) A rule restricted in application to contexts meeting this condition is what we call a rule of word phonology. Evidently, such rules will not reapply at successive stages of the transformational cycle, even if interspersed freely among the cyclic transformational rules.

The surface structure that enters the phonological component is determined by three factors: syntactic rules, lexical representations, and readjustment rules. The syntactic rules generate a syntactic surface structure of strings of grammatical and lexical formatives, the latter appearing in what we have called "lexical representation." The readjustment rules, which provide a link between syntax and phonology, may slightly modify the syntactically generated surface structure, and they will, furthermore, convert the string of formatives into what we have called "phonological representation," introducing various modifications into the lexical representations and eliminating grammatical formatives in favor of phonological matrices, in the manner discussed briefly in Chapter One, Section 5.1. In this chapter the distinction between lexical and phonological representation will not be too crucial, although the conceptual distinction should be borne in mind to prevent confusion. We will be concerned in this discussion with only one aspect of the readjustment rules, namely, with their effect on lexical representations of lexical items, particularly in connection with the matter of redundancy. Those readjustment rules which have the effect of restricting the class of possible lexical entries by eliminating certain possibilities we shall sometimes designate as "lexical redundancy rules." We return to the discussion of readjustment rules in Chapter Eight.

2. Phonological and phonetic representation

The phonological component accepts as input a structurally analyzed string. As output it provides the "phonetic representation" of this string. The phonetic representation consists of a sequence of "phonetic segments," each of which is nothing other than a set of "phonetic feature specifications." A phonetic feature specification consists of a "phonetic scale" (called a "phonetic feature") and an integer indicating the position of the phonetic segment in question along this scale.[1] The phonetic scales form a predetermined universal set, namely, the "(phonetic) distinctive features." Thus a particular segment might be marked as "noncontinuant" (i.e., "minus" with respect to the phonetic feature "continuant"), "highly aspirated," "nonvoiced," etc. In short, a phonetic representation is a "phonetic matrix" in which the columns correspond to segments and the rows to features and in which each entry states the extent to which a given segment possesses the corresponding feature. We will discuss the phonetic distinctive features in more detail in Chapter Seven. Here we merely emphasize that they must be determined absolutely, within general linguistic theory, and independently of the grammar of any particular language.

Let us now consider the structurally analyzed string that the phonological component takes as input. Its minimal elements are formatives. These formatives are provided originally by the lexicon, which forms one part of the syntactic component of the grammar. They may then undergo slight modification by the readjustment rules. In the lexicon, each formative must be represented in such a way as to determine precisely how the rules of the phonological component will operate on it, in each context in which it may appear. Thus the representation of a formative must be sufficiently rich so as to specify the corresponding phonetic matrix in each environment, given the phonological rules and the structural analysis of the string. As we noted in Chapter One, each formative falls into many categories; in fact, each formative can be regarded as being constituted simply by a certain set of categories. For example, the formative *inn* belongs to the syntactic categories "noun," "common," "nonanimate," "count," etc.; to certain semantic categories which specify its meaning; and to the phonological categories "initial-vocalic," "initial-nontense," "second-consonantal," "second-nasal," etc. The lexical entry *inn* is simply the complex of these categories, and the terminal symbol *inn* in the terminal string *the*+*man*+*stop*+*past*+*at*+*the*+*inn* (underlying *the man stopped at the inn*) is nothing other than the complex symbol consisting of this set of category specifications.

It is clear that many of the phonological categories can be represented in a natural way in terms of a "phonological matrix," in which the rows are associated with features such as "nasality" and "tenseness" and the columns are called "phonological segments." Thus, assignment of the morpheme *inn* to the categories "initial-vocalic" and "initial-nontense" can be indicated by entering + in the first column in the row labeled "vocalic" and − in the first column in the row labeled "tense"; its assignment to the category

[1] Often we restrict ourselves to two positions along a phonetic scale, in which case we may use the symbols + and − instead of integers to indicate phonetic values. We emphasize that the value in a phonetic specification is not an absolute physical property but is relative to the context of phonetic segments. (See Chapter Seven for further discussion.) Thus, the phonetic distinctive features are absolute in one sense, namely, they are universals, independent of any particular language and providing the basis for phonetic representation in every language; and they are relative in another, namely, the actual physical event represented will depend on the integral value of the phonetic specification, interpreted relative to the context in which the given segment occurs. Criticism of distinctive feature theory has occasionally confused these two entirely different notions of absoluteness.

"second-nasal" can be indicated by entering + in the second column in the row associated with "nasality," and so on. Details aside, it is clear that this is an appropriate means for presenting much of the categorial composition (the assignment to categories) of a complex symbol representing a formative, and it is reasonable, therefore, to propose that a lexical entry will, in general, consist of a phonological matrix of the kind just described, along with a set of other categories (syntactic, semantic, and phonological) to which the morpheme given by this lexical entry belongs. To a first approximation, then, we may think of this phonological matrix as the lexical representation, abstracting away from possible effects of readjustment rules.

The distinction between the phonological and phonetic matrices must be kept clearly in mind. In the case of the phonetic matrix, each row corresponds to a phonetic feature, physically defined, from a predetermined initial set. The entry occupying a particular square of the matrix will be an integer specifying the degree to which the segment in question is characterized by the corresponding property. In the case of the phonological matrix, each square represents simply a pair of opposed categories, to at most one of which the formative in question may belong. A + in this square indicates membership of the formative in one of these categories; a −, membership in the other, complementary category; a 0 indicates simply that no information is given for the formative in question concerning membership in these two categories. Thus the second column of the phonological matrix for *inn* would contain a + in the square associated with the feature "nasal," a − in the row associated with the feature "vocalic," and a 0 in the row associated with the feature "tense." This is a way of representing the fact that in the lexicon *inn* is assigned to the two categories "second-nasal," "second-nonvocalic," but is not assigned to either of the categories "second-tense" or "second-nontense." It is unnecessary for the tenseness of the nasal consonant in *inn* to be indicated in the lexicon since this information is redundant—it is provided by a general rule and is not an idiosyncratic property of the particular formative in question. It is this fact that is indicated by the zero entry in the phonological matrix. We will return later (Chapter Eight, Section 8, and Chapter Nine) to a more careful consideration of redundant information and how it is supplied. For the time being, we will continue to use the entry 0, along with + and −, as an expository device.

The categories of the phonological matrix for some formative may correspond in part to the feature specifications of the corresponding phonetic matrix, but this need not be the case in general. To illustrate some of the possibilities that may arise, let us consider in a bit more detail the phonological and phonetic matrices for the formative *inn* (in the context *the man stopped at the*——) and the formative *algebra* (in *he likes*——). The phonetic matrices, omitting irrelevant details, might contain the following submatrices:

(1)

	(a) *inn*		(b) *algebra*						
	i	n	æ	l	g	e	b	r	æ
consonantal	−	+	−	+	+	−	+	+	−
vocalic	+	−	+	+	−	+	−	+	+
nasal[2]	2	+	−	−	−	−	−	−	−
tense	−	−	−	−	−	−	−	−	−
stress	1	−	1	−	−	4	−	−	4
voice	+	+	+	+	+	+	+	+	+
continuant	+	−	+	+	−	+	−	+	+

[2] By giving the entry 2 for the vowel of *inn*, we indicate that its degree of nasalization is partial. For a discussion of the physical correlates of the phonetic features, see Chapter Seven.

Recalling now that the lexicon specifies only idiosyncratic features of lexical entries, omitting all those that can be determined by general rules, we might propose the following as the corresponding subparts of the phonological matrices:

(2)

	(a) *inn*		(b) *algebra*						
	i	n	æ	l	g	e	b	r	æ
consonantal	−	+	−	+	+	−	+	+	−
vocalic	0	0	0	+	−	0	−	+	0
nasal	0	+	0	0	−	0	−	0	0
tense	−	0	−	0	0	−	0	0	−
stress	0	0	0	0	0	0	0	0	0
voice	0	0	0	0	+	0	+	0	0
continuant	0	0	0	0	−	0	−	0	0

There are general rules that convert the representations of (2) into those of (1); consequently, the redundant specifications in (1) need not appear in the lexical entries themselves. A segment which is not fully specified may be called an "archi-segment." Phonological matrices typically consist of archi-segments. Thus, an important difference between phonological and phonetic matrices is that the latter are fully specified while the former are not. In fact, one major function of the phonological rules is to extend phonological matrices to full phonetic matrices. Notice that (2a) is a proper submatrix of (1a) and that (2b) is a proper submatrix of (1b). Thus, the only function of the phonological rules as so far discussed is to convert archi-segments to fully specified phonetic segments.

Suppose that a certain formative meets the following condition: the phonological matrix given in its lexical entry is a submatrix of the phonetic matrix corresponding to it, in each context in which it occurs.[3] In this case, we may say that the formative in question meets the condition of "invariance." (We can also extend the definition of invariance, in the obvious way, to the case of a particular segment of a formative.) Thus the formative *inn* meets the invariance condition, but the formative *algebra* does not, as we see if we carry the discussion a few steps further.

The lexical entry (2b) for *algebra* must specify that the final vowel is nontense; otherwise, it will not be stressless, nor will it reduce to [ə] (see Chapter Three, Section 14). But consider the form *algebraic*. In this case the final vowel of *algebra* is marked [+tense] in the phonetic matrix because of the rule that vowels become tense before vowels:

(3) $$V \rightarrow [+\text{tense}] \; / \; \text{——} V$$

This is the rule that we have stated as part of (30) in Chapter Three (p. 74). The phonetic matrix for *algebra* in *algebraic* will thus differ from that in *#algebra#* not only with respect to redundant features (e.g., degree of stress), but also with respect to the inherent feature of

[3] Technically this condition is never satisfied since the entries of phonological matrices are the symbols +, −, and 0 while the entries of phonetic matrices are positive integers. What we mean, of course, is that if the integral values for a particular feature are divided into two classes, one of which (1 to n, for some n) represents a refinement of the category + and the other of which ($n+1$ to m, where m is the minimal value along this dimension) represents a refinement of the category −, then the phonological matrix is a submatrix of the phonetic matrix when the integers $1, \ldots, n$ are replaced by + and the integers $n+1, \ldots, m$ by −.

tenseness. This illustrates the fact that phonological rules not only fill in redundant entries of matrices but also may change inherent features marked in the lexical entry.

Suppose that we now extend the description to the features that determine vowel quality. We have already noted that there is a rule determining that nonstressed, nontense vowels in final position become tense if they are nonlow (that is, [i], [e], [u], [o]), but reduce to [ə] if they are low (see Chapter Three, p. 74). Since the final vowel of *algebra* reduces, it must be marked in the lexicon as [+low]. Since it is also [−tense], the stress assignment rules of the preceding chapter assign stress only to the first syllable. But in *algebraic* this vowel is phonetically both [+tense] and [−low]. Consequently not only the inherent tenseness but also the inherent lowness of the lexical entry may be altered by the phonological rules. In fact, it is often the case that phonological rules change inherent properties, and it is not to be expected that the invariance condition will be met in general.

Occasionally the factors that determine what the underlying lexical entry must be are quite complex. To illustrate the range of considerations that may be involved, consider the words *reciprocal–reciprocity*, *frivolous–frivolity*, *demon–demonic*, etc. In each case we have a formative ending with a vowel followed by a single consonant, to which is added a suffix (*-al*, *-ity*, *-ous*, *-ic*). The final vowel of each formative appears in one of two phonetic forms—either [ə] (*reciprocal*, *frivolous*, *demon*) or [ā] (*reciprocity*, *frivolity*, *demonic*).[4] The problem is to determine the underlying phonological shape. We see at once that the vowel in question must be nontense in the phonological matrix to account for the stress placement in *recíprocal*, *frívolous*, *démon*. In each case, if the boldface vowel were tense, it would receive stress by the rules discussed in Chapter Three. Since, however, it is nontense and therefore nonstressed, the vowel instead reduces to [ə] by the Vowel Reduction Rule (rule (121) of Chapter Three). But we now have to account for the fact that when the vowel does receive stress, as when it is followed by the affix *-ity* or *-ic*, it becomes tense. Thus there must be a rule such as (4) (where V* is some nontense vowel):

$$(4) \qquad V^* \rightarrow [+\text{tense}]$$

If this rule follows the Vowel Reduction Rule, no further context need be given. Thus when V* is unstressed, it will reduce; when stressed, it will become tense by rule (4).

What, then, is the feature composition of V* beyond its nontenseness? The simplest solution would be to take V* as the nontense cognate of [ā], that is, as the low, back, nonround vowel [a]. In this case, rule (4) will suffice to determine the quality of V* when it does not reduce. We will see, however, that there are strong reasons for regarding [a] as itself being derived, by obligatory unrounding, from its round cognate [ɔ], which does not appear in phonetic matrices although considerations of symmetry would lead us to expect it.[5] But if we are to take V* as [ɔ], we must formulate rule (4) in terms that have the effect of (5) (where ˘ stands for "lax," that is, "nontense"):

$$(5) \qquad \breve{\text{ɔ}} \rightarrow \begin{bmatrix} +\text{tense} \\ -\text{round} \end{bmatrix}$$

[4] This is true of one major dialect. In other dialects the vowel in the second case may be [ɔ], [ō], or [ă] contrasting with [ā]. We return to the question of this dialectal variation later. It does not affect the point at issue here.

On our use of diagonals versus square brackets (i.e., / / vs. [ ]), see Chapter Three, page 65.

[5] We return to this matter later. Actually invariance is violated whether [a] or [ɔ] is chosen for V*, although the example is more striking, of course, in the latter case.

Moreover, if the boldface vowel in *reciprocal*, *frivolous*, *demon* is [ə] in the underlying matrix, then the vowel of the phonological matrix *never* appears in a phonetic matrix without a change in quality, so that the invariance condition is violated in an extreme way. However, the actual forms are determined by quite simple rules, and the choice of the underlying vowel is determined by a variety of systematic considerations.

Notice that in the case of the pair *reciprocal–reciprocity*, there is still another violation of invariance, namely, with respect to the final consonant of the formative *reciproc-*. This segment appears in one case as [k], in another as [s]. Other familiar facts of English force us to the conclusion that the underlying consonant is /k/ and that we have rules with the effect of (6):

$$(6) \qquad k \rightarrow s \; / \; \text{——} \begin{Bmatrix} i \\ e \end{Bmatrix}$$

We will see that rule (6) can be generalized considerably and analyzed into several independently motivated steps. For the moment we record it simply as another case of the violation of invariance of lexical entries.

Even though we cannot impose the condition of invariance on phonological matrices, we might still inquire whether some weaker condition is not satisfied. Can we, for example, require that the underlying phonological segment and the phonetic segment that corresponds to it not differ "too greatly," in some sense? Rule (6) suggests that this is unlikely, since [k] and [s] differ in the features "anterior," "coronal," "continuant," "strident." Later we will find an even more extreme violation of the invariance condition, in the vowel system. We shall see that in a sequence of steps, each well motivated and involving a change of just one feature, the underlying segment /ū/ becomes phonetic [æ] in certain dialects. This is a maximal change within the vowel system, for these two segments differ in the features "high," "low," "back," "round," "tense," that is, in all features that differentiate vowels.

Thus it seems that there is no hope for any condition of invariance that will relate phonological and phonetic matrices. No doubt there are certain conditions on "possible phonological rules," and these will, derivatively, impose certain conditions on the relation of phonological and phonetic matrices. But it seems that there is no general condition that can be established apart from whatever effects these conditions on rules may have.

Notice that although the invariance condition is not necessarily met by a grammar, there is often a cost attached to violating it, in terms of complexity of rules. Thus, in general, a grammar will contain fewer and simpler rules to the extent that the invariance condition is met; the condition will be violated, therefore, only when the corresponding gains more than compensate for the loss in simplicity. As we have indicated previously, an important part of linguistic theory is an evaluation measure for grammars that specifies those formal properties that play a role in the selection of one grammar (one theory of a language) over another, both by the learner of the language and the linguist analyzing it. A clear and precise formulation of such a measure (for discussion, see Chapter Eight) will determine exactly in what way violation of invariance will, *ceteris paribus*, reduce the valuation of a grammar. It will thus express a certain empirical hypothesis concerning the extent to which invariance is an important feature of language.

To summarize, we see that there are several respects in which phonological and phonetic matrices differ. First, the entries in the phonetic matrices may indicate degree along a physically defined scale, whereas the entries in the phonological matrices simply indicate membership of a segment in a category or in its complement (or give no information about membership). Secondly, the phonetic matrices are fully specified, whereas the phonological matrices in general are not. Thirdly, the phonetic matrices may differ from the underlying phonological matrices in the values which are inherent in the latter, as we have just noted. Finally, it is clear that a phonetic matrix may differ in number of segments from the underlying phonological matrix, as, for example, in the case of epenthesis or elision.

We have used the term "phonetic distinctive features" for the universal physical scales that determine the rows of the phonetic matrices. Correspondingly, we may use the term "phonological distinctive features" to refer to the categories that label the rows of the phonological matrices. Unfortunately, the discussion and development of the theory of distinctive features has been confused by the use of the term "distinctive feature" in both senses. This is appropriate only insofar as the invariance condition is met—that is, insofar as the phonological rules simply add redundant features to lexical matrices, giving additional specification of archi-segments. As we have seen, however, this is not the case in general. In fact, we do not believe that there is *any* significant intermediate level of linguistic representation between phonetic and phonological at which representations are strictly in terms of submatrices of the full phonetic representation.[6] In any event, the phonological and phonetic functions of distinctive features must be clearly distinguished.

It might be proposed, in the light of the distinction between phonological and phonetic distinctive features, that the two sets be absolutely unrelated—that in cases such as (1) and (2) above, for example, the rows be labeled entirely differently in the phonological and phonetic matrices. Thus in (1) we would have the phonetic features "consonantal," "vocalic," etc., as before, but in (2) we would have the phonological features *A*, *B*, and so on. Only the phonetic features would now be "substantive"; the phonological features would be without physical content and would provide an arbitrary categorization.

Adoption of this proposal would have two effects. For one thing, since all phonological rules would operate on the "empty" categories *A*, *B*, etc., gradually filling them in and revising their entries, the grammar would now have to be supplemented with a set of rules operating at the point at which all matrices are fully specified and providing that phonetic features be associated with the categories; for example, we would have rules providing that $[\alpha A] \rightarrow [\alpha \text{vocalic}]$, $[\alpha B] \rightarrow [\alpha \text{consonantal}]$ (where α is a variable ranging over the values of feature specifications, as in Chapter Three, p. 83). But every grammar will have to have exactly these rules; hence they do not contribute in any way to the choice among grammars and can just as well be eliminated from all grammars. To eliminate them means, simply, to use the names of the phonetic features to label the categories in the first place.

The second effect of this proposal would be nonvacuous, however. Recall that the phonetic features constitute a fixed and restricted set, independent of any particular language. Thus, our decision to restrict phonological categories to those that can be labeled by phonetic features amounts to an empirical hypothesis concerning the number of possible

[6] In other words, we believe untenable the view (characteristic of post-Sapirian linguistics, both in the United States and in Europe) that there is a level of representation meeting such conditions as invariance and biuniqueness. For discussion, see Halle (1959), Chomsky (1964), Chomsky and Halle (1965).

categories of a phonological matrix.[7] It reflects the hypothesis that beyond the categorization given by the features which are associated, ultimately, with phonetic values, all categorization applies to the formative as a whole and not to its separate (successive) parts. For example, a formative may belong to the category of items which are exceptions to a certain phonological rule, but we cannot state, in the lexical representation, that one but not another of its segments belongs to the category of exceptions to this rule. To achieve the latter effect, a special rule would have to be given, increasing the complexity of the grammar. We expect, to put it loosely, that there will be rules applying to segments specified in terms of categories very closely tied to phonetic features and rules applying to full lexical items; but rules of other sorts will necessarily be more complex, given the framework we are adopting. This becomes a significant claim as soon as an evaluation measure is fixed. If true, it is a formal property of language that would be missed if phonetic and phonological features were strictly dissociated.

We think, then, that there may be good reason to limit the class of phonological matrices in terms of the set of universal phonetic features. For the linguist or the child learning the language, the set of phonetic representations of utterances is a given empirical fact.[8] His problem is to assign a lexical representation to each word, and to develop a set of grammatical (in particular, phonological) rules which account for the given facts. The performance of this task is limited by the set of constraints on the form of grammars. Without such constraints, the task is obviously impossible; and the narrower such constraints, the more feasible the task becomes. Among the formal conditions is the one that we have just outlined, namely, that each lexical entry consists of a phonological matrix in which the rows are labeled by names of phonetic features along with a set of categories to which the formative in question belongs. The conditions on the form and application of rules and the evaluation measure for grammars set further constraints. The task, then, is to select the most highly valued grammar (including, in particular, a lexicon) that meets these conditions and is compatible with the particular data on which it is based.

[7] To further restrict the use of phonological features as mere "diacritics," we might add other conditions, for example, the condition that if a feature is totally redundant (as, for example, glottalization in English, which is always completely predictable from context), then it must not be used distinctively in lexical matrices. This would eliminate various techniques for escaping some of the force of the decision to limit phonological features to those with an absolute phonetic interpretation. We do not take this step here, however, since we are unable to formulate such a condition in a way which will still permit a wide class of familiar cases in which a distinctive feature is lost phonetically though it remains functional in phonological rules. Thus, to take just one of innumerable examples, in Modern Hebrew the feature of pharyngealization (which in Arabic distinguishes the class of "emphatic" consonants) is phonetically lost in stops, but it (or some other nonphonetic feature) must still be marked in lexical matrices, to prevent postvocalic spirantization in what is historically an emphatic [k], for example. Thus we have [kavar], [lixbor] contrasting with [kavar], [likbor], and we may account for the contrast by representing the former with a nonpharyngealized [k] and the latter with pharyngealized [k].

Presumably, the way to distinguish permissible from impermissible uses of diacritics is in terms of certain universal conditions on the kinds of rules in which a given feature can play a role. However, we are not in a position to say very much about this interesting question. For some discussion see Chapter Nine.

[8] But qualifications are necessary. Thus both the linguist and the child must determine which of the phenomena presented to them are legitimate examples on which to base their theory of the language of which these examples are a sample, and in part this decision must itself be made on grounds of systematic complexity. Furthermore, it must be borne in mind that the speaker of a language may assign to a physical signal a phonetic representation determined in part by grammatical rule rather than by overt properties of the signal.

2.1. LEXICAL REDUNDANCY RULES

To the rules that apply strictly within a single lexical entry and that simply fill in unspecified squares of phonological matrices, without violating invariance, we will give the special name of "lexical redundancy rules."[9] We will see that they have many special properties and interesting empirical correlates. Strictly speaking, they belong to the system of readjustment rules rather than to phonology, in our terms. Thus representations such as (2) are actually lexical rather than phonological representations. They become phonological representations when lexical redundancy rules (and perhaps other readjustment rules) apply, converting some—perhaps all—of the zero entries to plus or minus.

As an illustration of a lexical redundancy rule, we cite a familiar restriction on initial consonant clusters:

(7)
$$[+\text{consonantal}] \rightarrow \begin{bmatrix} -\text{vocalic} \\ +\text{anterior} \\ +\text{coronal} \\ +\text{strident} \\ +\text{continuant} \\ -\text{voice} \end{bmatrix} / + \text{—} \begin{bmatrix} +\text{consonantal} \\ -\text{vocalic} \end{bmatrix}$$

This rule asserts that the first segment of an initial consonant cluster must be [s] if the second segment is a true consonant (i.e., neither a liquid nor a glide). It rules out sequences such as [ps], [θm], but not [pl], [θr], in formative-initial position.

We cannot in all cases determine from the form of a rule whether it is a lexical redundancy rule or a rule of the phonology. If, for example, a rule such as (7) were to apply across formative boundary, it could not be a lexical redundancy rule. Thus consider the rule, dating back to Old English, that vowels are nontense in position before certain consonant clusters. Before clusters such as [kt] and [pt], we always find lax vowels, not only when the cluster occurs within a formative, as in *evict*, *apt*, *crypt*, but also when it occurs across formative boundary, as in *descrip*+*tion*, *satisfac*+*tion*. There are no tense vowels or diphthongs in this environment, that is, no morphemes such as *[dūwkt], *[dāwkt], *[ēypt], or *[krāypt] and no polymorphemic forms such as *[dāwk+tiv], *[skrāyp+tyūwr].[10] Thus this laxing rule, as opposed to rule (7), is a rule of the phonology rather than a lexical redundancy rule.

[9] These are rules which express regularities of lexical classification. In addition to the phonological redundancy rules, there are redundancy rules that deal with syntactic and semantic categories that appear in the lexicon, and that relate these several kinds of categories (see Chomsky, 1965, Chapter Four). In this book, however, we will consider only phonological redundancy rules. These are the "morpheme structure rules" of Halle (1959), where the notion is introduced.

[10] We find *opt* and *concoct* with tense [ā] before [pt] and [kt], but, as we have seen, this [ā] is the reflex of an originally nontense vowel by rule (5). The past tense [t] (e.g., *aped*, *liked*) must, of course, be marked as being excluded from the domain of this rule, as well as that of many other rules, in regular verbs. As we have already noted, it is regularly preceded by the boundary #. Some other apparent exceptions are dealt with below. The basic regularities discussed here were pointed out to us by P. Kiparsky.

Notice, incidentally, that [ŋ] acts as a cluster of the form C_2, rather than as a single consonant like [m] or [n]. Thus we have words such as *lime–line*, *loam–loan*, *lame–lane*, *town*, etc., with [āy], [ōw], [ēy], [āw], respectively, but forms such as *[lāyŋ], *[lōwŋ], *[lēyŋ], *[tāwŋ] are impossible in English. This is one of many factors contributing to the conclusion that the phonological matrix [+nasal] [g] underlies [ŋ].

2.2. TREATMENT OF EXCEPTIONS

As mentioned directly above, vowels in English are generally laxed before consonant clusters. Excluded from the domain of this laxing rule, however, are vowels preceding certain clusters within a single lexical item, in particular, vowels preceding dental clusters. For example, we have words such as *pint*, *count*, *plaint*, in which a diphthong precedes the cluster [nt], and words such as *hoist*, *toast*, *wild*, *field*, with diphthongs before other dental clusters. But a dental cluster with an intervening formative boundary has no special status, and we do have laxing in the boldface position in words such as *conven+tion*, *interven+tion*, *deten+tion*, *absten+tion*, *reten+tive*, *conten+t*, *wid+th*, *los+t*. (Note that laxing does not occur in *plaint+ive*, from the lexical entry *plaint*, or in *restrain#t*, *complain#t*—contrasting with *cóntènt* from *contain+t*—which have word boundary rather than formative boundary in the dental cluster, as seen from the fact that stress is not shifted to the left in the noun cycle.) Thus the laxing rule (see rule (20III) and note 2 in Chapter Five for a refined version of this rule) states that, with the exception of vowels occurring before dental clusters within formatives:

$$(8) \qquad V \rightarrow [-\text{tense}] \; / \; \text{——} C_2$$

Exceptions of the type just noted cannot be easily incorporated into the grammar as developed up to this point. We therefore consider next an extension of the available descriptive devices which would enable us to treat such exceptions in a straightforward manner.

Each phonological rule of the language applies to certain formatives and, in general, not to others, the domain of its application being determined by the feature composition of the phonological matrices. If a certain rule does not apply to a certain formative, this fact must somehow be indicated in the feature composition of the formative at the stage of derivation at which the rule is applicable. It is quite obvious that many of the phonological rules of the language will have certain exceptions which, from the point of view of the synchronic description, will be quite arbitrary. This is no more surprising than the fact that there exist strong verbs or irregular plurals. Phonology, being essentially a finite system, can tolerate some lack of regularity (exceptions can be memorized); being a highly intricate system, resulting (very strikingly, in a language like English) from diverse and interwoven historical processes, it is to be expected that a margin of irregularity will persist in almost every aspect of the phonological description. Clearly, we must design our linguistic theory in such a way that the existence of exceptions does not prevent the systematic formulation of those regularities that remain.[11] Furthermore, we must provide means for expressing those regularities that hold within the class of exceptions, however limited they may be. Finally, an overriding consideration is that the evaluation measure must be designed in such a way that the wider and more varied the class of exceptions to a rule, the less highly valued is the grammar.

In short, the most highly valued (simplest) grammar will be that in which the phonological rule $X \rightarrow Y$ (where X and Y are matrices) applies to any string containing X as a submatrix. We are certain to find, however, that in many cases formatives will have to be differentiated with respect to the applicability of the rule in question. Some formatives containing the submatrix X will undergo the rule, and others will not. The wider and more

[11] This obvious point is always taken for granted in morphological studies—e.g., no one would think of refusing to incorporate the rule for regular plurals in an English grammar because of *children*, *oxen*, *fish*, etc.

varied the class of cases that do not undergo the rule, the more complex must be the grammar in terms of the evaluation procedure that must constitute part of a significant linguistic theory.

We will deal with this problem in the following way. Each rule of the phonology has a certain identifying number. We associate with each number n a new "distinctive feature" $[\pm n]$. Suppose that the rule numbered n is $A \rightarrow B / C \text{ —— } D$. Then we stipulate that A must be marked $[+n]$ if the rule numbered n is to apply to it. Furthermore, we establish the following general convention:

Convention 1: Every segment of a lexical matrix is automatically marked $[+n]$ for every rule n.

Since the various decisions just formulated contribute equally to the complexity of all grammars, we may regard their total contribution to the evaluation of a grammar as nil. This is to say that we need not even present these conditions explicitly in a grammar but may regard them merely as conventions for interpreting a grammar. They do, however, play a role in determining whether or not two matrices are distinct.

If a certain formative is not subject to rule n, its segments must be marked $[-n]$. In the light of the decisions on the form of grammars that we have so far adopted, we must conclude that this fact is not a feature of any segment of the formative but of the formative as a whole. That is, the formative as such must be marked in the lexicon as belonging to the category of exceptions to rule n, and, consequently, the feature $[-n]$ must be marked in each of its segments. But in accordance with Convention 1, each of its segments is marked $[+n]$. Thus we must add a new convention, to be applied after Convention 1 and having the following effect:

Convention 2: Every segment of a lexical matrix μ is marked $[\alpha K]$ for each category $[\alpha K]$ to which μ belongs.

Thus, in particular, if a formative belongs to the lexical category $[-n]$, each of its segments will be marked $[-n]$ by Convention 2, after automatically having been marked $[+n]$ by Convention 1. Thus every time a certain formative is an exception to a rule, there is a certain "cost" associated with this fact, namely, a certain category assignment must be given the lexical entry. But an item that does undergo a rule need not be specially marked. Thus only exceptions to a rule contribute to the complexity of the grammar in this connection.

Furthermore, notice that the less "predictable" the class of exceptions, the greater the contribution to complexity. For example, if the class of formatives belonging to the category $[-n]$ is totally idiosyncratic, then each such category assignment must be given in the lexicon. But if this class plays some other role in the grammar, in whole or in part, then the category assignment need not be given as an independent lexical property. Thus in English, for example, there are many items that must be marked in the lexicon for the fact that they do not enter into the Romance derivational system. We shall designate such formatives as belonging to the category [−deriv]. A phonological property connected with the independently motivated category "subject to derivational processes" will contribute less to the complexity of the grammar than one that is entirely idiosyncratic, since its occurrence in lexical entries can in part be stated by redundancy rules. Consider rule (6), for example, which, when appropriately generalized, will have the effect of changing [k] to [s] and [g] to [j] (in a series of steps) when these segments appear before a high or mid front vowel ([i], [e], [ɪ], [ɛ]). This rule applies to the boldface segments of *reciproc-*, *receive*, *general*, etc., but not to the boldface positions of *kill*, *kennel*, *lackey*, *gill*, and so on. Yet there is good

reason to mark all these items as velar stops in the lexicon. Thus the items *kill, kennel, gill* (but not *reciproc-, -ceive, general*) will be marked in the lexicon as belonging to the category [−rule (6)].[12] However, this is not an entirely idiosyncratic classification since it is, in part, an automatic consequence (therefore statable by a redundancy rule instead of having to be independently marked in each case) of membership in the category [−deriv], characteristic of a formative which must anyway be specially marked in its lexical entry.[13] The lexical category [−rule (6)] will, by Convention 2, be marked as a segmental feature of each segment of the items belonging to this category, and these items will thereby be automatically excluded from the application of rule (6). This is a rather typical example of a characteristic aspect of English grammar to which we shall make reference again below.

Alongside of the partially systematic class of exceptions to rule (6), we also find purely idiosyncratic exceptions. For example, consider the rule that makes vowels nontense before certain affixes (e.g., compare *serene* and *serenity*, *obscene* and *obscenity*). There are exceptions to this rule (e.g., *obese–obesity*, in most dialects) which must simply be categorized as such in the lexicon, these lexical features becoming segmental features by Convention 2. Each such example contributes to the complexity of the grammar, but there is obviously no question of rejecting the rule. Doing so would amount to treating *each* item as an exception, in the manner of item-and-arrangement grammars (see Chapter Three, Section 16), and there is surely no point to such a decision.

Convention 2 asserts that each lexical category of a formative automatically becomes a distinctive feature of each of its segments. This will be true, then, even of the syntactic and semantic features ("animate," "proper," particular semantic properties, etc.) which ordinarily have no phonetic effects. No harm is done, however, by allowing Convention 2 to apply quite generally. In fact these lexical categorizations may indeed have phonetic effects occasionally. (See Chapter Eight, Section 7, for some examples.)

Let us be somewhat more precise about Convention 2. Suppose that a formative belongs to the syntactic categories [animate], [nonhuman], [exception to rule n]. Alternatively, we might represent these categories as [+animate], [−human], [−rule n] within the syntactic component of the grammar. From the point of view of the phonology, each of the categories [animate] (= [+animate]), [nonhuman] (= [−human]), [exception to rule n] (= [−rule n]) is simply a feature, which may be positively or negatively specified. Convention 2 asserts that each segment of the formative in question receives the specifications [+[animate]], [+[nonhuman]], [+[exception to rule n]], that is, the specifications [+[+animate]], [+[−human]], [+[−rule n]. To simplify the theory of rule application, we may assume that each segment of any formative is, by convention, specified as [−X] for any syntactic category X that appears anywhere in the lexicon for which it is not specified

[12] Notice that in the case of the unvoiced velar stop [k], the orthographic distinction of *k–c* comes close to marking the distinction [−rule (6)] vs. [+rule (6)], for obvious historical reasons.

[13] Notice that the items subject to derivational processes are further subdivided (ultimately, with respect to Greek or Latin origin) in terms of the categorization provided by rule (6). Thus we have *hierarch* (*-ic*, *-y*), *psych* (*-ic*, *-o-*), and a small number of other formatives which do not undergo softening of velars before *-ic*, etc., in contrast to the large class of regular cases which do. In short, we would certainly expect to find, in a complete grammar of English, that categories corresponding rather closely to Greek, Latin, and Germanic origin appear in lexical entries and that membership in these categories has phonetic effects. English is perhaps unusual in the intricate and complex way in which these categories and their effects have been worked into the grammar, but it is quite generally the case that the lexicon of a language is subdivided, in terms of phonological and morphological processes, into "native" and "foreign," or something of this sort. See, for example, Lees (1961) and the interesting discussion in Postal (1968).

[+X]. Thus the segments of the formative being considered in our example are specified [−[−animate]], [−[+human]]. We now specify, again by a general interpretive convention, that [+[−rule n]] = [−rule n]. Thus the feature [exception to rule n] as introduced by a lexical feature and as introduced by a rule are indistinguishable from the point of view of the rules of the phonological component. With these interpretive conventions, exceptions are handled in the intended way.

The formal devices just developed seem to be appropriate for dealing with exceptions to phonological rules. As we have noted, the grammar becomes more complex as exceptions increase in number, variety, and unpredictability. The complication is less severe if a class of exceptions can be characterized by a redundancy rule rather than by listing each example, that is, rather than by idiosyncratic lexical marking.

We are now in a position to return to the problem of the laxing rule (8). As noted, this applies to vowels that appear in the context ——C_2 unless, among other exceptional cases, the consonant cluster in question is a dental cluster and is internal to a formative. In our framework dentals are marked [+anterior, +coronal]. We must therefore incorporate into the grammar the lexical redundancy rule (9):

$$(9) \qquad V \rightarrow [-\text{rule (8)}] \;/\; \text{——} \begin{bmatrix} +\text{consonantal} \\ +\text{anterior} \\ +\text{coronal} \end{bmatrix} \begin{bmatrix} +\text{consonantal} \\ +\text{coronal} \end{bmatrix}$$

Being a lexical redundancy rule, rule (9) applies only within a single lexical entry. It specifies that a vowel in the context ——C_2 will not undergo the laxing rule (8) if the following cluster is dental. Thus, the effect of the combination of the lexical redundancy rule (9) and the phonological rule (8) is precisely as indicated in the informal description of page 172.

Another possible sort of exception involves "negative contexts." Thus, when the rule n, $X \rightarrow Y$, applies everywhere except in the context Z——W, we might state this fact in the following form:

$$(10) \qquad \begin{array}{ll} (n-1) & X \rightarrow [-\text{rule } n] \;/\; Z\text{——}W \\ (n) & X \rightarrow Y \end{array}$$

We have so far mentioned three kinds of exceptions: those indicated by lexical categorization, those given by lexical redundancy rules such as (9), and those that involve negative contexts for rules, as in (10). If we were to use the device of (10) more generally—if, in other words, we were to allow reference in a rule not only to the next rule, as in ($10n-1$), but to any rule—then we would increase the power and flexibility of the system greatly.

We have no examples that suggest the necessity for negative contexts or for any extension of the device of (10). Therefore, we will make the tentative assumption that the only kinds of exceptions to rules are those given by lexical categorization or by lexical redundancy rules such as (9), and we will restrict the formalism of the theory accordingly.

Although this approach to the problem of exceptions seems to us correct as far as it goes, it is far from definitive. There is, first of all, a certain ambiguity of reference when we specify an item as [−rule n]. Consider, once again, the laxing of vowels in English. Rule (8) is really an abbreviation for several rules, one of which applies to a vowel in the context ——C^m (where m is the maximum length of a consonant cluster in English), another in the context ——C^{m-1}, etc., and the last of which applies in the context C^2. We must decide, then, upon general conventions that determine whether an item marked as an

TABLE 1. *Distinctive feature composition of English segments*

	ɨ̄	ī	ū	ē	ō	ǣ	ā	ɔ̄	ə̄	i	u	e	ʌ	o	æ	ɔ	y	w	ɛ
vocalic	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−	−
consonantal	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
high	+	+	+	−	−	−	−	−	−	+	+	−	−	−	−	−	+	+	−
back	+	−	+	−	+	−	+	−	+	−	+	−	+	+	−	+	−	+	−
low	−	−	−	−	−	+	+	+	+	−	−	−	−	−	+	+	−	−	−
anterior	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
coronal	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
round	−	−	+	−	+	−	−	+	+	−	+	−	−	+	−	+	−	+	−
tense	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−
voice																			
continuant																			
nasal																			
strident																			

exception to rule (8) is an exception to all of the rules abbreviated by (8) or only to a specific one. From some points of view it seems natural to adopt the convention that a specification of [−rule *n*] refers to the rule numbered *n* in the completely expanded system of rules which involves no abbreviatory notations. Items will then have to be categorized as exceptions to one or another rule abbreviated by (8). An item which is an exception to rule (8) applying in the context ——CC will not necessarily be an exception to the rule applying in the context ——CCC (the consonant cluster being followed by a vowel or a nonsegment in both cases). In the case in question, this seems the correct interpretation. The vowels that are marked as exceptions to the rule laxing vowels in the context ——CC are not, apparently, excluded from laxing in the context ——CCC (cf. *children*, *Christmas*, in which the tense vowel becomes lax even before a dental cluster—in the word *Christmas*, the [t] later drops). Examples are so sparse, however, that this observation cannot be taken very seriously. And there is very little doubt that items which are exceptions to certain subcases of a rule will also, under some circumstances, be exceptions to other subcases. What these circumstances may be, however, we do not know, and we therefore leave the problem in this unsatisfactory state.

There are other aspects of the problem of exceptions not taken care of in the system presented above. Occasionally items must be specified not as exceptions to some specific rule but as exceptions to all rules of some general sort. For example, in Hebrew there are several rules deleting vowels, but none of them apply to the high vowels [i] and [u]; and there are several rules modifying vowel quality, but none of them apply to [u]. Thus we want to mark underlying /u/ as immune to all rules affecting quality, and to mark underlying high vowels as immune to all deletion rules. We came across a similar but more marginal problem in English in studying Auxiliary Reduction Rules in Section 14 of Chapter Three. In discussing the immunity to reduction of [ə̄y] and such exceptional cases as the vowel of *=nOt*, we pointed out that such vocalic nuclei are also tense where they would be expected to be lax (e.g., *exploitative*, *denotative*), and we observed in note 74 (p. 122) that they might be lexically marked as exempt from laxing—that is, exempt from several separate but related rules that make vowels nontense under various circumstances. Here, once again, a principled solution to the problem requires insights into rule classification that go beyond our present understanding.

r	l	p	b	f	v	m	t	d	θ	ð	n	s	z	c	č	ǰ	š	ž	k	g	x	ŋ	h	k^w	g^w	x^w
+	+	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	+	+	+
−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	+	+	+	+	+	−	+	+	+
−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	+	+	+	−	+	+	+
−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−	−	−
−	+	+	+	+	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−	−	−	−	−
+	+	−	−	−	−	−	+	+	+	+	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−
																			−	−	−			+	+	+
+	+	−	+	−	+	+	−	+	−	+	+	−	+	−	−	+	−	+	−	+	−	+	−	−	+	−
+	+	−	−	+	+	−	−	−	+	+	−	+	+	−	−	−	+	+	−	−	+	−	+	−	−	+
−	−	−	−	−	−	+	−	−	−	−	+	−	−	−	−	−	−	−	−	−	−	+	−	−	−	−
−	−	−	−	+	+	−	−	−	−	−	−	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−

3. *The features*

In our discussion of the stress rules of English, we have had occasion to analyze the segments as [±vocalic], [±consonantal], and [±tense]. The universal phonetic theory which we accept presents further possibilities for the categorization of segments. Those categorizations which play a role in the discussion of the present chapter are summarized in Table 1. (For a more detailed discussion see Chapter Seven and the literature cited there.)

In the vowel system the essential features are "high," "back," "low," "round," and "tense." For the consonants, the traditional points of articulation are supplanted in the present system by the features "anterior" and "coronal" as in Table 2:

TABLE 2.

	labial	dental	palato-alveolar	velar
anterior	+	+	−	−
coronal	−	+	+	−

These categorizations suffice for the examination of English consonants presented in this chapter, and in general the features "high," "back," and "low" will play no role in the discussion of consonants here. (See Chapter Seven and Chapter Nine, Section 4, for a more detailed treatment.)

The phonological rules specify coefficients associated with different features. Thus, rule (8) supplies the coefficient "minus" to the feature "tense" in a vowel before two consonants; the stress rules of the preceding chapter supply coefficients represented by positive integers to the feature "stress" in vowels in various contexts.

We extend the notation to allow variables—for which we use letters of the Greek alphabet—to function as coefficients of features in the formulation of rules. This extension allows us to handle many phenomena that would otherwise not be expressible. We have already made use of this notation in formulating the rules of stress assignment in the

preceding chapter. The familiar rule of voicing assimilation in consonant clusters provides another simple example of the use of variables:

$$(11)\qquad \begin{bmatrix} +\text{cons} \\ -\text{voc} \\ -\text{nasal} \end{bmatrix} \rightarrow [\alpha\text{voice}] \;/\; \text{——} \begin{bmatrix} +\text{cons} \\ -\text{voc} \\ -\text{nasal} \\ \alpha\text{voice} \end{bmatrix}$$

In other words, a nonnasal consonant becomes voiced before a voiced nonnasal (true) consonant and unvoiced before an unvoiced nonnasal (true) consonant.

Dissimilation can also be expressed by the use of variables. For example, in (11) if we replace [αvoice] by [−αvoice] in the segment to which the rule applies, then the rule will state a process of dissimilation, the first of two nonnasal true consonants becoming voiced where the second is unvoiced, and unvoiced where the second is voiced. To take a real example, consider a dialect of English in which diphthongs can take only low back vowels before the nonback glide [y] (i.e., [ɔ̄y], [āy]) and only nonback vowels before the back glide [w] (i.e., [æw]). To account for the phonetic quality of the vowels, we postulate the dissimilation rule (12):

$$(12)\qquad \begin{bmatrix} +\text{voc} \\ -\text{cons} \\ +\text{low} \end{bmatrix} \rightarrow [-\alpha\text{back}] \;/\; \text{——} \begin{bmatrix} -\text{voc} \\ -\text{cons} \\ \alpha\text{back} \end{bmatrix}$$

Observe that by permitting variables in the formulation of rules, we in effect commit ourselves to the view that assimilation and dissimilation are not merely a matter of fortuitous coincidence of almost identical rules, but are, rather, linguistic universals—that is, processes available to all languages though not necessarily used in all.

As we proceed, we will come across other examples which call for the use of variables in rules.

4. *Vowel alternations*

We are now in a position to deal with the central problem in the noncyclic phonology of English, that is, the problem of accounting for the intricate system of vowel alternations that are found primarily, but not solely, in the subpart of the vocabulary that is of Romance origin. We will consider first the nonback vowels and will work out the rules governing their alternations. We will then apply these results to the apparently still more complex system of back vowels and to the question of back-nonback alternations.

4.1. ALTERNATIONS OF NONBACK VOWELS

Consider first forms such as *divine–divinity*, *serene–serenity*, *profane–profanity*. Returning now to the notation of the preceding chapter (see p. 69), we give these in the representation *divIn–divinity*, *serEn–serenity*, *profAn–profænity*.[14] There are many other cases of the same system of alternations—*satIr–satiric*, *derIv–derivative*, *lIn–linear–delineate*, *mEtr–metric*, *appEl–appelative*, *dElicious–delicacy*, *compAr–compærative*, *explAn–explænatory*, *grAteful–grætitude*, and so on. It is clear that in the case of *divIn–divinity*, *serEn–serenity*, *profAn–profænity*, the underlying representation must have a tense vowel

[14] As in Chapter Three, we will preserve conventional spelling in expository passages as much as possible, using a fairly precise representation only for the elements explicitly under discussion.

in the second syllable so that in isolation the word will receive final stress by the strong cluster rule of Chapter Three; that is, these forms must be entered in the lexicon as *divIn*, *serEn*, *profAn*, where [I], [E], [A] (whatever their quality may be otherwise) are phonologically tense. In order to account for the lax vowels in the derivative nouns, however, we must incorporate in the grammar rules that have the effect of (13):

(13) $\left\{\begin{matrix} I & \rightarrow & i \\ E & \rightarrow & e \\ A & \rightarrow & æ \end{matrix}\right\}$ in certain contexts

Apart from tenseness, we have not yet settled the phonological distinctive feature composition of the segments that we are representing by capital letters. Phonetically the segments represented as [I], [E], [A] will appear as [āy], [īy], [ēy], respectively, that is, as a tense vowel followed by a *y*-glide. Suppose that *divine*, *serene*, *profane* are entered in the lexicon with [āy], [īy], [ēy] (or, perhaps, archi-forms of these) in the position of the second vowel. Then rule (13) would have the form:

(14) $\left\{\begin{matrix} āy & \rightarrow & i \\ īy & \rightarrow & e \\ ēy & \rightarrow & æ \end{matrix}\right\}$ in certain contexts

If we replace the informal notations of (14) by their precise representations in terms of features, we find that the rule is quite complex, expressing no underlying generalization. This suggests that the operation of the rule be subdivided into several stages, each of which can perhaps be expressed in some fairly general form. Instead of pursuing this possibility directly, however, let us turn to some other evidence that strongly brings into question the decision to accept the phonological feature analysis of [I], [E], [A] as [āy], [īy], [ēy], respectively.

Alongside of the rules (14), we must also have rules that produce effects precisely opposite to those of (14). To see this, consider the forms *various–varIety*, *impious–pIety*, *funeral–funEreal*, *manager–managErial*, *Abel–AbElian*, *Canada–CanAdian*, *marginal–marginAlia*, *algebra–algebrAic*, etc. We have already noted that there are rules applying to nontense vowels in final position, causing those that are nonlow (that is [i], [e], [u], [o]) to become tense and those that are low to reduce to [ə] (see (30), p. 74). Since the final vowel of *algebra* reduces, it must be marked in the lexicon as [+low]. Moreover, it must also be [−tense], for otherwise the stress assignment rules of the preceding chapter would have assigned stress to it. But in *algebraic* this vowel is both [+tense] and [−low]; it is, in fact, [A]. The vowel is also nonback and nonround in *algebraic*, and the simplest assumption with respect to these features is, clearly, that the same is true of the underlying representation of the vowel in *algebra-*. In sum, the segment underlying the final vowel of *algebra* must be nontense, low, nonback, and nonround; i.e., it must be /æ/. To give the proper vowel in *algebrAic*, then, the grammar must contain rule (15):

(15) æ → A in certain contexts

Consider now *various–variety*. Clearly the underlying form of *vary* must have a lax final vowel or the stress would be on the last syllable. The phonetic tenseness of this vowel in *vary* and in *various* is an automatic consequence of rules applying to vowels in final and in prevocalic position; its diphthongal quality is a consequence of its tenseness, as we shall see directly. Furthermore, it is clear from the word *vary* in isolation that the underlying

vowel must be /i/. Since in *variety* this vowel appears as [I], we see that the grammar must contain, along with the rule æ → *A*, the rule *i* → *I*.

Consider, finally, *manager–managerial*. Again, considerations of stress placement and vowel reduction tell us that in *manager* the final vowel is lax. Considerations analogous to those cited in the preceding paragraph tell us that it is nonback. It can be neither /i/ nor /æ/ for it would then become [I] or [A] by the rules just discussed. Therefore it is /e/, and the grammar contains the rule *e* → *E*.

In short, the grammar must contain rules that have the effect of (16):

(16) $\begin{Bmatrix} i & \rightarrow & I \\ e & \rightarrow & E \\ æ & \rightarrow & A \end{Bmatrix}$ in certain contexts

If, as in (14), we take the phonological composition of [I], [E], [A] to be essentially the same as the phonetic composition, then (16) becomes:

(17) $\begin{Bmatrix} i & \rightarrow & \bar{a}y \\ e & \rightarrow & \bar{\imath}y \\ æ & \rightarrow & \bar{e}y \end{Bmatrix}$ in certain contexts

As we have noted above in connection with (14), this is an extremely complex rule.

For a grammar to contain a rule of the complexity of (14) or a rule of the complexity of (17) is implausible enough. For it to contain both of these rules is quite intolerable, not only because of the doubling of complexity, but, more importantly, because it is clear that such a grammar is missing a significant generalization. Thus the fact that (17) simply reverses (14) does not contribute to the simplicity of this grammar, i.e., the generalization that similar processes are involved is unexpressed. The grammar would be no more complex if (14) were retained and (17) were replaced by (18), for example:

(18) $\begin{Bmatrix} i & \rightarrow & \bar{\imath}y \\ e & \rightarrow & \bar{e}y \\ æ & \rightarrow & \bar{a}y \end{Bmatrix}$ in certain contexts

In fact, the grammar would actually be simplified in this particular case, contrary to obvious conditions of adequacy.

These considerations are sufficient to show that a theory of English (an English grammar) is surely in error if it attempts to account for the *I–i*, *E–e*, *A–æ* alternations by assigning to [I], [E], [A] a phonological feature analysis that corresponds to the phonetic feature analysis and relating the variants by the rules (14) and (17).

Let us therefore approach the problem of alternations of nonback vowels in a rather different way. It is clear that these alternations involve both a change of tenseness and a change of vowel quality. Let us put aside for the moment the question of the quality and concentrate on the tenseness. Rule (13) asserts that vowels become lax in certain contexts, and rule (16) asserts that they become tense in certain other contexts. Consideration of the examples given above, and many others, shows that the contexts in question are those in rules (19) (corresponding to (13)) and (20) (corresponding to (16)):

(19) $$V \rightarrow [-\text{tense}] \; / \; \text{——} C \begin{cases} C_0 + i \begin{Bmatrix} k \\ d \\ š \end{Bmatrix} & \text{(a)} \\ (C_1+) \begin{bmatrix} -\text{stress} \\ V \end{bmatrix} C_0 V & \text{(b)} \end{cases}$$

By rule (19) a stressed vowel becomes lax before the affix *-ic*, *-id*, or *-ish* (though not *-iv* or *-is*) and before an unstressed nonfinal syllable. In particular, then, bisyllabic affixes such as *-ity*, *-ify* will have the effect of laxing the immediately preceding vowel, and the same will be true in a variety of other cases.[15]

In case (b) we have the two subcases $\_\_ CC+VC_0V$ and $\_\_ CVC_0V$. The first subcase causes laxing in the boldface position in *profund+ity*, *pronunc+iation*, *wild+erness* (if derived from *wIld*); but neither case applies in the boldface position of ***mountainous***, ***countenance***, ***counterfeit***, ***mountebank***, ***bountiful***, etc., since in these words the consonant sequence after the stressed vowel is not followed by a formative boundary (+). Examples of laxing still unaccounted for in this analysis are *abundant*, *contrapuntal*.

Like many other phonological rules, the laxing rule (19) does not apply to a number of categorially marked exceptions (see Section 2.2). In monosyllables, in particular, we simply have two categories of formatives with respect to case (a)—those to which the rule applies and those to which it does not. Some examples that do not undergo laxing are *scEnic*, *bAsic*, *cIclic*. For case (b), there are exceptions such as *obEsity*, *hIbernate*, *Isolate*, *prObity*, and many before $\_\_ CVC_0\begin{bmatrix}-\text{low}\\-\text{consonantal}\end{bmatrix}$ (e.g., *rotary*, *notary*, *rosary*, *decency*, *primary*, *papacy*, *vagary*, *vacancy*, *ivory*, *irony*, *regency*, *potency*, *credence*, *nature*—these examples from Luick (1898)).[16]

The tensing rule required by the facts examined above has the form:

$$(20)\qquad V \rightarrow [+\text{tense}] \Big/ \left\{ \begin{array}{ll} \left[\begin{array}{l}\alpha\text{low}\\ \beta\text{stress}\end{array}\right] \left\{\begin{array}{l}V\\ \#,\ \text{where } \beta = + \text{ if } \alpha = +\end{array}\right\} & \text{(a)} \\ \left[\begin{array}{l}-\text{high}\end{array}\right] C_1^1 \left[\begin{array}{l}-\text{low}\\-\text{back}\\-\text{cons}\\-\text{stress}\end{array}\right] V & \text{(b)} \end{array} \right.$$

[15] The second part of the rule is the modern reflex of the Middle English "sound law," whose effects were characterized by Jespersen (1909, Section 4.33): "When a stressed syllable is followed by two (or more) weak ones, there is a strong tendency to shorten it." The rule itself was apparently discovered by Luick (1898).

Many writers on this subject (see, e.g., Jordan, 1934; Wyld, 1927; Dobson, 1957) give the impression that this development affected only a small part of the vocabulary. Luick (1898, pp. 349-50), however, specifically noted that "die englischen quantitaetsgesetze treten ferner zu tage in den vielen romanischen sowie auch in den spaeteren lateinisch-griechischen lehnwoertern." And Jespersen (1909, Section 4.71) gives an extensive list of examples from the non-Germanic component of the language.

[16] As implied here, part (b) of rule (19) should actually be generalized so that the last segment mentioned is [−consonantal] rather than V; that is, the segment in this position may be a glide as well as a vowel.

Recall in this regard that the last two forms—*credence* and *nature*—like the other forms mentioned, have a final glide in their underlying representations. In the case of these two forms the glide is [ε], which is deleted by a simplified version of the e-Elision Rule (155) of Chapter Three. (See p. 161 for discussion.)

We may note that if we analyze *-ic* as /ik+ al/, as suggested in Chapter Three, Section 7, the first part of case (a) disappears, falling under case (b). The motive for this analysis in Chapter Three was that it accounted for the exceptional behavior of *-ic* with respect to stress placement. The same artifice will, we now see, account for its exceptional behavior with respect to laxing.

In fact, there are other phenomena relevant here. Thus there are certain VC strings that permit only nontense vowels in the preceding syllable even though there is no reason to assign a formative boundary before VC #; for example, *-id* (as in *acid*, *rapid*—the sole exception is *hybrid*), *-ish* (as in *radish*, *abolish*, *establish*, *relish*), and *-it* (as in *credit*, *limit*, *visit*). This may be a matter for a lexical redundancy rule. Notice that *-it* permits tense vowels when it can be regarded as an affix (*plaud+ it*, *aud+ it*).

Examples such as *lucid*, *stupid*, *cubic* are not exceptions to laxing before *-id*, *-ic*. We have already

Case (a) of (20) is simply rule (3) extended to final position and sharpened along the lines indicated in Chapter Three (see rule (30) there). Case (b) is the rule that is involved in all of the other examples given above in connection with the discussion of rules (16)–(17). It asserts that a nonhigh vowel becomes tense before a single consonant followed by [i] or [e] or the corresponding glides, which must in turn be followed by another vowel. Thus $e \rightarrow E$ in this position (*Abel–Abelian, manager–managerial*),[17] and $æ \rightarrow A$ (*Canada–Canadian, simultaneous, Arab–Arabian*), but *i* does not convert to *I* (*punctilious, Darwinian, reptilian, vicious*, etc.)

These observations support the decision to analyze the affix *-ion* as /iVn/. As we have already observed (p. 87), this decision is motivated by the placement of primary stress. But if we consider the syllables that precede *-ion*, we can give independent support for this conclusion. Examples such as *decision, revision* suggest that the trisyllabic laxing rule (19b) must have applied; thus *-ion* must be bisyllabic at this point. The high vowel in the context ——C+*ion* does not then become tense by rule (20b) since this context is restricted to nonhigh vowels; thus we have a lax vowel in this position in *decision, inhibition*, etc. But the first vowel of *-ation*, being nonhigh, does become tense by (20b), giving [At+iVn], which becomes [Ašən] by processes that we discuss in Section 6. (Certain formatives with nonhigh vowels are lexically marked as excluded from this tensing rule; e.g., *-cede*, as in *recede–recession, succeed–succession.*) Such configurations of nontense high vowels and tense nonhigh vowels are characteristic of the context ——C*i*V, as is clear from an inspection of rules (19b) and (20b).[18]

We must require in rule (19b) that the vowel following the vowel to which the rule applies be specified as [−stress], not just as having some weak stress. This is clear from consideration of the variants of *presentation*, for example, discussed in Chapter Three (p. 161). If the vowel in the second syllable has the specification [−stress], so that it eventually reduces, then rule (19b) applies to the vowel in the first syllable and we derive

---

seen (Chapter Three, pp. 149–50) that there is a subsequent rule that tenses underlying /u/ in the context ——CV. (Notice, however, that this tensing of /u/ does not take place before *-ish*. *Punish, flourish, nourish* are the only relevant examples.) Similarly, *abolish, stolid* are not exceptions because the phonetic [ā] in the penultimate syllable derives from underlying /ɔ/ (see rule (5)). Furthermore, *squalid* is not an exception, as we shall see in Section 4.3.7. The adjective-forming affix *-ish*, as in *swinish, loutish*, is irrelevant here, being preceded by #.

[17] Recall again that formatives may fall into two categories with respect to these rules, according to whether or not the rules apply. Thus, alongside of *Abelian* we have *Maxwellian*, and alongside of *managerial* we have *perennial*, etc. Nonapplication of the rule can just as well be marked, as in orthography, by a double consonant. (Recall that clusters of two identical consonants simplify—see (156), p. 148, Chapter Three.)

Case (20b) often does not apply when the consonant following the vowel to be tensed is a liquid. Thus we have *valiant, batallion, clarion, Marion, secretarial*, etc. (The reason that [l] is followed by [y] and [r] by [E] in these forms will be discussed in Section 6; for *secretarial* see p. 202.)

[18] Comparison of *simultaneity* [sIməltənEətE] with *variety* [vərIətE] indicates that the underlying vowel following the [n] in *simultan-* must be /e/, not /i/, so that the rule $e \rightarrow$ E will apply. (The occasionally heard variant [sIməltənAətE] is apparently a hypercorrect form.) We might account for the appearance of phonetic [E] in forms such as *simultaneous* (but not in *courageous*) by postulating an ad hoc rule which raises unstressed /e/ to [i] under certain conditions. The vowel so raised, being high, will be subject to the Tensing Rule (20b) and then to Diphthongization (see rule (21)) but not to Vowel Shift (see rule (43) and the comments there). Formative-final /e/ that does not undergo raising is elided by the *e*-Elision Rule of Chapter Three.

[prez^{3}ənt^{1}Ašən]; if the vowel in the second syllable has the specification [+stress], so that it is protected from reduction and eventually is marked [4 stress], then rule (19b) does not apply to the first vowel and we derive [pr^{3}Ez^{4}ənt^{1}Ašən].

We must also require that the penultimate segment in the environment of (20b) be specified as [−stress], for otherwise tensing would take place in the nonprimary-stressed vowel of forms such as *variety*, with the result that the vowel would incorrectly be prevented from undergoing Vowel Reduction.

Notice that rules (19) and (20) must apply in the order given. Otherwise the forms that meet the contextual conditions of both rules (e.g., *simultaneous*, *emaciate*) will have lax rather than tense vowels in the phonetic representation. Notice also that rule (19) can be combined with rule (8), which makes a vowel lax before a double consonant.

In discussing Auxiliary Reduction Rules in Section 14 of the preceding chapter, we observed that the rule stated finally as (118), which makes a vowel lax and unstressed under certain conditions, must precede various tensing rules, in particular, those that determine that the vowels in the boldface position of words such as *commutation*, *commutative* have tense vowels (see p. 124). The Auxiliary Reduction Rule in question will fall together naturally with the Laxing Rule (19), and the rule that tenses the boldface vowel in these words will fall together with the Tensing Rule (20). Thus the observations of the preceding chapter confirm the conclusion that the order is Laxing Rules first and then Tensing Rules.

Clearly rules (19) and (20), which have opposite effects, are both needed in the grammar. This is a minimum of reversibility that is inescapable. Since, however, each of these rules is very simple in feature composition, this is not a disturbing or surprising fact.

Rules (19) and (20) allow us to account for the tenseness of the vowels that take part in the alternations of nonback vowels. As we have seen, the quality of the underlying lax vowel must be given in the lexicon. Still to be accounted for is the quality of the tense vowel and its diphthongization. We are now proposing that [I], [E], [A] be represented simply as the tense vowels corresponding to [i], [e], [æ] and that the specific quality of these tense vowels result from special rules, which in fact turn out to be rather simple.

It is a well-known fact that English tense vowels are diphthongized or have off-glides. For the nonback vowels [ī] and [ē], the glide is [y] (that is, high, nonback, nonround); for the back vowels [ū] and [ō], it is [w] (that is, high, back, round). Generalizing these phonetic observations somewhat, let us simply give a rule of diphthongization to the effect that after *any* tense vowel, a high glide is inserted which agrees in backness with the vowel in question and is, furthermore, nonround if nonback and round if back. Thus [y] is introduced after nonback vowels, and [w] after back vowels.

(21) DIPHTHONGIZATION

$$\phi \rightarrow \begin{bmatrix} -\text{voc} \\ -\text{cons} \\ +\text{high} \\ \alpha\text{back} \\ \alpha\text{round} \end{bmatrix} / \begin{bmatrix} +\text{tense} \\ \alpha\text{back} \end{bmatrix} \text{——}$$

We now have rules giving the alternations *i–īy*, *e–ēy*, æ–ǣ*y*, and we must add a rule which

changes [ī] to [ā], [ē] to [ī], and [ǣ] to [ē]. Taking [ā] of [āy] to be [ǣ] for the moment, we see that we need a rule which has the effect of (22):

(22)

ī	ē	ǣ
↓	↓	↓
ǣ	ī	ē

We will then have to add a rule converting [ǣ] to [ā]. The rule sketched in (22) we will call the Vowel Shift Rule (it is, in fact, a synchronic residue of the Great Vowel Shift of Early Modern English), and we will discuss it in detail in Section 4.3.

We return now to our original examples in order to see how these are handled by the rules that have already been established here. Consider first the alternations *divIn–divinity*, *serEn–serenity*, *profAn–profanity*. The underlying forms in the lexicon, as we have already noted, must be *divIn*, *serEn*, *profAn*, with a tense vowel in the second syllable. We are now taking each capital letter to represent the tense vowel corresponding to the lower-case letter; that is, /I/ = /ī/, /E/ = /ē/, /A/ = /ǣ/, in terms of phonological features. Thus capitalization simply expresses tenseness, and this expository device used in the preceding chapters turns out to have systematic significance.[19] To derive the forms *divine*, *serene*, *profane* in isolation, we apply the Diphthongization Rule (21) to the underlying forms that head the derivations of (23), giving the forms of the second line, to which we apply the Vowel Shift Rule, thus giving the forms of the third line:

(23)

divīn	serēn	profǣn	
divīyn	serēyn	profǣyn	RULE (21)
divǣyn	serīyn	profēyn	RULE (22)

The forms of (23) then receive their final phonetic interpretation by the application of other phonetic rules which, except for the change of [ǣy] to [āy], will not be considered here.

Suppose now that we wish to derive *divinity*, *serenity*, *profanity*. In this case we have the derivations of (24):

(24)

divīn+i+ty	serēn+i+ty	profǣn+i+ty	
divin+i+ty	seren+i+ty	profæn+i+ty	RULE (19b)

The initial forms are again from the lexicon. The second line derives from the first line by the rule that makes stressed vowels lax when they are followed by a nonfinal unstressed syllable. The full phonetic detail again follows by other rules that do not concern us now.

All of the cases that exemplify the $I \rightarrow i$, $E \rightarrow e$, $A \rightarrow$ æ alternations are handled in the same way.

Let us now turn to the cases that motivated the $i \rightarrow I$, $e \rightarrow E$, æ $\rightarrow A$ alternations discussed in connection with rules (16)–(17). Consider the forms *vary*, *manager*, *algebra*. The vowel in the final syllable of these words in isolation is derived directly from the lexical

[19] Notice, incidentally, how well the problem of representing the sound pattern of English is solved in this case by conventional orthography. Corresponding to our device of capitalization of a graphic symbol, conventional orthography places the symbol *e* after the single consonant following this symbol ([e] being the only vowel which does not appear in final position phonetically—see Chapter Three, note 22). In this case, as in many other cases, English orthography turns out to be rather close to an optimal system for spelling English. In other words, it turns out to be rather close to the true phonological representation, given the nonlinguistic constraints that must be met by a spelling system, namely, that it utilize a unidimensional linear representation instead of the linguistically appropriate feature representation and that it limit itself essentially to the letters of the Latin alphabet. (See also note 44, Chapter Two.)

representations in (25) without application of any of the rules we are now considering:[20]

(25)

vāri	mænæger	ælgebræ

To derive the forms *variety*, *managerial*, *algebraic*, we proceed as follows:

(26)

vāri+i+ty	mænæger+i+æl	ælgebræ+ic	
vārī+i+ty	mænægēr+ī+æl	ælgebrǣ+ic	RULE (20)
vārīyity	mænægēyrīyæl	ælgebrǣyic	RULE (21)
vārǣyity	mænægīyrīyæl	ælgebrēyic	RULE (22)

By other familiar rules, not here relevant, we derive the full phonetic forms.

To appreciate further the scope and interplay of these rules, consider the class of polysyllabic words ending in *-ate*, with the antepenultimate syllable receiving main stress (see Chapter Three, Section 4). Consider, in particular, the character of this stressed vowel, which appears in the context:

(27)

$$\text{——}\, C_j^i V C_m^n \bar{æ} t \#$$

Suppose first that $m \geq 1$; i.e., there is at least one consonant before *-ate*. Suppose also that $i = j = 0$; that is, the stressed vowel appears prevocalically. Then rule (20a) will tense this vowel and the Diphthongization and Vowel Shift Rules will apply to it, giving forms such as *violate*, *annihilate*, *aerate*.

Suppose now that $j = 1$; that is, at least one consonant appears directly after the stressed vowel. Then rule (19b) will make the stressed vowel lax, and we will have, typically, words such as *elaborate*, *prevaricate*, *medicate*, *mitigate*.

Finally, suppose that $m = n = 0$ and $i = j = 1$; that is, there is a vowel directly before *-ate*, and the stressed vowel appears in the context:

(28)

$$\text{——}\, C_1^1 V \bar{æ} t \#$$

If, now, the stressed vowel is nonhigh and the following vowel is [i] or [e], the stressed vowel will become tense by rule (20b); hence it will be diphthongized and subject to the Vowel Shift Rule. Thus we have tense vowels in the boldface position in words such as *mediate*, *radiate*, *ingratiate* (compare *gratify*, *gratitude*). If, however, the stressed vowel in the context (28) is high or the vowel following it is not [i] or [e], then rule (20) will not apply, and the stressed vowel will remain lax and hence unaffected by Diphthongization or Vowel Shift. Thus we have *conciliate*, *officiate*, *attenuate*, *insinuate*, *superannuate*, etc.

These examples illustrate how a variety of forms can be generated by quite simple and general rules. It is particularly important to note that by breaking the alternation rules (13), (16) into several steps and by accepting underlying representations in which invariance is violated (e.g., the second vowel in *divIn*, *serEn*, *profAn*), we have been able to avoid the intolerable consequence of stating (14) and (17) as entirely independent and precisely opposed rules. In fact, the Vowel Shift Rule expresses just what is common to these two complex phonological processes, and the rules (19) and (20) express what differentiates them. We

[20] Actually, rule (20a) is applied to make the final vowel of *vary* tense, and rule (21) is applied to diphthongize it. As we have noted, these rules are needed quite apart from anything we are discussing here. The reason for nonapplication of the Vowel Shift Rule in this case and others (see (26)) will be given directly.

We disregard here the problem of determining the tenseness of the vowel in the first syllable of *vary–various–variety* (see also (26)).

have thus, in effect, extracted the Vowel Shift Rule as the generalization underlying both (13)-(14) and (16)-(17).

4.2. ALTERNATIONS OF BACK VOWELS

As we shall see in Section 4.3, the effect of the Vowel Shift Rule on back vowels is precisely parallel to its effect on the nonback vowels (cf. (22)):

(29)

ū	ō	ɔ̄
↓	↓	↓
ɔ̄	ū	ō

Hence, from the lexical entries /pōl/, *pool*, and /gōl/, *goal*, we obtain [pūwl] and [gōwl], respectively, by Diphthongization (21) and Vowel Shift. From the entry /lūd /, *loud*, on the other hand, we obtain [lɔ̄wd] instead of the required [læwd] or [lāwd]. The latter forms will be obtained by special rules adjusting rounding (and, for some dialects, backness and tenseness) of vowels. We postpone discussion of these adjustments until the next section; in the present section our aim is to extend to the back vowels the results of our survey of the effects of tenseness alternations (resulting from rules (19) and (20)).

Among the back vowels we find the following major types of alternations:

(30)

(a) ə–ōw: *Newt**o**n–Newt**o**nian, cust**o**dy–cust**o**dian*
(b) ā–ōw: *verb**o**sity–verb**o**se, c**o**nic–c**o**ne*
(c) ʌ–æw: *prof**u**ndity–prof**ou**nd, ab**u**ndant–ab**ou**nd*

Types (a) and (b) are both found in the case of forms such as *harm**o**ny–harm**o**nious–harm**o**nic*.

In fact, the rules as given above largely accommodate these vowel alternations. Consider the case of the formative *harmon-*. If we enter this in the lexicon in the form /harmən+/ (but see p. 193), we then have the following derivations:

(31)

harmən+y	harmən+i+ous	harmən+ic	
hármən+y	harmón+i+ous	harmón+ic	STRESS ASSIGNMENT RULES
	harmɔ́n+i+ous		RULE (20b)
	harmɔ́wn+i+ous		RULE (21)
	harmów̄n+i+ous		VOWEL SHIFT (29)

The first line represents the lexical forms. The rules of the transformational cycle assign stress in the manner indicated on the second line. Rule (19) applies vacuously. Rule (20b) tenses the boldface vowel of *harm**o**nious*, which occurs before a single consonant followed by [iV]. The Diphthongization and Vowel Shift Rules then convert this tense vowel to its phonetic form [ōw].

The derived form [harmón+ik] deviates from the actually attested pronunciation in the dialect under description. In place of the lax [ə], the dialect has a tense [ā], a fact which we have already provided for with rule (5). We saw in Section 2 that this rule was needed to account for the position of stress and the vowel quality in words such as *recíprocal–reciprócity, frívolous–frivólity, démon–demónic*. We now see that there is independent motivation for this rule, namely, to account for *ōw–ā* vowel alternations, as in *harm**o**nious–harm**o**nic*, for Vowel Shift (29) turns [ɔ̄] in *harm**o**nious*, which derives from lax /ə/ by (20b), into the required [ō].

Consider now the case of the alternation *verb**o**se–verb**o**sity*, for example. The word *verb**o**se* will have the lexical entry given in the top line of (32) (with an underlying tense

vowel to account for the stress on the final syllable in the isolated form), and the derivations will proceed in a straightforward manner, as shown:

(32)

verb+ōs	verb+ōs+i+ty	
verb+ṓs	verb+ṓs+i+ty	STRESS ASSIGNMENT RULES
	verb+ṓs+i+ty	RULE (19b)
verb+ṓws		RULE (21)
verbṓws		VOWEL SHIFT (29)
	verbā́sity	RULE (5)

Finally, consider case (30c), which illustrates the alternation [æw]–[ʌ]. Clearly the underlying form of *profound* must contain a tense /ū/ in stressed position, which by Vowel Shift and adjustment rules becomes [æw] or [āw], exactly as in the case of [læwd] from underlying /lūd/. In the word *profundity*, the tense /ū/ is laxed by rule (19b), but instead of the expected [u] we have phonetic [ʌ] in this position. The grammar must therefore contain a rule turning [u] into [ʌ]. We return to this rule on page 203.

Thus, we see that the major class of alternations of back vowels poses no problems and is already accounted for by the rules we have given for nonback vowels. Superficially, the nonback and back vowel alternations seem to differ, because in one case we have *ē*–*æ*, while in the other we have *ō*–*ā*, instead of what would be the parallel form, *ō*–*ɔ*; but this is simply a consequence of the independently motivated rule (5).

4.3. THE VOWEL SHIFT RULE

In (22) and (29) above, we have summarized the effects of what is without doubt the pivotal process of Modern English phonology, the Vowel Shift. We must now give a formal statement of this process.

It will be recalled that Vowel Shift operates after the tense vowels have been diphthongized by rule (21), which supplies the appropriate glides. As a result, it is necessary for the rule to account only for changes in the quality of tense vowels. For convenience of reference, we summarize these changes once again:[21]

(33)

ī	ū	ē	ō	ǣ	ɔ̄
↓	↓	↓	↓	↓	↓
ǣ	ɔ̄	ī	ū	ē	ō

The simplest account of these alternations is given by the following two-part rule:[22]

(34)

$$\begin{bmatrix} +\text{tense} \\ \text{V} \end{bmatrix} \rightarrow \left\{ \begin{array}{ll} [-\alpha\text{high}] \;/\; \left[\overline{\begin{array}{c}\alpha\text{high} \\ -\text{low}\end{array}}\right] & \text{(a)} \\ [-\beta\text{low}] \;/\; \left[\overline{\begin{array}{c}\beta\text{low} \\ -\text{high}\end{array}}\right] & \text{(b)} \end{array} \right.$$

The first part of the rule applies to nonlow vowels only, with the result that originally high

[21] As noted above, the reflexes [ǣ] and [ɔ̄] of original [ī] and [ū] are subject to further rules (see (37), (39), and (40) below) which adjust backness and rounding (and possibly tenseness) and result in the required [āy] and [āw] or [æw].

[22] The rule as stated applies to tense vowels only; it will later be extended to certain nontense vowels (see Section 4.3.5).

vowels become nonhigh while originally nonhigh vowels become high. In tabular form the effects of part (a) are represented as follows:

(35)

ī	ū	ē	ō	ǣ	ɔ̄
↓	↓	↓	↓	(not applicable)	
ē	ō	ī	ū	ǣ	ɔ̄

An exchange rule also constitutes the second part of the Vowel Shift Rule (34); it affects the nonhigh vowels in the bottom row of (35) and causes them to exchange the values assigned to the feature "low." In (36) we summarize the modifications in the tense vowels that are produced by Diphthongization (21) and Vowel Shift (34) jointly:

(36)

ī	ū	ē	ō	ǣ	ɔ̄	
↓	↓	↓	↓	↓	↓	
īy	ūw	ēy	ōw	ǣy	ɔ̄w	DIPHTHONGIZATION
↓	↓	↓	↓	↓	↓	
ēy	ōw	īy	ūw	(not applicable)		VOWEL SHIFT (a)
↓	↓			↓	↓	
ǣy	ɔ̄w	(not applicable)		ēy	ōw	VOWEL SHIFT (b)

4.3.1. REFINEMENTS AND EXTENSIONS OF THE VOWEL SHIFT RULE

In our presentation of the Vowel Shift Rule, we made a number of tacit assumptions which must now be stated explicitly and properly justified. Several of these questions are of rather narrow scope; nevertheless, they must be dealt with. Furthermore, some fairly complex phenomena will fall into place rather naturally as we proceed.

4.3.1.1. ROUNDING AND BACKNESS ADJUSTMENTS. We have observed that low vowels before glides are subject to a great deal of dialectal variation which we will not attempt to deal with in any detail.[23] In the dialect that we are taking as a prototype, *ride* is phonetically [rāyd] and *loud* is phonetically [læwd]. As noted above, the Diphthongization and Vowel Shift Rules give [ǣy] and [ɔ̄w] as the reflexes of the high vowels [ī] and [ū]. Further rules are then called for to give, finally, [āy] and [æw] for the dialect in question. Thus, in *ride*, the low vowel [ǣ] resulting from Vowel Shift must subsequently become back, while the resulting low vowel [ɔ̄] of *loud* must go from back to nonback, at the same time also becoming nonround and nontense.

The unrounding of the segment [ɔ̄] resulting from Vowel Shift is quite general and cross-dialectal:[24]

(37)

$$\begin{bmatrix} +\text{back} \\ +\text{low} \\ \text{V} \end{bmatrix} \rightarrow [-\text{round}]$$

[23] For some discussion of the matter, see Kurath and McDavid (1961) and Keyser's review (1963).

[24] It might be proposed that rule (37), because of its generality, be directly incorporated in the Vowel Shift Rule. This could be done easily if we were to restate the rule as follows, using the angle notation of Chapter Three, Section 3:

$$\text{V} \rightarrow \left\{ \begin{bmatrix} -\alpha\text{high} \\ \langle -\alpha\text{round} \rangle \end{bmatrix} / \begin{bmatrix} \overline{\alpha\text{high}} \\ -\text{low} \\ \langle +\text{back} \rangle \end{bmatrix}, \quad [-\beta\text{low}] / \begin{bmatrix} \overline{\beta\text{low}} \\ -\text{high} \end{bmatrix} \right\} / \begin{bmatrix} \overline{\quad} \\ +\text{tense} \end{bmatrix}$$

The first part of this rule now states not only that a nonlow tense vowel changes the value of the feature

The second modification undergone by low vowels, as mentioned above, is that those which at this stage of the derivation are nonback appear as back in the output, whereas those that are back at this point in the derivation end up as nonback; that is:

(38) [ǣy] → [ɔ̄y][25] [ǣy] → [āy] [āw] → [æw]

In discussing these facts in Section 3, we treated them as an instance of backness dissimilation contingent upon the backness of the glide. For reasons that will become clear later (see rule (88) on page 215 and the discussion there), it is more appropriate to treat this phenomenon as a shift in backness independent of the backness of the glide. We therefore replace rule (12) with (39):

(39) $$\begin{bmatrix} +\text{low} \\ \alpha\text{back} \\ \text{V} \end{bmatrix} \rightarrow [-\alpha\text{back}] \;/\; \text{——} \begin{bmatrix} -\text{voc} \\ -\text{cons} \end{bmatrix}$$

For dialects which have phonetic [āw] in *loud, cow*, etc., instead of [æw], we can simplify rule (39) by dropping the specification [αback] on the left-hand side of the arrow and replacing the [−αback] on the right-hand side of the arrow with [+back]. For dialects such as we are discussing, which have phonetic [æw] in such words, α is free in (39), and we must add a rule converting [ǣw] to [æ̆w]. This process is actually somewhat more general. Thus in many dialects we also find laxing of [āy] to [ăy] (and, in some, raising of [ăy] to [ʌy]) before nonvoiced segments (e.g., [răyt] or [rʌyt] vs. [rāyd], [lăyf] or [lʌyf] vs. [lāyv]). These two cases of laxing can be accounted for by the supplementary rule (40) (where G stands for a glide):

(40) $$\begin{bmatrix} +\text{low} \\ \text{V} \end{bmatrix} \rightarrow [-\text{tense}] \;/\; \text{——G} \;/\; \begin{cases} \text{——}[-\text{voice}] & \text{(a)} \\ \begin{bmatrix} \text{———} \\ -\text{round} \end{bmatrix} & \text{(b)} \end{cases}$$

The central core of rules consists of rules (19) and (20), which determine tenseness, the Diphthongization Rule (21), and the Vowel Shift Rule (34) adjusted by rule (37). The Vowel Shift Rule and rule (37) are quite general; the supplementary rules (39) and (40) are subject to much dialectal variation. It is only the "true diphthongs" (that is, the low vowels followed by glides) that are subject to these adjustments.

Notice that underlying /ū/ becomes phonetic [æw] in the dialect we have discussed. Thus every feature of underlying /ū/, aside from [+vocalic] and [−consonantal], is modified by the phonological rules. This is an example of maximal violation of invariance, as noted above on page 168.

In Chapter Three (p. 152) we discussed another example of backness adjustment that converts [ā] to [æ], namely, in the boldface position of words such as *Alabama, koala*. This should presumably fall together with the process described by rules (39), (40b).

"high," but also that if the vowel in question is back, it becomes nonround if it was high (and remains round if it was nonhigh). Thus, underlying /ō/ will remain round, but underlying /ū/ will be unrounded as well as lowered.

Although this formulation has some plausibility, we prefer, rather, to separate the unrounding as a distinct process. The reason is that in many cases unrounding takes place quite apart from Vowel Shift, and we will see below that rule (37) generalizes considerably in ways which are incompatible with this formulation.

[25] The diphthong [ɔ̄y], which is the result of the diphthongization of an underlying tense vowel [ǣ], is discussed in detail in Section 4.3.3.

4.3.1.2. ROUNDING AND STRESS. As formulated above, the Vowel Shift Rule (34) applies to all tense vowels, but there are certain restrictions that must be imposed.

First, the Vowel Shift Rule must not apply to [ā] in *father*, *Chicago*, etc., for this vowel is not converted into the corresponding nonlow vowel. The rule must therefore be restricted to the nonback vowels [ī], [ē], [ǣ] and the back vowels [ū], [ō], [ɔ̄], that is, to the nonback vowels that are, furthermore, nonround, and to the back vowels that are round ([ā] being back and nonround); i.e., the Vowel Shift Rule must be restricted so as to apply only to vowels in the context (41):

(41) $$\left[\overline{\begin{matrix}\gamma\text{back}\\ \gamma\text{round}\end{matrix}}\right]$$

A second adjustment necessary in the Vowel Shift Rule is motivated by examples such as *various*, *variety*, which we considered above. In both of these forms, we have occurrences of the tense vowel [ī] at the stage of derivation at which the Vowel Shift Rule applies. That is, we have at this stage the forms of (42) for *various*, *variety*, respectively:

(42) (a) [vǽrī+ɔs]
(b) [vǽrí+i+tī]

Of the three occurrences of [ī] in these forms, only the one which is stressed undergoes Vowel Shift. In general, we must limit the Vowel Shift Rule to tense segments which have the feature [+stress]. Tense vowels with the feature [−stress] will be reduced to [ə], except when they are prevocalic or final (see rule (20)); and in these positions they must be excluded from the application of the Vowel Shift Rule.

Summarizing these adjustments, we can now give the Vowel Shift Rule in the nearly final form (43):

(43) $$\begin{bmatrix}\gamma\text{back}\\ \gamma\text{round}\end{bmatrix} \rightarrow \left\{\begin{matrix}[-\alpha\text{high}] \;/\; \left[\overline{\begin{matrix}\alpha\text{high}\\ -\text{low}\end{matrix}}\right]\\ [-\beta\text{low}] \;/\; \left[\overline{\begin{matrix}\beta\text{low}\\ -\text{high}\end{matrix}}\right]\end{matrix}\right\} \;/\; \left[\overline{\begin{matrix}+\text{tense}\\ +\text{stress}\end{matrix}}\right]$$

Notice that even weak-stressed tense vowels will undergo Vowel Shift since they are in the category [+stress]. For example, tense vowels in the context $\#C_0$——$C_0\overset{1}{V}$ receive secondary (ultimately, tertiary) stress by the Auxiliary Reduction Rule discussed in Chapter Three, Section 14, and formulated finally as (120d) of that chapter. The Auxiliary Reduction Rules precede the Vowel Shift Rule. Therefore, we have Vowel Shift in the first syllable of words such as *Crimea*, *Siam*, *reality*, *gradation*. Examples such as *Siam*, *reality*, incidentally, indicate that the Auxiliary Reduction Rule assigning secondary stress must apply after the Tensing Rule (20), as noted on page 124 of Chapter Three.

4.3.2. FINAL WEAK-STRESSED [o]

The fact that the Vowel Shift Rule applies only to those tense vowels that are stressed enables us to give a very simple account of a well-known and otherwise quite mystifying phenomenon of English phonetics, namely, that there is, in many dialects, a contrast between final zero-stressed phonetic [ōw], as in *mótto*, and final tertiary-stressed phonetic [ōw], as in *vétò*. A consequence of the stress difference in these dialects is a contrast between the aspirated [t] of *veto* and the alveolar flap [D] of *motto*—thus we have the phonetic contrast

[vī$\overset{1}{\text{y}}\overset{3}{\text{t}}^{\text{h}}$ō$\overset{}{\text{w}}$] vs. [m$\overset{1}{\text{ā}}$Dōw]. Given the general predictability of stress, it would be very curious if a tertiary–zero stress contrast were phonologically distinct in this one position. Consequently, it seems likely that the phonetic contrast in stress can be attributed to some phonological distinction of vowel quality. The question arises, then, as to whether there is some vowel V* that does not appear phonetically in final position and that is similar in feature composition to [ō] so that a simple rule will convert it to [ō] when stressed. If such a vowel is found, we can provide the grammar with the following rules:

(44) (a) V* → [3 stress] / —— #
(b) V* → ò

Then *veto* can be given the underlying representation /vētV*/, and *motto* the representation /mɔto/. Rules (44), together with the rule (20a) tensing final vowels, the Diphthongization Rule (21), and a rule that turns /t/ into the flap [D] intervocalically before unstressed vowels will give the correct contrasting phonetic forms.

Rules (44), however, are quite ad hoc and hardly preferable to a recognition of tertiary stress as phonologically distinctive in this position, strange as this conclusion would be. One is naturally led, therefore, to try to select V* in such a way that rules (44) are independently motivated. Suppose, in fact, that we were to take V* as phonological /ɔ/, so that *veto* is represented /vētɔ/. Then the final vowel of *veto* receives tertiary stress by rule (44a), is tensed by rule (20a), diphthongized by rule (21), and raised to [ǒw] by the Vowel Shift Rule. Vowel Shift, as we observed, applies to vowels only if they have the feature [+stress]; thus, it will apply to the final vowel of *veto* but not to that of *motto*, given the above analysis. Hence rule (44b) is superfluous and can be dropped from the grammar, leaving only the following rule:

(45) ɔ → [3 stress] / —— #

This improves matters. However, we may still ask whether there is any independent justification for (45). In fact, there is. Notice, first of all, that final phonetic [ɔ] does not appear, for it would be reduced to [ə] by the Vowel Reduction Rule, which applies to lax low vowels. If [ɔ] were treated like [æ] by the Tensing Rule (20a), we would expect to find back alternations analogous to *algebra–algebraic*; that is, we would expect to find pairs of the form [...Cə]–[...Cōwik]. There are no such pairs (although we do have *hero–heroic*, *echo–echoic*, etc., with final [ō]). To explain this gap, we would need some rule that excludes final [ɔ] from the domain of the Vowel Reduction Rule. But (45) does precisely this, and thus has some independent motivation. Hence there is a quite simple and independently justified explanation for the [ǒw#]–[ǒw#] contrast.

Notice that rule (45) must precede the Tensing Rule (20a), so that the final vowel will be tensed.

4.3.3. THE DIPHTHONG [ɔ̄y]

English has three "true" diphthongs phonetically, namely, [āy] (*ride*), [æw] (*loud*), and [ɔ̄y] (*coin*) (with their variants and several dialectal forms). Of these, we have so far accounted only for the first two. We now turn our attention to the phonological representation of phonetic [ɔ̄y].

Notice first that we have no vowel-glide sequences in the lexicon so far since [æw] and [āy] derive from /ū/ and /ī/, respectively. Hence the lexical redundancy rules will be much simplified if we can represent [ɔ̄y], too, as a monophthong V* on the lexical level. The optimal

solution would be to take V* as some vowel which fills a gap in the phonological system and which is converted to phonetic [ɔ̄y] by independently motivated rules. In fact, this optimal solution can be attained in this case.

To see this, observe that we do have the Diphthongization Rule (21) which inserts a glide after a tense vowel. To account for the glide of [ɔ̄y], we must, therefore, take V* to be some tense vowel to which the *y*-glide can be attached by rule (21). Since a *y*-glide is inserted by this rule only after a nonback vowel, we must take V* to be nonback, which means it cannot be [ɔ]. The vowel of phonetic [ɔ̄y] is low and round; therefore, if we are to avoid adding new rules to the grammar, we must take the underlying vowel V* to be low and round as well. We are thus led to the conclusion that V* should be the tense, nonback, low, round vowel, that is, [ǣ]. In further support of this conclusion is the observation that [ǣ] in fact constitutes an otherwise unexplained gap in the phonological pattern, since the other three tense low vowels (namely, [ǣ], [ā], [ɔ̄]) do appear in lexical matrices.

Suppose, then, that we take the form /kǣn/ as the underlying lexical entry for *coin*, thus filling this gap in the phonological pattern. By the Diphthongization Rule (21), /kǣn/ → [kǣyn]. The Vowel Shift Rule, amended above as (43), applies only to vowels which are the same in backness and rounding. Consequently, it does not apply to [ǣ], which is round but nonback, just as it does not apply to [ā], which is back but nonround. We now require a rule which will convert [ǣ] to [ɔ̄], that is, a rule which makes this vowel back. But we already have such a rule in the grammar, namely, rule (39), which, in effect, makes a tense low vowel back before a nonback glide; hence it converts [ǣ] to [ɔ̄], just as it converts [ǣ] to [ā], before [y]. Thus it turns out that the grammar already contains rules that account for [ɔ̄y] from an underlying monophthongal segment [ǣ], which, furthermore, fills a gap in the phonological pattern.[26]

As we have noted several times, the segment [ǣ] which underlies [ɔ̄y] is not subject to laxing (e.g., in *exploitative*). Thus we must either restrict the Laxing Rule, like the Vowel Shift Rule, to segments which are the same in rounding and backness, or add a special adjustment to the Tensing Rule so that it always tenses [æ].

4.3.4. PREVOCALIC *y*-GLIDES

We have not yet accounted for the "vocalic nucleus" [yūw] that appears phonetically in words such as ***pure***, ***cu****taneous*, *acc****u****se* in the boldface position. As in the case of phonetic [ɔ̄y], which we discussed above, there is strong motivation for regarding this as phonologically unitary. We need not concern ourselves about the final [w] of [yūw]; this will be introduced by the Diphthongization Rule. The problem, rather, concerns the [y] preceding the vowel. If this is not introduced by some phonological rule, then the underlying representations of words such as *pure*, *cube* must be of the form CGVC. This conclusion would force us to give up several otherwise valid generalizations concerning consonant-glide-vowel sequences in underlying representations; for example, the following:

(46)

(a) G → w / C——V
(b) C → [−nasal] / ——G
(c) [+ant] → [+cor] / ——G
(d) C → [−ant] / s——G

[26] Since contemporary English differs from its sixteenth or seventeenth century ancestor in the fact that it no longer admits phonological diphthongs—i.e., sequences of tense low vowels followed by lax high vowels—in its lexical formatives, [ǣ] is the proper representation for what historically was the diphthongal sequence [ɔ̄y]. For further discussion of this point, see Section 5 of Chapter Six.

$$\text{(e)}\quad \begin{bmatrix} +\text{voc} \\ -\text{cons} \\ -\text{low} \end{bmatrix} \rightarrow [-\text{back}] \;/\; [-\text{cont}]\,\text{G}\text{——}$$

Case (a) permits *twist, dwell, twang, quote, quarry*, etc., but excludes [y] in the position of the [w] of these words. However, we have [y] in phonetic [Cyūw]. Case (b) excludes forms such as **nwist*, **nwell* (alongside of *twist, dwell*); but we have *new* ([nyūw])[27] and so on regularly with [+nasal] [y]. Case (c) explains the inadmissibility of **pwin*, **bwell*, **mwist* (compare also case (b)), and so on, but would be falsified by *pure, muse, abuse*. (We shall see that case (c) need not be restricted to anterior consonants when we turn to a more careful study of glides.) Case (d) permits forms such as *square, squint, squall*, but not **stware*, **stwint*. On the other hand, we have *stew, fistula*, and so on. Case (e) excludes phonological forms such as /kwōt/, /kwūt/, which would eventuate as phonetic *[kwūwt], *[kwæwt] (or *[kwāwt]), respectively, by the Diphthongization and Vowel Shift Rules, while permitting phonological /kwēr/, /kwīt/, which become [kwīyr] (*queer*), [kwāyt] (*quite*), respectively. But it would be contradicted by *cube, accuse*, and numerous other such forms.

In short, consideration of lexical redundancy rules provides strong motivation for regarding phonetic [yūw] as a reflex of some unitary phonological segment, and we shall see directly that there are other, independent sources for this conclusion.

Let us consider, then, the question of whether there is some reason, apart from lexical redundancy rules, for adding to the grammar at some point the rule:

$$\text{(47)}\qquad \phi \rightarrow \text{y} \;/\; \text{——} \begin{bmatrix} \alpha\psi \\ +\text{high} \\ +\text{back} \\ \text{V} \end{bmatrix}$$

where ψ is some feature that differentiates the cases of high back vowels before which [y] will be inserted from those before which it will not be inserted. Notice that whether (47) precedes or follows the Vowel Shift, some such discrimination must be made.

There are certain lexical items that have high vowels, either back or nonback, as "stem-forming augments" (see Chapter Three, pp. 129–30). Such items might be introduced into the lexicon as in (48):[28]

$$\text{(48)}\qquad \begin{array}{l} /\text{hæbit}+\text{u}/ \\ /\text{perpet}+\text{u}/ \\ /\text{prə}+\text{verb}+\text{i}/ \\ /\text{pre}=\text{sīd}+\text{ent}+\text{i}/ \end{array}$$

The stem-forming augment drops except before certain affixes (*-al, -ous, -ate, -ity*) by an early rule (possibly a lexical rule). Thus we have *president–presidential* (with [ti+V] going

[27] In some dialects, the effect of this and several other rules that we will mention is masked in certain forms by the fact that a later rule deletes [y] in certain positions after dentals and palatals, so that *new* would be [nūw]. Such dialects may also contain pairs such as *constitutive* ([kənstíčətiv], with [č] from [ty]) vs. *constitute* ([kánstətūt]), *residual* ([rəzíjūwəl], with [j] from [dy]) vs. *residue* ([rézədūw]), and so on. For simplicity of exposition, we dismiss this possibility from consideration here, returning to a discussion of it in Section 6.

Observe that the different cases of (46), as usual, have marginal exceptions, e.g., *ennui* (case (b)), *pueblo* (case (c)). Our formulation of redundancy rules will not include the rules of (46) as given, but these do remain as valid generalizations about formatives, and this is all that is necessary for the present argument.

[28] Notice that there are many obvious generalizations—e.g., the suffixes *-ent, -or*, and others are automatically followed by the augment [+i].

to [š+V] by rules that we describe in Section 6), *proverb–proverbial, habit–habitual–habituate, perpetual–perpetuity–perpetuate*, etc.

Our concern here is with the stem-forming augment [+u]. But consider first its nonback analog [+i]. When unstressed, this vowel is tensed by rule (20) and appears as phonetic [īy], as in *proverbial*. When stressed, it undergoes Vowel Shift after being tensed by rule (20) and appears as phonetic [āy], as in *sobriety, propriety*. This is straightforward in terms of the processes that we have already discussed.

Consider now the stem-forming augment [+u]. We would expect it to behave exactly as its counterpart does, that is, to become phonetic [ū] when unstressed and phonetic [æw] when stressed. But this is not what we find; rather, in both stressed and unstressed positions we have [yūw] (*ambiguous, ambiguity*). Thus stem-forming [+u] is peculiar in two respects: it has a *y*-glide inserted before it, and it does not undergo Vowel Shift where it would be expected to do so.

How are these two facts related? If they are to be related, there must be some segmental feature that is automatically assigned to stem-forming [+u] (but not to certain other occurrences of [u] or [ū]) that exempts it from the Vowel Shift while at the same time requiring rule (47) to apply to it, prefixing to it a *y*-glide. Notice that the augment [+u] is always prevocalic and therefore tensed by rule (20). Rule (47) thus inserts a [y] before some tense vowel that differs from [ū] in the feature ψ. Apparently, then, the stem-forming augment [+u] must be specified as [$\alpha\psi$], whereas [ū] is [$-\alpha\psi$]. We are then faced with the problem of determining ψ in such a way that when a high back vowel is [$\alpha\psi$], it is exempt from the Vowel Shift Rule. If this is possible, then stem-forming [+u] will not only be supplied with a preceding *y*-glide by rule (47), but will also be excluded from the Vowel Shift, as required.

We have already observed that for a tense stressed vowel to be exempt from Vowel Shift, it must not be the same in rounding and backness. Since stem-forming [+u] is tense and stressed in forms such as *ambiguity* (which are the crucial ones in this connection), we see that to be exempt from Vowel Shift it must be not [ū] phonologically but rather the corresponding unrounded vowel [ɨ] or the corresponding nonback vowel [ü]. But we know that the vowel in question receives a postvocalic *w*-glide, which is inserted by the Diphthongization Rule (21) only after back vowels. Therefore the vowel must be back, namely, [ɨ]. We see, then, that the feature ψ must be "round," and that the augment [+u] must receive the feature [−round] which differentiates it from ordinary [ū] and prevents it from undergoing Vowel Shift when stressed and tensed. Thus $\alpha\psi$ in (47) must be [−round].

Summarizing, then, we have the following rules:

(49) $$u \rightarrow [-\text{round}] \quad \text{in some context}$$

(50) $$\phi \rightarrow y \; / \; \text{——} \begin{bmatrix} +\text{tense} \\ -\text{round} \\ +\text{high} \\ +\text{back} \\ V \end{bmatrix}$$

(51) $$ɨ \rightarrow [+\text{round}]$$

Rule (49) must precede the Vowel Shift Rule; rule (51) must follow the Vowel Shift Rule. We will determine the position of rule (50) directly.

It remains to establish the context for rule (49). Recall that we have already discussed a rule that converts /u/ to [yūw] in words such as *Neptune* (see Chapter Three, Section 16). This rule tenses /u/, inserts a *y*-glide in front of it and a *w*-glide after it, and prevents it from undergoing Vowel Shift (as in *neptunian*, for example, which does not become *[neptǽwnEən]). As we have already noted, this process applies in the context —— CV. If we now generalize it to the context —— C_0^1V, it will apply to the stem-forming augment [+u], which is always prevocalic. We therefore restate rule (49) as (52):

(52) $$u \rightarrow \begin{bmatrix} +\text{tense} \\ -\text{round} \end{bmatrix} / \text{——} C_0^1V$$

Rules (52), (50), Diphthongization, and (51) now convert underlying /u/ to phonetic [yūw] in the boldface position of words such as *cube*, *annual*, *Neptune*, *ambiguity*. Rule (52) belongs together with the Tensing Rules (20). Words such as *menu*, *value*, *cue*, *fuel* will be represented lexically as /menue/, /vælue/, /kue/, /fuel/. We thus, incidentally, account for the fact that the first syllable in words such as *menu*, *value*, *tissue*, *issue*, *nephew*, *sinew* has a lax vowel. Laxing here results from the application of rule (19b), the trisyllabic laxing rule (the only exception being *Hebrew*). Phonetic contrasts such as *cow–cue*, or *foul–fuel–mule* ([fæwl]–[fyūwəl], [myūwl]) do not require new phonological segments; rather, they result from the lexical contrasts /ku/–/kue/, /fūl/–/fuel/–/mule/. Words such as *immune*, *commute*, *inure*, *cutaneous* will be derived from the underlying forms /imune/, /kəN=mute/, /inure/, /kutæni+əs/, respectively.

The stem-forming augments [+i] and [+u] may be represented phonologically simply as [−back] and [+back], respectively. Augments are redundantly vocalic, high, and lax. Rounding redundantly corresponds to backness for lax vowels. The augments are tensed by rule (52) or (20a) and achieve their final phonetic forms (as [īy] or [āy], or [yūw]) by other rules that we have already discussed. Thus for a word such as *ambiguity* we will have the following derivation:

(53)

æmbig+[+back]+ity	
æmbig+u+ity	READJUSTMENT RULES
æmbig+ī+ity	RULE (52)
æmbig+īw+ity	DIPHTHONGIZATION (21)
æmbig+yīw+ity	RULE (50)
æmbig+yūw+ity	RULE (51)

Rule (52) is restricted to lax [u]. This is, in fact, a necessary restriction. It prevents *espousal* /espūs+æl/, *avowal* /ævū+æl/ from becoming *[espyūwzəl], *[əvyūwəl], for example.

Notice that phonetic [yūw] cannot occur before a double consonant, since it can arise only by rule (52) (but see Chapter Five, note 3). This excludes forms such as *[myūwnt] or *[pyūwnd]; rather, the reflex of underlying /ū/ in this position will always be [æw] (or [āw]), as in *mount*, *pound*.

There are certain redundancies involving phonological /u/ that deserve mention. As is well known, labials do not occur after phonetic [æw]; that is, we have *cube*, *dupe*, *fume*, but no such words as *[kæwb], *[dæwp], *[fæwm].[29] Actually, the restriction is more general: velars do not occur in this position either. That is, we do not have such forms as

[29] This rule has long been familiar to students of the historical phonology of English; see, e.g., Jespersen (1909, Section 8.23): "Before lip consonants we do not get the [[au]—NC/MH] diphthong."

*[dæwk] or *[hæwg] alongside of *duke* or *huge* (from underlying /huge/). We might account for these observations with a redundancy rule to the effect that:

(54) $$C \rightarrow [+\text{cor}] \;/\; \bar{u} \text{——} [-\text{seg}]$$

Thus noncoronal consonants will occur after /ū/ only before vowels (in which case $u \rightarrow U$); they cannot occur before consonants because of the restriction on tense vowels before clusters (see rule (8) and the related discussion on page 172).

Another phenomenon relevant at this point is illustrated by a comparison of forms such as *table–tabular–tabulate*, *constable–constabulary*, *angle–angular–triangulate*, *fable–fabulous*, *title–titular*, *miracle–miraculous*, *circle–circulate*. Evidently, in nouns and stems that are subject to derivational processes (see pp. 173–74), phonetic [yūw] appears in a final stop-[l] cluster when certain affixes follow. Thus we must have rules with the effect of (55):

(55) $$\phi \rightarrow \text{yūw} \;/\; \begin{bmatrix} -\text{cont} \\ -\text{voc} \\ +\text{cons} \end{bmatrix} \text{——} 1{+}\text{VC}\,[-\text{seg}]$$

For the moment, let us simply take (55) as the required rule. We see, then, that it will convert [tæbl+ær] to [tæbyūwl+ær]. The segment [æ] of the latter form will be made lax by rule (19b) (which, as a result of the required ordering of the rules—see (57) below—will apply when the representation is [tæbul+ ær]). We will have, then, [tæbyūwlər] (*tabular*), contrasting with [tēybl̩] (*table*), in which the segment [æ] has become [ēy] by Diphthongization and Vowel Shift, and the liquid has become syllabic by processes described in Chapter Three, pages 85–86. The other examples of this sort cited above can be taken care of in the same way.

We already have a rule that inserts [y] before [ī] (originally [u]), namely, (50). Therefore we may simplify (55) to (56):[30]

(56) $$\phi \rightarrow \text{u} \;/\; \begin{bmatrix} -\text{cont} \\ -\text{voc} \\ +\text{cons} \end{bmatrix} \text{——} 1{+}\text{VC}\,[-\text{seg}]$$

We assume the following ordering:

(57)
(a) Rule (56)
(b) Laxing Rule (19)
(c) Tensing Rule (52) (u → ī)

[30] Note that (56) does not insert a vowel before the [l] in words such as *legislate* because a continuant rather than a stop precedes the [l]. It also will not apply when [l] precedes suffixes such as: *-age* (as in *assemblage*), which is phonologically [æge]; *-ify* (as in *amplify*), which is phonologically [i+fīk] (see Section 4.3.5, p. 201); the comparative and superlative (*nobler*, *noblest*) if we regard these as having the characteristic # boundary of elements adjoined by transformation at the stage when (56) applies; *-ance*, *-ly*, etc. (*resemblance*, *capably*) because of their phonological shape. It does apply before the major affixes *-ate*, *-al*, *-ous*, etc. (Note that *-ar* is, with rare exceptions, simply the variant of *-al* after [l].)

As noted above, however, it is only the nouns and stems subject to derivational processes to which this rule applies. Thus it does not apply to agentive *-er* (*gambler*, *peddler*, *angler*, contrasting with *angular*).

Notice that rule (56) might also be used to account for the occurrence of [yə] in nouns ending in [l] followed by *-a*, *-us*, *-um* (e.g., *formula*, *modulus*, *curriculum*) as an alternative to considering this to be an inherent vowel. This is plausible since it would account for the overwhelming predominance of [U] over other vocalic nuclei in this position.

Another possibility, for all such cases, is to regard the [u] as an inherent vowel in the lexical entry, dropping rule (56). We see little to choose between these alternatives, and will simply continue, arbitrarily, with the assumption in the text.

(d) *y*-Glide Insertion (50)
(e) Diphthongization (21)
(f) Vowel Shift (43)
(g) Rounding Rule (51)

This will give the following derivation for *tabular*, for example:

(58)

$\overset{1}{\text{t}}\bar{\text{æ}}\text{bl}+\text{ær}$	FIRST CYCLE
$\overset{1}{\text{t}}\bar{\text{æ}}\text{bul}+\text{ær}$	RULE (57a)
$\overset{1}{\text{t}}\text{æbul}+\text{ær}$	RULE (57b)
$\overset{1}{\text{t}}\text{æb}\bar{\text{i}}\text{l}+\text{ær}$	RULE (57c)
$\overset{1}{\text{t}}\text{æby}\bar{\text{i}}\text{l}+\text{ær}$	RULE (57d)
$\overset{1}{\text{t}}\text{æby}\bar{\text{i}}\text{wl}+\text{ær}$	RULE (57e)
$\overset{1}{\text{t}}\text{æby}\bar{\text{u}}\text{wl}+\text{ær}$	RULE (57g)
$\overset{1}{\text{t}}\text{æby}\bar{\text{u}}\text{wlər}$	VOWEL REDUCTION

This derivation seems accurate for fairly careful speech, in which the medial vowel is rounded. Suppose, however, that we wish to account for the variant [tæ̀byələr]. We might add a special ad hoc laxing rule such as (59), which would apply only to this vocalic nucleus and would follow (57d) and precede (57e):

(59)

$$\bar{\text{i}} \rightarrow [-\text{tense}] \;/\; \left[\frac{\quad}{-\text{stress}}\right]$$

This rule would subject the medial vowel of *tabular* to the Vowel Reduction Rule, which applies to minus-stressed lax vowels (see Chapter Three, rule (121), p. 126), so that the derivation (58) would terminate with [tæbyələr]. The same rule would apply in forms such as *commutation*, *accusation*, where [U] derives from an original /u/, giving $\overset{1}{\text{[kāmyətAšən]}}$, $\overset{1}{\text{[ækyəzAšən]}}$ as possible variants. Recall that in these words we have *commute*, *accuse* at the termination of the first cycle, but in the second, word-level cycle the vowel in the second syllable becomes [−stress] by the Auxiliary Reduction Rule (118) of Chapter Three (which falls together with (57b) above) after the various stress placement rules have applied. Rule (57c) makes this vowel [+tense], permitting *y*-glide insertion by (57d). The application or nonapplication of (59) will therefore determine whether the phonetic form is [kāmyətAšən] or [kāmyūwtAšən], and so on.

There is more to the matter of reduction of [U] than these remarks indicate. Thus we have reduction in the boldface position of *nature*, *fortune*, *cómmunal*, as well as (optionally) in the examples given above, but not in *Neptune*, *commune*, for example. However, we have not been able to determine precisely what the correct form of (59) should be.

Of the rules listed in (57), all are rules of word-level phonology. In view of the uncertain status of VC*l* as a strong cluster (see Chapter Three, pp. 83, 140, and note 82), we have placed (57a) (= (56)) before the stress rules. We know that the underlying form of *miraculous*, for example, must be /mirækl+əs/. The position of main stress in the noun *míracle* indicates that the second vowel is phonologically lax. Thus, if /Vkl/ is a weak cluster, the vowel [u] must be inserted in the second cycle prior to the application of the stress rules, or we would derive **míraculous*. If /Vkl/ is a strong cluster, there is no such compelling need to impose this ordering, but it does not result in any incorrect forms. Since the Laxing Rule (57b) (= (19)) depends on the position of stress, it must follow the stress assignment rules. Rule (57c), which tenses the inserted segment [u], must also follow

the stress assignment rules or we will derive **miracúlous*. Therefore the ordering of the rules is determined by several considerations to be as in (57), with the rules of stress assignment following (57a) and preceding the other rules of (57).

Summarizing, we see that there is good evidence to support the conclusion that all of the English vocalic nuclei that we have so far considered are phonologically monophthongal. Phonetic [īy], [ēy], [āy], [ūw], [ōw], [æw] (with their various dialectal and stylistic variants) derive from underlying /ē/, /ǣ/, /ī/, /ō/, /ɔ̄/, /ū/, respectively, by Diphthongization, Vowel Shift, Rounding Adjustment, and Backness Adjustment. Phonetic [ā] (which may have an off-glide which we discuss in Section 4.3.6) derives from underlying /ā/, which does not undergo Vowel Shift. Phonetic [ɔ̄y] derives from underlying /ǣ/, the fourth possible low vowel, by Diphthongization and Backness Adjustment (Vowel Shift being inapplicable). Phonetic [yūw] (or [yə]) derives from underlying /u/ in the context —— C_0^1V. We can then preserve the generalizations regarding consonant-glide strings illustrated in (46). The rules of this section account for alternations such as *table–tabular*; the occurrences of phonetic [yūw] in forms such as *ambiguous*, *ambiguity*, instead of phonetic [ūw] (paralleling the [īy] of *proverbial*) or phonetic [æw] or [āw] (paralleling the [āy] of *sobriety*); the occurrence of phonetic [yūw] as a reflex of phonological /u/ in *fume*, *cutaneous*, and so on; the occurrence of phonetic [æw] or [āw] as a reflex of underlying /ū/ in *profound*, *mountain*, *pound*, and the impossibility of phonetic [yūw] in these positions; the impossibility of phonetic [æw] or [āw] before noncoronal consonants.

The rules summarized in (57) account for a few other apparently exceptional phenomena. For example, Jespersen remarks (1909, Section 4.73): "the three syllable rule [our rule (19b)—NC/MH] does not apply to [iu] = F *u* (or Latin *u*)"; and cites, among other examples: *credulity*, *community*, *obscurity*, *lunacy*, *scrutiny*. These examples now fall together with such apparent counterexamples to trisyllabic laxing as *mediate*, *radiate*, *ingratiate* (see p. 185). In all cases we have laxing by rule (19b) and subsequent tensing (by (52) in the case of [u]; by (20b) in the other cases). In the same way we account for the tenseness of the first vowel in words such as *mutual*, *usual*, *uvula*. Similarly, the fact that [U] does not reduce to [ə] in *commutation*, *communism*, etc., as noted in Section 14 of Chapter Three (see p. 122), is a consequence of the Tensing Rule that applies after the Auxiliary Reduction Rule which falls together with the Laxing Rule.

Consider, next, pairs such as *sulfur–sulfuric*, *talmud–talmudic*, *cherub–cherubic*. The vowel of the second syllable must be lax in the phonological representation, as we can see from the position of main stress in the simple form. The fact that we have a tense vowel in this position in the derived forms is explained by rule (52).

There is one problem in this analysis of [yūw] that must still be dealt with, however. Consider words such as *avenue*, *revenue*, *residue*, *continue*, which terminate with [yūw] (or, in the case of *residue*, with [dūw], in some dialects, for reasons that we will discuss in Section 6). As matters now stand, the underlying lexical representation must be /ævVnue/, /revVnue/, /re=sidue/, /kəN=tinue/. (In the case of *residue*, the medial vowel might be tense; the = boundary is required to account for the voicing of [s], as we shall see in Section 5.) But the stress placement rules, as given in the last chapter, will assign to these words the stress contours **avénue*, **revénue*, **resídue*, **continúe*. That is, in the case of the three nouns, the Main Stress Rule (Chapter Three, rule (102), p. 110) will exclude from consideration the final lax vowel /e/ and assign primary stress under case (i) to the syllable before the weak cluster /u/; and in the verb *continue*, the primary stress will be placed by case (i) of the Main Stress Rule on the vowel immediately preceding the weak cluster /e/.

Within the framework so far developed, we can account for this arrangement of facts only by treating the source of final [yūw] in these words as a weak cluster, that is, as a string of the form VC_0^1; if the words *avenue*, *revenue*, *residue*, *continue* are represented as /ævenφ/, /revenφ/, /re=sidφ/, /kəN=tinφ/, where φ is a weak cluster, then the stress contours will be assigned in the correct way. In the case of *avenue*, *revenue*, the final weak cluster φ will then be omitted from consideration under condition (b) of the Main Stress Rule, and primary stress will be placed on the first syllable of the residual string, its second syllable being weak. In the case of *residue*, the final cluster φ will be omitted from consideration in the same way, and primary stress will be placed on /sid/, the = boundary preventing stress assignment to /re/ under case (i). Under condition (c), the Stressed Syllable Rule, primary stress is shifted to the left, giving [$\overset{1}{\text{re}}=\overset{2}{\text{sid}}$φ], the string [$=\overset{1}{\text{sid}}$φ] being omitted from consideration, as is permitted by this rule. The other rules then give the form [$\overset{1}{\text{rez}}$əd(y)ūw], as required. The verb *continue* will receive primary stress on the second syllable in the usual way, under condition (e) of the Main Stress Rule, by case (i), which places stress before the weak cluster φ.

The analysis presented earlier failed because φ was not a weak cluster, but was rather the phonologically bisyllabic element /ue/. We must therefore revise this analysis in such a way as to assign the words in question a weak cluster in the position of φ. There are two ways to achieve this result. The first would be to take φ to be not /ue/, as before, but rather /uɛ/, where [ɛ] is the glide corresponding to [e], that is, the segment with the features [−vocalic], [−consonantal], [−back], [−high], [−low]. This decision requires only one change in the rules given earlier: we must rephrase rule (52) so that [u] becomes [ī] in the context ——C_0^1[−consonantal], that is, before a vowel or a glide. Since this is a simplification of the rule, we would make the modification in any event. Furthermore, we have already had occasion to make use of /ɛ/ in the lexicon (see Chapter Three, Section 16, p. 161).

The second alternative is to take φ to be /u/, and to modify rule (52) so that it converts [u] to [ī] either in the context ——C_0^1[−consonantal] or in the context —— #. Under this modification, φ will be a weak cluster and stress will be assigned properly.

We see little to choose between these alternatives. Rather arbitrarily, we will accept the assumption that /uɛ/ is correct, for expository purposes, leaving a more principled resolution of the problem to a deeper study.

Notice that we can regard all instances of final /ue/ as /uɛ/. We have made use of the bisyllabic character of /ue/ for only one purpose, namely, laxing of the first vowel in *value*, *tissue*, etc. But quite apart from the analysis of [yūw], we would have to give the context for trisyllabic laxing in the simplest form: $C(C+)\begin{bmatrix}+\text{stress}\\ V\end{bmatrix}C_0$[−consonantal]; and in this form, it applies to the first vowel of [vælueɛ], etc. Notice also that the choice of /uɛ/ requires a complication of condition (b) of the Main Stress Rule, which omits from consideration a final string of the form φ[+consonantal]$_0$, where φ is an unstressed lax vowel or glide (see p. 133). To cover the case [uɛ], we must replace φ[+consonantal]$_0$ by $\varphi\begin{Bmatrix}[+\text{consonantal}]_0\\ [-\text{vocalic}]_0^1\end{Bmatrix}$. A form such as [re=siduɛ] falls under the second of these conditions in two ways, first with the omitted string being [uɛ] and second with the omitted string being [ɛ]. If the rules are to apply properly, these two cases must be disjunctively ordered and the first must apply before the second. This is provided for by our present system of notations. Notice that φ[−vocalic]$_0^1$ is an abbreviation for two cases, φ[−vocalic] and φ, applying in that order. Since [uɛ] falls under the first of these, the second will never apply to the forms in question.

Notice also that in a derived form such as *residual*, no further rules are needed. Thus we begin the second cycle with the representation [$\overset{1}{\text{re}}$=siduɛ+æl]. Primary stress is placed before the weak cluster [uɛ] under condition (a) of the Main Stress Rule (the Affix Rule), giving [$\overset{2}{\text{re}}$=$\overset{1}{\text{si}}$duɛ+æl]. The string [uɛ] becomes [yūw] in the usual way, and [ɛ] elides before a boundary by the *e*-Elision Rule. By other familiar processes, we derive [rəz$\overset{1}{\text{i}}$ǰūwəl].

In short, by simplifying rule (52) (dropping one feature) and replacing final /ue/ by /uɛ/ (either in lexical representations or by a redundancy rule), we derive just the required forms in these examples.

We might mention a few other minor tensing rules that belong together with rule (52). There is some evidence that we should add the rules in (60) at this point:

(60)

(a) $\begin{Bmatrix} æ \\ u \end{Bmatrix} \rightarrow [+\text{tense}] \; / \left[\frac{\qquad}{+\text{stress}}\right] nge$

(b) $ɔ \rightarrow ō \; / \; \text{——}\,\text{CV}\,[-\text{seg}]$

Rule (60a) accounts for the appearance of a tense vowel in forms such as *angel* and *lounge*, which would otherwise contradict rule (8). Notice that *lunge*, *sponge* cannot be derived from underlying /lunge/, /spunge/, respectively. We shall see below in Section 4.3.7 that they can be derived from an underlying representation containing lax /o/ in stressed position.

Rule (60a) will also account for contrasts such as *angel–angelic* from underlying /ængel/. In *angel* in isolation, stress is placed on the first syllable, which is tensed by rule (60a) and then undergoes Diphthongization and Vowel Shift in the usual way. In *angelic*, (60a) does not apply, and we derive [ænǰelik]. The same rule explains the tense vowel in *range*, *strange*, etc. (from underlying /ræng/, /stræng/, respectively). Tense vowels are not, in general, to be expected before this cluster. Notice, incidentally, that formatives with phonetic [...ænǰ...] are extremely rare (examples being *flange*, *gange*, and, with formative boundary, *tang*+*ent*). This fact is explained by rule (60a). The cluster [nǰ] will arise only from /nge/ by Velar Softening (see Section 6), and, when /æ/ precedes this cluster under stress, it will be tensed by rule (60a), with the exceptions noted.

Rule (60b) is needed to account for alternations such as *telescope–telescopic–telescopy*. Consider the underlying vowel of *scope*. From the position of stress in *teléscopy*, we know that this vowel must be lax. From the form *telescopic*, we know that the underlying vowel of *scope* must be either /ɔ/ or /ō/, since our study of back vowel alternations has shown that these are the only vowels that give rise to phonetic [ā] before *-ic*. Since the underlying vowel has already been determined to be lax, it must therefore be /ɔ/. But this leaves the problem of accounting for the form *telescope*, where the phonetic reflex of this vowel is [ōw]. This phonetic form can derive only from [ō], by Diphthongization and Vowel Shift. Therefore we need a rule tensing /ɔ/ in some position. It cannot be that /ɔ/ is tensed to [ō] in the context ——C#, as we can see from words such as *cot*, *stop*, where the /ɔ/ remains, to become [ā] in a manner we have already discussed. The only possibility, then, is to make use once again of the rule of *e*-Elision in final position, and to take the underlying representation to be /tele+skɔpe/, tensing being determined by rule (60b).

The same rule might also be used to account for contrasts such as *photograph* (with [ōw] in the first syllable) versus *monotone* (with [ā] in this syllable). In both cases it seems that the underlying vowel can only be /ɔ/. The distinction, then, can be in terms of a lexical opposition [±rule (60b)], which appears to be quite idiosyncratic from a synchronic point of view.

4.3.5. VOWEL SHIFT FOR LAX VOWELS

We have so far restricted the Vowel Shift Rule to tense vowels. By extending it to certain lax vowels, we can account for several other phenomena, some marginal, some perfectly regular.

Consider first the nonback high vowel [i]. If this were to undergo Vowel Shift, it would become [æ], just as [ī] becomes [ǣ]. (We continue to restrict Diphthongization and Backness Adjustment to tense vowels, so that the alternation [i]–[æ] for lax vowels is parallel to the alternation [ī]–[āy] for tense vowels.) The alternation [i]–[æ] is, in fact, found in a certain class of irregular verbs in English, e.g., *sit–sat*, *sing–sang*. These verbs will be marked in the lexicon as belonging to a special lexical category, and by Convention 2, page 173, this lexical category will be distributed as a feature of each segment of these verbs, in the appropriate context. Thus, in particular, the vowel of *sit* will have a certain feature [+F] when it is in the syntactic context ——*past*. (*Past* is deleted after determining the category of the lexical item and, in consequence, the distinctive feature composition of its segments.) We can then account for the alternation that gives the past tense form by permitting the Vowel Shift Rule to apply also to vowels in the following specially marked context:[31]

(61) $\left[\frac{\quad}{+\mathrm{F}}\right]$

Thus we can find a small "subregularity" in the class of irregular verbs by generalization of the Vowel Shift Rule to certain lax nonback vowels.

Extension of the Vowel Shift Rule to the context (61) also enables us to account for the alternation *satisfy–satisfaction*. The form underlying *satisfy* clearly contains the formative *-fy* which we also find in *ramify*, *clarify*, etc., and, presumably, it also contains the formative *sate*, which has the underlying representation /sǣt/. The underlying representation of *-fy* must be /fīk/. In forms such as *clarification*, the vowel of this formative will be reduced to [ə] by the processes described in Chapter Three, Section 14. In final position, the [k] is dropped by the ad hoc rule (62), which also applies to *multiply*, etc.

(62) $\mathrm{k} \rightarrow \phi \;/\; +\mathrm{C}_1\bar{\mathrm{i}}\text{——}\#$

When the vowel of *-fy* remains tense, it becomes phonetic [āy] by the Diphthongization and Vowel Shift Rules discussed above.

These remarks are quite general. We apply them now to the special case of *satisfy*, with the underlying representation /sǣt+is+fīk/.

In isolation, this form emerges from the stress cycle with the representation [sǽ̀t+is+fì̀k]. By rule (19b), the trisyllabic case of the Laxing Rule, the vowel [ǣ] becomes [æ]. The Diphthongization and Vowel Shift Rules convert [ī] to [āy], and rule (62) drops the final [k], giving [sǽtisfà̀y].

Consider now *satisfaction*, with the underlying representation /sǣt+is+fīk+ǣt+iVn/. The lexical item *satisfy* belongs to the large class of irregular verbs that drop the /ǣ/ of /+ǣt+/ in the derived forms (*receive–reception*, *reduce–reduction*, *describe–descriptive*, etc.) This gives the form [sǣt+is+fīk+t+iVn]. The stress cycle now yields [sǽ̀t+is+fík+t+iVn]. In Section 2 we observed that English phonology contains

[31] Recall that by Convention 2, every segment of the lexical items that do not belong to the category [+F] is automatically marked [−F], so that the extended Vowel Shift Rule will apply only to the appropriate irregular forms.

rule (8), which makes vowels lax before consonant clusters, as a special case of the general Laxing Rule. As noted there, this rule is not a lexical redundancy rule which applies only within formative boundaries, but rather a phonological rule which applies to *any* tense vowel followed by a consonant cluster, in particular, to the vowel [ī] of [sǣt+is+fīk+t+iVn]. Furthermore, [ǣ] becomes lax by rule (19), as in *satisfy* in isolation. If, now, we assign *satisfy* (or, perhaps, the formative *-fy*) to the category [+F], along with *sit*, *sing*, etc., in their past tense forms, then the Vowel Shift Rule, now extended to the context (61), will apply, giving [sæ̀t+is+fǽk+t+iVn], which becomes [sætisfǽkšən] by rules to be discussed later.

In short, to account for the superficially unique [āy]–[æ] alternation of *satisfy–satisfaction*, we need only assign *satisfy* to a certain subclass of irregular verbs that receive the feature [+F]. Once again, we can extract a subregularity from what appears to be a totally exceptional case.[32]

Certain other irregular phenomena can also be brought into the scope of the Vowel Shift Rule in the same way. Consider, first, forms such as *retentive*, *retention*, *content*, *exemplary*, *biennial*. In each case the vowel in boldface has undergone an exceptional change from expected [æ] to phonetic [e]. Thus the vowel of *-tain*, for example, becomes lax by rule (8) before the double consonant in the derived forms. But the underlying vowel is /ǣ/ (which, when it remains tense, becomes [ēy] by Diphthongization and Vowel Shift, as in *retain*, *contain*); hence the corresponding lax vowel should be [æ]. To account for the fact that we have [e] in place of [æ] in these words, we can assign the formative *-tain* to the category [+F]. It will thus fall under the Vowel Shift Rule, extended to the context (61), after the vowel becomes lax by rule (8). Since the Vowel Shift Rule converts [æ] to [e], we derive the desired form. The other cases are similar.

We can use the same device to take care of the *A–e* alternation noted in the preceding chapter. As we observed there (see (142), page 136), underlying /ǣ/ becomes [e] in the affix *-ary* in words such as *secretary*, *secretarial*. Since a form of laxing is involved, it is reasonable to combine this with the Laxing Rule (19), as a special case. Thus the Laxing Rule, appropriately extended to *-ary*, will convert this /ǣ/ to [æ]. If we now assign to *-ary* the feature [+F], the Vowel Shift Rule will convert [æ] to [e]. Notice that Tensing will not apply to the laxed [æ] of *secretarial* (see note 17).

According to (43), Vowel Shift applies to vowels that are [+stress] and [+tense]. In (61) we extended Vowel Shift to vowels marked with the diacritic feature [+F]. By our conventions, these two contexts must be conjunctively ordered. Consequently, if a vowel satisfies both (43) and (61), it will undergo Vowel Shift twice. Thus, for instance, a tense stressed [ǣ] which is also marked [+F] would first be turned into [ē] by virtue of (43) and subsequently into [ī] by virtue of (61). The cases we have examined up to this point have all contained nontense vowels and were hence subject to only a single application of the Vowel Shift Rule. There are, however, instances where Vowel Shift does appear to apply twice; for example, double application of Vowel Shift gives *clear* [klīyr] from underlying /klær/ (cf. *clarity*). Similarly, verbs such as *rise–rose* and *take–took* require double application of the Vowel Shift Rule in their past tense forms. If we take the present tense form as the underlying form, we must assign the lexical representations /rīz/, /tǣk/, respectively, which give [rāyz], [tēyk] in the usual way. To derive the past tense forms, we first apply a rule shifting backness and rounding, which is widely applicable to irregular verbs and other

[32] Observe that extension of the Vowel Shift Rule to certain occurrences of lax [i] amalgamates entirely unrelated historical processes which have fallen together synchronically in English (see (36), Chapter Six).

irregular forms and which we shall discuss later. This gives [rūz], [tōk]. Diphthongization and Vowel Shift give [rōwz], [tōwk]. Finally, reapplication of the Vowel Shift Rule gives the forms [rōwz], [tūwk].[33] We can readily account for this double application of Vowel Shift by marking all such forms as [+F]. If the stressed vowels so marked are also tense, the Vowel Shift Rule will apply twice.

Let us turn now to the case of the lax, high, back vowel [u]. Suppose that we were to add (63) as a context for the Vowel Shift Rule:

(63)
$$\begin{bmatrix} \_\_\_\_ \\ -\text{tense} \\ +\text{high} \\ +\text{back} \end{bmatrix}$$

In this context, the first part of the Vowel Shift Rule would apply, with the result that [u] would be converted to [o]. The second part of the Vowel Shift Rule would not apply to this newly formed segment, however; [o], not being [+tense], [+F], or [+high], does not meet the conditions for application of the Vowel Shift Rule. We have seen that the Rounding Adjustment Rule (37) applies to the vowel [ō] which results from underlying /ū/ by Vowel Shift, so that original /ū/ becomes phonetic [āw]. If we extend this rule to [o] arising by Vowel Shift from /u/, then the rule will convert [o] to its nonround counterpart [ʌ] (i.e., to the lax vowel which is [−high], [−low], [−round]). We will see, in fact, that the Rounding Adjustment Rule is even more general than this. With this extension, underlying /u/ will become phonetic [ʌ] by Vowel Shift and Rounding Adjustment, whereas underlying /ū/, which undergoes *both* stages of the Vowel Shift, as well as Diphthongization and Rounding Adjustment, becomes phonetic [āw] (or [æw], with further Backness Adjustment and Laxing).

Thus, extension of the Vowel Shift Rule to the context (63), and a corresponding extension of Rounding Adjustment, will convert /u/ to [ʌ]. In fact, as we have already noted in connection with the alternation *profound–profundity* (30c), there is good evidence that this process exists as a part of English phonology. Notice further that phonetic [u]–[ʌ] contrasts are very rare in English, and in many contexts they are not found at all. Thus, for example, although we have words such as *fund*, *duct*, *lung*, *bunt* (phonetically, [fʌnd], [dʌkt], [lʌŋ], [bʌnt]), we could not have words with the phonetic forms *[fund], *[dukt], *[luŋ], *[bunt]. These forms are inadmissible in the English dialects that we are studying and must be excluded by appropriate rules. The Vowel Shift Rule and the extensions just mentioned have just the required effect, converting /fund/ to [fʌnd], etc. We can thus account for the lack of contrast and, at the same time, preserve the symmetry and simplicity of the system of lexical representations, which will contain, among lax vowels, only those which are [−back], [−round] (/i/, /e/, /æ/) or [+back], [+round] (/u/, /o/, /ɔ/).

The Vowel Shift Rule, as just formulated, will convert *all* cases of phonological /u/ to phonetic [ʌ]. But clearly there are cases of phonetic [u] in the language (e.g., *push*, *pull*, *bushel*, *bull*); that is, there are residual cases of contrast or near contrast involving phonetic [u] and [ʌ]. Phonological /u/ thus gives rise to phonetic [ʌ] by the Vowel Shift Rule, and to phonetic [u] when the Vowel Shift Rule does not apply.

[33] The representation [tūwk] becomes [tuk] by a fairly general rule that applies to [ūw] in various contexts, in particular ——*k*, before rule (62). Apart from the word *spook* and various slang forms, which often break low-level rules, all of the forms with phonetic [ūwk] derive from underlying /ŭ/.

On page 168, we noted that it is possible for the values of *all* of the features of an underlying vowel to be changed in its phonetic representation. The example given was underlying /ū/, which becomes [æ] in some dialects. Now we have another example, namely, underlying /ǣ/, which becomes [u] in *take–took*

In Section 4.3.4 we dealt with a very similar problem. There we wanted to find a tense, high, back vowel which did not undergo Vowel Shift and could serve as the source for [yūw]. We saw that the proper choice was the unrounded vowel corresponding to [ū], that is, the vowel [ɨ], which is immune to Vowel Shift because it is not the same in backness and rounding. This vowel itself derives from underlying /u/ by rule (52), which tenses and unrounds [u] in the context ——C_0^1V. The vowel [ɨ] finally becomes [ū] by the late rule (51).

The analysis of [yūw] suggests a way of providing for phonetic [u]. Suppose that we add an early rule with the effect of (64):

(64) u → [−round] in certain contexts

If we then generalize rule (51) so that it rounds [ɨ] as well as [ɪ], we will have the derivations of (65) for *push*, *pun*, for example:

(65)

puš	pun	
piš		RULE (64)
	pon	VOWEL SHIFT, EXTENDED TO (63)
	pʌn	EXTENSION OF ROUNDING ADJUSTMENT
puš		GENERALIZATION OF (51)

All that is necessary, then, is to specify the contexts for rule (64) in such a way that it covers all words with phonetic [u]. Investigation of the examples suggests the following formulation:

(66)

$$\begin{bmatrix}-\text{tense}\\+\text{high}\end{bmatrix} \rightarrow [-\text{round}] \;/\; \begin{bmatrix}-\text{nasal}\\+\text{ant}\\-\text{cor}\end{bmatrix} \text{——} \begin{cases} l\begin{Bmatrix} l \\ \# \end{Bmatrix} & \text{(a)} \\ \begin{bmatrix}-\text{ant}\\+\text{cor}\end{bmatrix} & \text{(b)} \end{cases}$$

Rule (66) unrounds /u/ when it is preceded by a nonnasal labial segment and followed either by [ll] or final [l] or by [š] or [č]. Case (a) applies in the boldface position in such words as ***pu**llet*, ***pu**lley*, ***bu**llet*, ***bu**llock*, ***pu**ll*, ***fu**ll*. We know, in the first four cases, that the medial cluster is double [l] by the fact that /u/ does not become [ɨ] by rule (52) (and, finally, [yūw]), as would happen in the context ——CV. Case (b) of the rule applies in words such as *bush*, *push*, *bushel*, *butcher*. Notice that the occurrences of phonological /u/ that are unrounded by rule (66) (or rule (52)) will be phonetically round, and those that remain round because rule (66) (or rule (52)) does not apply will be phonetically nonround, that is, [ʌ].

Rule (66) is a lexical redundancy rule; it precedes all phonological rules. It does not cover several exceptional cases of unrounding; for example, *put*, *pudding*, *puss*, *cushion*. These must be listed in the lexicon, either as purely idiosyncratic or by an extension of rule (66). Thus, insofar as there is a marginal phonetic [u]–[ʌ] contrast, there is a marginal phonological /ɨ/–/u/ opposition in the lexicon.

There are various other problems connected with these cases; for example, the absence of tensing of /u/ in *budget*, *butcher*, and *bushel* (which suggest that the stressed vowel is followed by a double consonant) and the inapplicability of (66) to words such as *budge*, *budget*, and *fudge*, which can be accounted for either by limiting (66) to segments preceding voiceless palato-alveolars only, or by assuming that the lexical representation corresponds to the spelling, in which case (66) will be automatically blocked.

Summarizing the phonetic variety of underlying high back vowels, we have the following situation. The tense phonological segment /ū/ always undergoes Vowel Shift. In the cases so far considered (there will be a slight extension below), this gives phonetic [āw] or [æw], depending on dialect. The lax phonological segment /u/ becomes phonetic [yūw] when it is in the context —— C_0^1V; it remains phonetic [u] (after unrounding and compensating rounding) when it is in the contexts of (66); elsewhere it undergoes the first stage of Vowel Shift and becomes phonetic [ʌ].

4.3.6. FURTHER REMARKS ON DIPHTHONGIZATION

We are now in a position to account for a defect in the Diphthongization Rule, formulated as (21) in Section 4.1. This rule introduces a glide after a tense vowel, the glide being [w] if the vowel is back and [y] if the vowel is nonback. Thus, [ī], [ē], [ǣ], [ǣ] receive a *y*-glide, and [ū], [ō], [ɔ̄], [ā] receive a *w*-glide. This assignment is appropriate for all cases except [ā], where it is clearly incorrect. For example, *father* and *Chicago* do not become phonetic *[fāwðər], *[šəkāwgōw], respectively; rather, [ā] receives a centering glide of some sort or a feature of extra length (with various dialectal differences that do not concern us here).

We may account for this phenomenon by adding the following supplement to the Diphthongization Rule:

(67) $$[-\text{cons}] \rightarrow [+\text{voc}] \quad / \ \bar{a} \text{——}$$

Thus Diphthongization will convert [ā] to [āw], and rule (67) will convert [āw] to [āu]. The first part of the Vowel Shift Rule, followed by the Rounding Adjustment Rule discussed in the preceding section, will then convert [āu] to [āʌ], just as /pun/ is converted to [pʌn]. Thus *father*, *Chicago*, which are lexically represented as /fāðVr/, /šVkāgo/, are converted ultimately to [fāʌðər], [šəkāʌgōw]. The phonetic interpretation of [āʌ] varies with the dialect, as does the phonetic interpretation of the other complex vocalic nuclei. Thus [āʌ] may represent [ā] followed by a centralizing glide (a mid central vowel) or simply extra-long [ā]; or the off-glide may be dropped and [āʌ] will not be distinguished phonetically from [ā].

In Section 2 we presented rule (5), which converts underlying /ɔ/ to phonetic [ā], as in *cot*, *stop*. This rule falls together with the Rounding Adjustment Rule and therefore comes after Vowel Shift in the ordering of the rules. The segment [ā] formed by rule (5) will not be diphthongized and will contrast with the phonetic [āʌ] that comes from original /ā/. Thus we have such contrasts as *father–bother* ([fāʌðər]–[bāðər]), from underlying /fāðVr/–/bɔðVr/, and *rajah–Roger*. For essentially the same reasons, we will have length contrasts as in *balm–bomb*, *starry–sorry*, with the shorter of the two paired vowels deriving from /ɔ/ by rule (5). (The source of [āʌ] in these items will be discussed in the next section.) In dialects in which [āʌ] is interpreted phonetically as [ā], the contrast will not appear.

4.3.7. FURTHER REMARKS ON PHONETICALLY LOW VOWELS

To complete the discussion of the system of English vocalic nuclei, we must account for the phonetically low tense vowels: [ɔ̄] as in *lawn*, *audacious*; [ā] as in *spa*, *balm*; and, for some dialects, [ǣ], as in *can*, meaning "receptacle" (as opposed to *can* meaning "be able," which has lax [æ] phonetically).

The distribution of [ǣ] varies from dialect to dialect, but in each dialect almost all cases are predictable from underlying /æ/, which tenses in positions determined by lexical

category or by the following consonant. The few cases that cannot be predicted[34] must be listed in the lexicon as involving a highly marginal subclassification of [æ] in certain monosyllabic morphemes.

The case of [ɔ̄] is less marginal and more important. In words such as *laud, brawl*, it appears that [ɔ̄] must come from some tense vowel that does not undergo Vowel Shift. We must therefore find a vowel V* which is not subject to Vowel Shift and is later converted to [ɔ̄] by rules which are, as far as possible, independently motivated. The obvious proposal is to take V* to be [ā]; since this vowel is different in backness and rounding, it does not undergo Vowel Shift, and it can be converted to [ɔ̄] by a late rule of Rounding Adjustment of which we have already found many examples. This proposal is strengthened by the observation that [ā] has, otherwise, an extremely restricted distribution in lexical entries. In particular, it is excluded from monosyllables. Thus there are no such forms as *[lāʌn] contrasting with [lɔ̄ʌn] (*lawn*),[35] or *[brāʌl] contrasting with [brɔ̄ʌl] (*brawl*). This fact permits us to derive phonetic [ɔ̄] in monosyllables from underlying /ā/. We therefore add rule (68), which will fall together with the other Rounding Adjustment Rules, as we shall see.

(68) $$\bar{a} \rightarrow [+\text{round}] \;/\; [-\text{seg}]\, C_0 \text{——} VC_0\, [-\text{seg}]$$

Thus the word *laud*, for example, will have the following derivation:

(69)

lād	
lāwd	DIPHTHONGIZATION (21)
lāud	RULE (67)
lāod	VOWEL SHIFT, EXTENDED TO (63)
lɔ̄ʌd	ROUNDING ADJUSTMENT

Rounding Adjustment applies twice to give the final line of (69), once to [ā] by case (68), rounding the tense vowel, and once in the manner described in the preceding section, unrounding the lax [o] that derives from [u] by Vowel Shift.

We thus are assuming that the vowel of *laud, brawl* has a centering glide, like the boldface vowel of ***father***, *Chic**a**go*. Again, we are limiting ourselves to the phonetics of a single, prototype dialect, passing over much phonetic detail and dialectal variation that are beyond the scope of this study.

We have already noted quite a few cases of Rounding Adjustment following the Vowel Shift Rule. We will summarize the various cases in Section 4.3.8. In order to achieve maximal generalization in the formulation of this rule, we will want to extract from the rule the particular contexts that restrict its various special cases. In particular, we will want to eliminate from (68) the restriction to monosyllables, which will be unique to this case. The obvious way to achieve this result is by a lexical redundancy rule that exempts /ā/ from rounding adjustment in polysyllables (e.g., *father, Chicago, restaurant*). We therefore add the rule (70) (where *n* is the number of the rule that rounds /ā/ after the Vowel Shift Rule as a special case of Rounding Adjustment, i.e., the rule temporarily formulated as (68)):

(70) $$\bar{a} \rightarrow [-\text{rule } n] \quad \text{in polysyllables}$$

[34] For example, in our prototype dialect, the vowel in monosyllabic adjectives ending in [d], e.g., [sæd] (*sad*) versus [bǣd] (*bad*).

[35] Of course, we may have such forms from phonological /ɔ/, which goes to [ā] by rule (5). Thus words such as *conch, fond, pot* must be given the representations /kɔnč/, /fɔnd/, /pɔt/ in their lexical entries. Forms such as *spark, spar, spa* have underlying [æ], as we shall see directly.

We have now accounted for the cases of phonetic [ō] in monosyllables, but we must still find a source for the vowel in the boldface position of ***au**dacious, **clau**strophobia, mulliga**tawny***, etc. An interesting fact regarding this vowel is that in polysyllables it is in complementary distribution with phonetic [āw] or [æw], that is, with the reflex of phonological /ū/. The latter appears only in the context ——[+nasal]C, as in *council, countenance, mountain, scoundrel, mountebank*, and in the context ——V in some dialects, as in *Howell, dowel* (contrasting with *howl, foul*). Typically, [ō] does not appear in these contexts and [āw] or [æw] does not appear elsewhere in polysyllabic formatives.[36] This fact suggests that in polysyllables phonetic [ō] may derive from underlying /ū/, just as [āw] or [æw] derives from /ū/. This is quite plausible on other grounds, since [ō] is, in fact, an intermediate stage in the derivation of [āw] (or [æw]) from /ū/. Recall that after it is diphthongized, /ū/ becomes [ō] by Vowel Shift and then becomes [ā] by Rounding Adjustment. To derive [ō] from underlying [ū], then, it is necessary only to arrest the /ū/ → [ō] → [ā] transition at its middle stage, permitting Vowel Shift to apply but not Rounding Adjustment. Since phonetic [ō] and phonetic [āw] are, as just noted, in complementary distribution in polysyllables, the cases in which only Vowel Shift applies to underlying /ū/ can be distinguished from the cases in which both Vowel Shift and Rounding Adjustment apply to underlying /ū/.

In short, there is good reason to suppose that phonetic [ō] derives from underlying /ā/ in monosyllables and from underlying /ū/ in polysyllables.[37]

Clearly the segment [ō] appearing in polysyllables is not to be distinguished on phonetic grounds from the segment [ō] in monosyllables, although they have different phonological sources. In particular, the following glide, if any, must be the same. In the dialect we are taking as our prototype, this is a centering glide, which we are representing as [ʌ]. In the case of the [ō] deriving from /ā/, we have already accounted for this glide by rule (67), which converts [w] to [u] after [ā], [u] then going automatically to [ʌ] by Vowel Shift and Rounding Adjustment. Clearly, then, we must extend (67) to the occurrences of [w] which follow those cases of /ū/ which are going to become phonetic [ō] rather than phonetic [āw]. That is, we must revise rule (67) so that it converts [w] to [u] not only after all cases of [ā] but also after [ū] everywhere except in final syllables, before nasal clusters, and before vowels. The simplest way to express these facts is by the rule (71), the exceptions to (71) being marked by the lexical redundancy rule (72):

$$(71) \qquad w \rightarrow u \; / \; \begin{Bmatrix} \bar{u} \\ \bar{a} \end{Bmatrix} ——$$

$$(72) \qquad \bar{u} \rightarrow [-\text{rule (71)}] \; / \; —— \begin{Bmatrix} C_0\# \\ [+\text{nasal}]C \\ V \end{Bmatrix}$$

(The fact that (72) applies to the vowel whereas (71) applies to the glide will be dealt with shortly.) The phonological rule (71) will now convert [w] to [u] not only in words such as *father* and *laud*, as before, but also in *maudlin, aug=ment*, etc. The lexical redundancy rule

[36] This formulation requires that words such as *saunter, launder, trousers* be treated as phonologically monosyllabic. (Note that *laundry* is [lōndrīy] phonetically, not [lōndərīy].) There are, incidentally, other sources of phonetic [ɔ] (e.g., before liquids, in certain contexts), as we shall see directly.

[37] We have observed (see p. 195) that [āw] (or [æw]) does not occur before labials or velars, and we have suggested that this is a result of the lexical redundancy rule (54) that makes consonants coronal in the context $\bar{u}$ —— [−segment]. But this redundancy rule does not affect noncoronal consonants following /ū/ in medial position, and we have forms such as *awkward, auburn, augur, traumatic*, in which underlying /ū/ appears before a labial or a velar.

(72) will block the application of (71) in words such as *renown, frown, allow, rowdy; mountain, fountain; tower, dowel.* In these cases, it will leave a labializing glide after the tense vowel. For rule (72) to apply correctly, it is necessary to make a few otherwise unmotivated decisions about the placement of formative boundary, and there still will remain marginal contrasts in the lexicon; but we will not press the investigation of this point any further.

Let us now compare the derivations of *mountain* and *maudlin*:

(73)

mūntən	mūdlin	
mūwntən	mūwdlin	DIPHTHONGIZATION
	mūudlin	RULE (71)
mōwntən	mōodlin	VOWEL SHIFT
māwntən	mōʌdlin	ROUNDING ADJUSTMENT

In the third line of (73), rule (71) applies to *maudlin*, changing [w] to [u]; but it is prevented by rule (72) from applying to *mountain*, which has a nasal cluster following /ū/. To form the final line of (73), Rounding Adjustment applies to the lax vowel [o], giving [ʌ], and changes the segment [ō] in the context ——*w* but not in the context ——V. The exact mechanics of the Rounding Adjustment Rule will be presented in Section 4.3.8. For the present it is only necessary to observe that the cases in which the rule effects a change are distinguishable from the cases where it does not, the relevant distinction here being the specification of the feature "vocalic" in the following segment.

Rule (71) makes the glide [w] vocalic when it follows [ā] or [ū] but not when it follows other vowels. Since the segments [ā] and [ū] are the only vowel segments followed by [w] that have the same coefficients for the features "round" and "high," we can reformulate rule (71) as follows:

(74)

$$\begin{bmatrix} -\text{cons} \\ +\text{back} \end{bmatrix} \rightarrow [+\text{voc}] \; / \; \begin{bmatrix} \alpha\text{round} \\ \alpha\text{high} \\ \text{V} \end{bmatrix} ——$$

We will henceforth refer to this as the Glide Vocalization Rule.

There is a discrepancy in the formulation of rules (72) and (74) that must be eliminated. Notice that the lexical redundancy rule (72) assigns the feature [−Glide Vocalization Rule] (=[−rule (74)]) to the vowel /ū/ in certain contexts in lexical formatives. But the Glide Vocalization Rule (74) refers to a glide following the vowel [ū], not to this vowel itself. Therefore the fact that the vowel is marked [−rule (74)] will not prevent rule (74) from applying to the glide which follows this vowel, a glide which is inserted only by the Diphthongization Rule. Clearly this glide must also be assigned the feature [−rule (74)]. Recall that the Diphthongization Rule (21) inserts after a tense vowel a glide agreeing in backness and rounding with the backness of the vowel. Evidently, we must also require that the glide agree with the vowel in the feature [αrule (74)], and the Diphthongization Rule (21) must be modified to include this specification. The rule will then insert a glide which undergoes rule (74) just in case the vowel it diphthongizes is not excepted from Glide Vocalization by the lexical redundancy rule (72).

There is clearly a more general way to state the Diphthongization Rule, thus expressing an aspect of this rule missed in our formalization. The Diphthongization Rule inserts a glide which accepts from the vowel preceding it *all* feature specifications that are possible for a glide. The Diphthongization Rule is, in other words, the simplest sort of "assimilation rule," in a very general sense of this notion. This is clearly a linguistically

significant fact, a generalization not captured in our formalization. We will return, inconclusively, to a discussion of this and several other related inadequacies in Chapter Nine.

The next problem involving phonetically low vowels has to do with the realization of underlying /ɔ/ as [ā], noted several times in our discussion. The rule (5) which converts /ɔ/ to [ā] can be analyzed into two steps, the first of which unrounds /ɔ/ and the second of which tenses the resulting [a]. The first step can then be formulated as a special case of the Rounding Adjustment Rule which follows Vowel Shift in the ordering. We will discuss some of the dialectal variation involving underlying /ɔ/ below.

Still to be accounted for are the occurrences of phonetic [ɔ̄ʌ]—the same phonetic segment as in *laud, audible*, etc.—in words such as *long, soft, cost, toss, cloth*, and before liquids. We will put aside the case of liquids for the moment and consider the other cases. Since the words cited are monosyllables, the vowel cannot derive from underlying /ū/ in the manner just outlined. The other alternative is underlying /ā/, as in *lawn* and *fraud*. This is ruled out in words such as *long* and *soft*, however, since tense vowels do not occur before such clusters, as we have noted (see p. 171 and note 19).

The case we are now discussing can be incorporated into the grammar as so far constructed in several different ways, and we have not found any entirely compelling argument for one or another approach. We therefore sketch one possibility, which seems to us to involve the fewest ad hoc rules and to leave the smallest number of exceptions, observing, however, that there are other plausible hypotheses.

In discussing double applications of the Vowel Shift Rule (p. 202), we noted that there is a phenomenon of backness adjustment that applies to many irregular lexical items. For example, if we take present tense forms of verbs to be the underlying forms, then we have nonback vowels becoming back and round in the case of alternations such as *cling–clung, tell–told, bind–bound, break–broke*, and back vowels becoming nonback and nonround in the case of alternations such as *run–ran, hold–held*. Similarly, in irregular plurals we have back vowels becoming nonback and nonround, as in *mouse–mice, foot–feet*. These phenomena suggest that there must be a pre-cyclic readjustment rule switching backness in certain lexical items in certain contexts:

$$(75) \qquad V \rightarrow \begin{bmatrix} -\alpha\text{back} \\ -\alpha\text{round} \end{bmatrix} / \begin{bmatrix} \text{———} \\ \alpha\text{back} \end{bmatrix} \quad \text{in certain irregular forms}$$

Given the readjustment rule (75), we can account for the derived forms in the examples of the preceding paragraph by assuming the underlying representations /kliNg/, /tel/, /bīNd/, /brǣk/, /run/, /hold/, /mūs/, /fōt/. Rule (75) will, in the appropriate contexts, convert: /kliNg/ to [kluNg], which becomes [klʌNg] by Vowel Shift and Rounding Adjustment, in the manner described above, and, finally, [klʌŋ] by Nasal Assimilation and the dropping of final [g] after a nasal; /tel/ to [tol] before [d] (the vowel then becoming [ōw] by processes discussed on page 214); /bīnd/, which by Diphthongization, Vowel Shift, and other rules becomes [bāynd], to [būnd], which in parallel fashion ultimately is turned into [bæwnd]; /brǣk/, which becomes [brēyk] by Diphthongization and Vowel Shift, to [brōk], which becomes [brōwk] in the same way; /run/, which becomes [rʌn] by Vowel Shift under condition (63) and by Rounding Adjustment, to [rin], which must be marked [+F] in the past tense so that it becomes [ræn] by Vowel Shift under condition (61); /hold/ to [held]; /mūs/ to [mīs] (these being realized as [māws] or [mæws], [māys], respectively, in the usual way); /fōt/, which becomes [fūwt] by Diphthongization and Vowel Shift, then [fut] in the

manner described in note 33, to [fēt], which then undergoes Diphthongization and Vowel Shift in the usual way.

But notice that we have the alternations *long–length*, *strong–strength*, which also clearly illustrate the backness switch stated by rule (75). This fact strongly suggests that the underlying forms should be /long/, /strong/, and that to account for the phonetic forms [lɔ̄ʌŋ], [strɔ̄ʌŋ], we consider some process that has the effect of (76):

(76) $$o \rightarrow \bar{ɔ}ʌ$$[38]

Further support for this assumption comes from the observation that we clearly cannot derive *long* from underlying /lɔng/, since /ɔ/ in this context becomes phonetic [ā] in the usual way, as we can see from words such as *congress*, *thong* (which is [θāʌŋ] in the dialect that is being described here). Additional evidence is provided by the example *lose–lost*. The simplest analysis of *lose* (phonetically [lūwz]) is from underlying /lōz/ by Diphthongization and Vowel Shift. Then *lost* must be represented /lōz+d/, the irregularity of this verb being that the usual # boundary before the past tense affix is replaced by formative boundary (i.e., # → [−word boundary]; see pp. 13, 67). There is a general rule devoicing clusters which will convert /lōz+d/ to [lōs+t]. (Cluster devoicing here must be a case of "linkage" in the sense of Chapter Nine.) The Laxing Rule (8), which applies to a vowel followed by a double consonant, will then convert [lōs+t] to [los+t]. (Recall that dental clusters are excluded from this rule only if they appear within a formative—see page 172.) Now the processes summarized as (76) will convert [lost] to the desired phonetic form [lɔ̄ʌst].

There are, then, fairly good reasons for assuming that there must be rules with the effect of (76). If we can convert /o/ to [ā], we will have succeeded in accounting for (76), since [ā] becomes [ɔ̄ʌ] by Diphthongization, vocalization of [w] by rule (74), Vowel Shift, and Rounding Adjustment.[39] The questions we must consider, then, are how much the grammar must be complicated to convert /o/ to [ā] before the application of the Diphthongization Rule and in what contexts this change takes place.

A change of [o] to [ā] involves three features, namely, "round," "tense," and "low." Notice that we already have a rule making [u] tense and unrounded, namely, rule (52), which is part of the system of Tensing Rules. We can therefore generalize rule (52) by extending it to [o]. If, then, we restate (52) as (77) and add rule (78) as a final addendum to the

[38] Consider, however, the alternation *broad–breadth*. As mentioned, *long* and *strong* cannot have an underlying /ā/ because of their final clusters. The word *broad*, on the other hand, has no such cluster and must derive from underlying /brād/ in the manner described previously (p. 206). Rule (75) will then convert /brād+θ/ to [brǣd+θ]. Cluster devoicing will convert the latter to [brǣt+θ], which will become [bræt+θ] by the Laxing Rule (8). If we now assign the feature [+F] to *broad*, then [bræt+θ] will become [bret+θ], just as [retæntiv] becomes [retentiv], by Vowel Shift under condition (61). Thus the only irregularity of *broad*, other than its being subject to rule (75), will be its assignment to the ad hoc category [+F].

[39] Recall that Rounding Adjustment applies to all cases of [ā] except those specified by the lexical redundancy rule (70) as excluded from the rounding rule because they appear in polysyllabic formatives. Suppose, then, that the word *Boston* is represented as /bostɔn/, and becomes [bāstɔn] by the rules that we are now discussing, which convert /o/ to [ā]. By Diphthongization, Glide Vocalization, and Vowel Shift, we derive [bāʌstɔn]. But Rounding Adjustment now applies, despite the fact that this is polysyllabic, since the vowel [ā] in question is not an underlying vowel and hence is not excluded from Rounding Adjustment by the lexical redundancy rule (70). Therefore we derive [bɔ̄ʌstən], as required.

Once again, we are not concerned here with the exact phonetic details of [ɔ̄ʌ], which will vary with dialect, phonetic context, and style. What is crucial at this point is that this vowel not be distinguished phonetically from the other cases of [ɔ̄ʌ], which undergo the same phonetic modifications.

system of Tensing Rules, we achieve the desired conversion of [o] to [ā].

(77)
$$\begin{bmatrix} -\text{tense} \\ +\text{back} \\ \text{V} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{tense} \\ -\text{round} \end{bmatrix} / \left\{ \begin{array}{ll} \left[\frac{\quad}{+\text{high}}\right] C_0^1 [-\text{cons}] & \text{(a)} \\ \left[\frac{\quad}{\begin{matrix}-\text{high} \\ -\text{low}\end{matrix}}\right] \ldots & \text{(b)} \end{array} \right.$$

(78)
$$\bar{\text{A}} \rightarrow [+\text{low}]$$

Rule (77a) is rule (52). Rule (77b) is the new rule applying to underlying /o/ in some yet-to-be-determined context, indicated in (77b) by .... Rule (78) is the only quite ad hoc modification that is necessary to account for the processes summarized in (76).

From the examples we have so far considered, it appears that the relevant context for rule (77b) is the following:

(79)
$$\text{—} \left\{ \begin{matrix} \left[\begin{matrix}-\text{voice} \\ +\text{cont} \\ +\text{ant}\end{matrix}\right] \\ [+\text{nasal}]\,\text{C} \end{matrix} \right\}$$

That is, the processes summarized in (76) apply, so far, before [f], [s], [θ], and nasal clusters. There are, in fact, many other restrictions, which can be stated as lexical redundancy rules.[40] These processes are, of course, the synchronic reflexes of the well-known tensing of ME /ā/ and /ɔ̄/ which is attested in our records from the sixteenth century onward. (See Horn and Lehnert, 1954, pp. 667–92.)

Given these rules, we will have the following derivation for *long*, for example:

(80)

long	
lA̅ng	RULE (77b), IN THE CONTEXT (79)
lāng	RULE (78)
lāwng	DIPHTHONGIZATION
lāung	RULE (74)
lāong	VOWEL SHIFT
lɔ̄ʌng	ROUNDING ADJUSTMENT
lɔ̄ʌŋ	NASAL ASSIMILATION; DROPPING OF FINAL POSTNASAL [g]

In the same way, we can derive *moss, often, cost, cloth* from the underlying forms /mos/, /ofn/ (or /oftVn/), /cost/, /kloθ/, respectively.

In the light of these extensions, we can return to the dialectal variation of the segment /ɔ/, as in *stop, cot, conic*. The rules that we have given so far assign to this segment the phonetic form [ā], which, as we have noted, may contrast with [āʌ] resulting from underlying /ā/ (*Roger–rajah, bother–father*, etc.—see p. 205). In another American dialect (Eastern New England), phonological /ɔ/ becomes not phonetic [ā] but what according to workers on the American Linguistic Atlas is "a weakly rounded low-back vowel."[41] If we disregard the fact that rounding is somewhat weaker here than in other rounded vowels, we can designate the segment under discussion as [ɔ̄ʌ], that is, as the same (at this level of representation) as

[40] For example, for many dialects we have only /o/, not /ɔ/, before /st/, /f/, and /θ/; only /ɔ/, not /o/, before /n[t, d]/.

[41] Wetmore (1959).

the vowel of *lawn, cost* in the dialect we have been taking as our prototype. To obtain this phonetic realization of the segment /ɔ/, we need only extend rule (77) to low vowels, as a third case. Then underlying /kɔt/ (*cot*), for example, will become [kāt] by the new (77c) and, finally, [kɔ̄ʌt] by Diphthongization, Rounding Adjustment, and the subsidiary processes that we have discussed. Notice that this modification of rule (77) can be stated without adding any features to the rule if we use the angled bracket notation of Chapter Three (see pp. 76–77). Thus we can reformulate rule (77) as (81):

(81)
$$\begin{bmatrix} -\text{tense} \\ +\text{back} \\ \text{V} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{tense} \\ -\text{round} \end{bmatrix} \Big/ \left\{ \begin{array}{ll} \left[\overline{}\right] \begin{bmatrix} \\ +\text{high} \end{bmatrix} C_0^1 [-\text{cons}] & \text{(a)} \\ \left[\overline{}\right] \begin{bmatrix} -\text{high} \\ \langle -\text{low} \rangle \end{bmatrix} \langle \ldots \rangle & \langle\text{(b)}\rangle, \text{(c)} \end{array} \right\}$$

By the conventions that we have already established, this schema abbreviates three rules, each carrying out the process described in (81) in the contexts (82a), (82b), (82c), in that order:[42]

(82)
$$\left[\overline{}\right] \begin{bmatrix} \\ +\text{high} \end{bmatrix} C_0^1 [-\text{cons}] \qquad \text{(a)}$$

$$\left[\overline{}\right] \begin{bmatrix} -\text{high} \\ -\text{low} \end{bmatrix} \ldots \qquad \text{(b)}$$

$$\left[\overline{}\right] \begin{bmatrix} -\text{high} \\ +\text{low} \end{bmatrix} \qquad \text{(c)}$$

Consider next the situation in British Received Pronunciation, in which phonetic [ɔ] appears in *cot, stop, conic*, etc. We can account for this dialect by adding one further set of angled brackets to (81), as in (83):[43]

[42] Where ... is as specified in (79). Recall that the angled bracket convention interprets a schema of the form $X\langle[\alpha F]\rangle Y\langle Z\rangle W$ as an abbreviation for the two successive, disjunctively ordered rules $X[\alpha F]\ YZW$, $X[-\alpha F]\ YW$, where F is a feature and Z some string other than a single specified feature. (See Chapter Three, note 78.) We give a precise statement of these conventions in the Appendix to Chapter Eight.

[43] The schema (83) (p. 213) expands to:

(I)
$$\begin{bmatrix} -\text{tense} \\ +\text{back} \\ \text{V} \end{bmatrix} \rightarrow \begin{bmatrix} \langle +\text{tense} \rangle \\ -\text{round} \end{bmatrix} / \left[\overline{}\right] \begin{bmatrix} \\ +\text{high} \end{bmatrix} C_0^1 [-\text{cons}]$$

(II)
$$\begin{bmatrix} -\text{tense} \\ +\text{back} \\ \text{V} \end{bmatrix} \rightarrow \begin{bmatrix} \langle +\text{tense} \rangle \\ -\text{round} \end{bmatrix} / \left[\overline{}\right] \begin{bmatrix} -\text{high} \\ \langle -\text{low} \rangle \end{bmatrix} \langle \ldots \rangle$$

Schema (I) expands to two disjunctively ordered rules, the first with the element in angled brackets and the second without it. But notice that the second of the two will never apply, since it is disjunctively ordered with respect to the first and has the same context as the first. Therefore schema (I) is identical to case (a) of (81). Notice that we are here assuming a different convention than in Chapter Three for rules of the form $X\langle Y\rangle Z$. (See note 24 in Chapter Three.) At a later point we will incorporate these conventions into a more general framework which will permit both alternatives.

Schema (II) expands to two disjunctively ordered rules, the first of which tenses and unrounds the nonhigh nonlow vowel in the context represented by ..., and the second of which unrounds the nonhigh low vowel everywhere.

(83)
$$\begin{bmatrix} -\text{tense} \\ +\text{back} \\ \text{V} \end{bmatrix} \rightarrow \begin{bmatrix} \langle +\text{tense} \rangle \\ -\text{round} \end{bmatrix} \Big/ \left\{ \begin{array}{ll} \left[\overline{}\right]_{+\text{high}} C_0^1 [-\text{cons}] & \text{(a)} \\ \left[\overline{}\right]_{\substack{-\text{high} \\ \langle -\text{low} \rangle}} \langle \ldots \rangle & \langle\text{(b)}\rangle, \text{(c)} \end{array} \right.$$

With this modification, the rule converts [u] to [ɨ] and [o] to [ʌ̄] in the stated contexts, as in cases (a) and (b) of (77) and (81); but it converts [ə] to [a], the corresponding nonround, nontense vowel. Thus underlying /kət/ will become [kat] by (83c) and, finally, [kət] by Rounding Adjustment.

Thus all three dialects, namely, General American, Eastern New England, and British Received Pronunciation, have the same lexical representations for the words in question and differ only in trivial modifications of rule (77).[44] In our terms, the three variants of this rule (namely, (77), (81), and (83)) are equally complex (see Chapter Eight, Section 1).

Let us return now to the vowel /o/. Consider such words as *courage*, *oven*, *covey*, *honey*, *money*, with phonetic [ʌ] as the vowel of the first syllable. Notice that in each case we can derive the vowel of the first syllable from underlying /o/; furthermore, this is the simplest (and for *courage*, *oven*, the only) source for these forms.[45] In the case of *courage*, we know that the first syllable terminates in a weak cluster since it reduces in *courageous*; the vowel, however, cannot be /u/ or it would become [yūw] in *courage*. There is no other possibility, apart from /o/, that will not require new, ad hoc rules. Therefore we must take the underlying representation to be /koræge/. The only rule that applies to the first syllable, then, is Rounding Adjustment, which converts the vowel to [ʌ]. Since the underlying /o/ does not appear in the context (79), it does not undergo the processes summarized in (76). Velar Softening, Vowel Reduction, and *e*-Elision give the phonetic form [kʌrəǰ] (see p. 235, (133)). In the word *oven*, once again we cannot have an underlying /u/ since rule (77a) would apply, changing the vowel ultimately to /yūw/. If we take the underlying form to be /ovVn/, we will derive phonetic [ʌvən] by Rounding Adjustment. Notice that *oven*, with a voiced medial consonant, does not fit the context (79) and therefore does not undergo the processes of (76), as contrasted with *often*, with an unvoiced consonant following /o/, which does undergo these processes.[46]

Proceeding now with the discussion of phonetic [ɔ̄ʌ], we must still account for its occurrence before [rC] in *port*, *chord*, *force*. One possibility is that the underlying vowel is /o/ and that the second context of (79) should be extended to all sonorants (that is, to nasals and

[44] A further differentiation, into dialects which do and those which do not contrast *Roger* with *rajah*, *bother* with *father*, etc., in the first syllable, depends on a late phonetic rule involving [āʌ]. (See p. 205.)

[45] In the case of *honey*, *money*, a possible lexical representation is /hunni/, /munni/ (the double consonant being necessary to prevent application of rule (77a), which would result finally in phonetic [yūw]. The representations /honi/, /moni/ are more economical, however, in terms of features. Furthermore, in the case of *money* the latter representation has the advantage that only one feature change is then necessary to account for the alternation *money* (/moni/) – *monetary* (/mɔnitAry/).

[46] It is possible that the underlying representation of *oven* is /ofVn/ and that the medial consonant is voiced intervocalically. There are cases of intervocalic voicing of [s], and of [θ] as well, but we have not been able to arrive at a satisfactory formulation of these processes. (See Section 5.)

A similar observation is relevant in the case of the alternation *cloth–clothe*. Speculating beyond what we have worked out in detail, one might suppose that *cloth* has the underlying form /klɔθ/, and *clothe* the underlying form /klɔθe/. Intervocalic voicing converts the latter to [klɔðe], and the rule mentioned in note 40 converts the former to [kloθ], which then becomes phonetic [klɔ̄ʌθ] in the manner just indicated. The form [klɔðe] becomes [klɔ̄ðe] by rule (60b), which tenses [ɔ] before final CV, and then [klōwð] by the regular processes of Diphthongization, Vowel Shift, and *e*-Elision.

liquids, there being no vowels in this context). Suppose, then, that we replace (79) by (84):

(84) $$\text{——} \left\{ \begin{bmatrix} -\text{voice} \\ +\text{cont} \\ +\text{ant} \end{bmatrix} \right\} \\ [+\text{sonor}]\,\text{C}$$

The examples so far discussed are unchanged. But underlying /port/ will undergo a derivation exactly like that of (80), becoming, finally, [pɔ̄ʌrt].[47]

Consider now the words *told*, *hold*, etc., in which [o] occurs before [lC]. (See the discussion of Backness Adjustment (75)). The phonetic reflex of [o] in such cases is not to be distinguished from [ōw] resulting from underlying /ɔ̄/; thus *told* is phonetically identical to *tolled*, from /tɔ̄l#d/. We thus must account for the modification in (85):

(85) $$\text{o} \rightarrow \text{ōw} \;/\; \text{——l}$$

This is fairly simple within the present framework of rules. The segment [o] in the context ——*l*C will become [ʌ̄] by rule (77b) in the context (84). If we now block application of both rule (78), which converts [ʌ̄] to [ā], and the Glide Vocalization Rule, then the vowel [ʌ̄] will be assigned the glide [w] by the Diphthongization Rule, will be unaffected by Glide Vocalization and Vowel Shift, and will become [ō] by Rounding Adjustment. Thus [told] (which results from the application of rule (75) to underlying /tel/ before [d]) and underlying /hold/ will become phonetic [tōwld] and [hōwld], as required. The only modification of our rules is that rule (78) and Glide Vocalization must be blocked before [l]. We might provide for this by a lexical redundancy rule adding the feature specifications [−rule (78)] and [−Glide Vocalization] to lax vowels followed by [l] (thus, to the vowels of *tell*, *hold*, etc.) The fact that two exceptional properties must be noted raises doubts about the analysis. Observe that if we were not to block Glide Vocalization, the phonetic reflex of /ol/ would be [ōʌl], which would be acceptable if [ōwl] and [ōʌl] are not distinguished on phonetic grounds.

Still to be accounted for are occurrences of phonetic [āʌ] in final position and before [r], as in *spa*, *spar*, *spark*, *start*, and in words such as *balm*, *palm*, *calm*. The latter might be derived from underlying /ɔ/ in dialects which do not contrast the reflexes of /ɔ/ and /ā/, i.e., which do not contrast *bother–father*, *comet–calmer*, *bomb–balm*, etc. The situation is more interesting where these contrasts are retained, and underlying /ɔ/ is therefore excluded as a source. We cannot derive these words from underlying /bām/, etc., because /ā/ undergoes Rounding Adjustment in monosyllables, as we have seen (rule (68)). Conventional orthography suggests what is probably the optimal phonological solution. Notice, in fact, that although there are words such as *film*, *helm*, *culm* (from underlying /film/, /helm/, /kulm/), there are no cases of low vowels in the phonetic context ——*lm*. This suggests that words such as *balm* derive from underlying /bV*lm/, etc., where V* is some lax low vowel, by rules that convert /V*l/ to [āʌ]. Before turning to the choice of V* and the position

[47] The redundancy rule implied in note 40 will then have to be extended to the context ——*r*C for dialects in which only /. . . orC. . ./ appears and not /. . . ɔrC. . ./. This rule will state that lax back vowels become nonlow in the context ——*r*C. Notice that this extended rule, however, must be a rule of the phonology rather than a lexical redundancy rule, and must, in fact, follow the Laxing Rule (8). Thus, consider words such as *tear*, *swear*, *bear*, from underlying /tær/, /swær/, /bær/. With past and perfect inflection, these forms undergo Backness Adjustment (75) and become [tɔ̄r], etc. In the perfect, furthermore, /+Vn/ becomes [+n], and we have [tɔ̄r+n], etc. The Laxing Rule (8) converts this to [tɔrn], which must undergo the rule making lax vowels nonlow in the context ——*r*C, so that it will eventually become [tɔ̄ʌrn] (like [pɔ̄ʌrt], etc.)

and form of these rules, let us consider the other examples of phonetic [āʌ] mentioned at the outset of this paragraph.

Words such as *spa* seem rather difficult to account for. Clearly the underlying vowel cannot be /ā/, for Rounding Adjustment would give [spɔ̄ʌ] (like *law, flaw*). It cannot be any other tense vowel, for Vowel Shift would give a form from which [āʌ] cannot be derived; and even if the underlying vowel is lax, it will be tensed in final position by rule (20) and, being stressed, will undergo Vowel Shift, again giving a form which cannot become final [āʌ]. In fact, all of the tense vowels do appear in final position under stress (e.g., *fly, flee, flay, cow, coo, mow, boy, law*, from underlying /flī/, /flē/, /flǣ/, /kū/, /kō/, /mɔ̄/, /bɔ̄/, /lā/, respectively). Evidently, the only possibility is to represent *spa* with a lax vowel which is somehow prevented from being tensed by rule (20). We can block this rule, which tenses final vowels, by assigning some segment in the position after the vowel. This segment cannot be a vowel for the vowel of *spa* will become tense in prevocalic position. It cannot be a true consonant or a liquid since, in general, these segments do not drop when postvocalic in final position. It is, therefore, best to assume that these words end with a glide. We must, then, add a rule inserting some glide after the vowel of *spa* before the Tensing Rule (20) applies. Furthermore, consideration of the framework of already established rules indicates that the inserted glide must be [w], which will become [u] by the Glide Vocalization Rule (74) and will then undergo Vowel Shift to [ʌ], providing the centering off-glide needed in the phonetic representation [spāʌ]. We must therefore select as the underlying vowel of *spa* some lax vowel V* which will permit vocalization of the glide to take place and will ultimately become phonetic [ā]. In fact, we can achieve this result, adding only one rule, if we take V* to be /æ/.

Suppose, then, we represent *spa* as /spæ/ and add to the grammar a rule of *w*-Insertion, rule (86), to precede the Tensing Rule (20):

(86) $$\phi \rightarrow w \;/\; æ \text{——} \#$$

We will then have the following derivation for *spa*:

(87)

spæ	
spæw	RULE (86)
spæu	RULE (74)
spæʌ	VOWEL SHIFT; ROUNDING ADJUSTMENT
spaʌ	BACKNESS ADJUSTMENT (39)
spāʌ	RULE (5)

The rule of *w*-Insertion, which is entirely new, precedes the Tensing Rule (20) and permits the preceding vowel to remain lax, as required. The Glide Vocalization Rule (74) converts [w] to [u] when [w] follows a vowel that has the same value for the features "round" and "high." In previous examples this rule applied after [ū] and [ā]; since [æ] is [−round] and [−high], the rule applies after this vowel as well, and gives the third line of derivation (87). Vowel Shift and Rounding Adjustment apply in the usual way to give the fourth line of the derivation. To derive the next line, we apply the Backness Adjustment Rule (39), modified so as to yield [āw] as the reflex of /ū/. In this form, the rule is:

(88) $$\begin{bmatrix} +\text{low} \\ \text{V} \end{bmatrix} \rightarrow [+\text{back}] \;/\; \text{——} [-\text{cons}]$$

We have simplified rule (39) by dropping the feature [−vocalic] from the context (see p. 189). In the form (88), the Backness Adjustment Rule converts [ǣy], which results by Vowel Shift from underlying /ī/, to [āy]; it converts [ǣy] to [ōy] (see Section 4.3.3); and it converts [æʌ] to [aʌ] to yield the fifth line of the derivation (87). Recall that this form of the rule is designed for the dialect in which the phonetic reflex of /ū/ is [āw]. The rule must be slightly complicated, now, for the dialect in which the phonetic reflex is [æw].[48] The final line of the derivation results from the application of (89), which we have already presupposed, although we have not actually stated it:

(89) $$a \rightarrow [+\text{tense}]$$

This rule is presupposed by rule (5), which converts [ɔ] to [ā] (as in *cot*, *stop*, *conic*, etc.) Rule (5) involves unrounding and tensing. The unrounding will, of course, be a special case of Rounding Adjustment. Therefore (5) can be simplified to (89), which will apply in the derivation (87) to give the phonetic representation.

In summary, the only new rule is (86), the rule of *w*-Insertion.[49] Furthermore, there are several considerations that determine the underlying vowel of *spa* to be /æ/, as in the orthography.

Consider now phonetic [āʌ] in the words *spar*, *spark*, etc. We can account for these by extending rule (86) to (90):

(90) $$\phi \rightarrow w \;/\; æ \text{——} \begin{Bmatrix} rC \\ (r)\# \end{Bmatrix}$$

If we now take the underlying vowel to be /æ/, we derive the desired phonetic representations by derivations that are parallel to (87). Alternations such as *bar–barrier*, *bar–barrister*, *par–parity*, *car–carriage* lend some slight additional plausibility to the derivation of [ā] from /æ/ before [r].

Having outlined a possible solution to the problem of *spa*, *spar*, *spark*, etc., let us return to the forms *balm*, *calm*, and so on. We saw that these must apparently be derived from underlying /bV*lm/, /kV*lm/, where V* is some lax low vowel that we have not yet fully specified. Given the framework already established, the simplest solution seems to be to extend rule (90) to the context —— *lm* and to add a rule dropping [l] after the insertion

[48] For the dialect in which Backness Adjustment also applies to [āw], to give [æw], as in (39), we must further restrict the rule so that it applies to back vowels only in preglide position; otherwise [āʌ] (as in *father*) and [ōʌ] (as in *law*) will become nonback. This modification is straightforward, but it complicates the rule.

[49] We have very little to say, unfortunately, about the interesting question of how complexity of the lexicon should be measured against complication of the phonology in evaluating a grammar. Examples of the sort just considered are relevant to this, although the obviously tentative nature of the analysis we have just offered prevents us from relying on such evidence too heavily. It seems fairly clear that words such as *spa*, *pa* are not exceptions that must be independently memorized but, rather, follow from general rules. If true, this means that the phonetic form of these words should not be accounted for by idiosyncratic lexical specification. Notice that we could have accounted for the phonetic forms of *spa*, *pa* by deriving them from underlying /spā/, /pā/, which are differentiated from *paw* /pā/, which becomes [pōʌ] in the usual way, by the single feature [−Rounding Adjustment Rule]. Thus the alternatives seem to be these: (1) mark words such as *spa*, *pa* as exceptions with the single feature [−Rounding Adjustment Rule]; (2) incorporate rule (86) in the grammar. If it is correct that these words are "regular," not "exceptional," then (2) must be the correct alternative, and the evaluation measure must be so designed as to meet the empirical condition that having rule (86) in the phonology is less complex than adding the features in question to the lexicon.

of [w]. We can then take V* to be /æ/. We therefore extend rule (90) to (91) and derive *balm*, *calm*, etc., along the lines of (87).[50]

(91) $$\phi \rightarrow w \;/\; æ \text{——} \left\{ \begin{matrix} rC \\ \left(\left\{ \begin{matrix} r \\ lm \end{matrix} \right\} \right) \# \end{matrix} \right\}$$

It might be that (91) should be simplified by allowing *w*-Insertion after [ɔ] as well as [æ]. In this case we might account for the *horse–hoarse* contrast in certain dialects by representing *horse* as /hors/, as before, and representing *hoarse* as /hɔrs/. *Horse* becomes phonetic [hɔ̄ʌrs] in the manner described earlier (see (84)). According to Kenyon and Knott, the vowel of *hoarse* in such dialects is [ōw]. To account for this pronunciation, we add a rule tensing [ɔ] before [w], after the Diphthongization Rule and before the Vowel Shift Rule. Then /hɔrs/ becomes [hɔwrs] by the proposed simplification of (91), and the new tensing rule converts this to [hɔ̄wrs]. Finally Vowel Shift gives [hōwrs], as required.

Notice that phonetic [ɔ̄ʌ] in *salt*, *fault*, *somersault*, *scald*, etc., can be derived by the usual method for this vocalic nucleus, namely, from underlying /ā/ in monosyllables and /ū/ elsewhere, since /lt/ and /ld/, being dental clusters, may be preceded by tense vowels in formatives. There are, in fact, phonetic [ælC] clusters, as in *alp*, *scalp*, *formaldehyde*, *altitude*, so that we would not want to derive phonetic [ɔ̄ʌlC] from underlying /ælC/ in general.

There are a few other obvious remarks about tense low vowels. For example, Backness Adjustment applies to [æ] after [w], giving [ā] instead of the expected [æ] in *squalid*, *equality*, *wallet*, *want*, etc.; and there is a further step of Rounding Adjustment after [w] before liquids, as in *warn*, *squall*, and so on. It should also be noted that the vowels of words such as *tear*, *tore*, *pale* are phonetically low in many dialects, necessitating either a restriction on the Vowel Shift Rule before liquids or a late rule affecting mid tense vowels before liquids. In general, there is much more to say about vowel-liquid clusters beyond the few remarks that we have made, but we have not investigated this in any detail and will drop the matter here.

4.3.8. ROUNDING ADJUSTMENT

We have so far come across the following cases of Rounding Adjustment following Vowel Shift:

(92)
(a) ɨ̄ → [+round]
(b) ʌ̄ → [+round]
(c) ā → [+round]
(d) ɔ̄ → [−round]
(e) ɨ → [+round]
(f) a → [+round]
(g) o → [−round]
(h) ɔ → [−round]

The first case is the rule that applies to give phonetic [yūw] (p. 194). Case (b) gives phonetic [ōw] as in *told*, *sold* (p. 214). Case (c) gives phonetic [ɔ̄ʌ] as in *law*, *fraud* (p. 206). Case (d) gives phonetic [āw] or [æw] (p. 189). Case (e) gives phonetic [u] as in *pull*, *bush* (p. 204). Case (f) gives phonetic [ɔ] as in *cot*, *conic*, in British Received Pronunciation (pp. 212–13).

[50] We do not give (91) in the most compact possible form since it is quite likely that a deeper investigation of vowels before liquids will lead to a modification of the rules that we are suggesting here as a first approximation.

Case (g) gives phonetic [ʌ] in *courage, money* (p. 213). Case (h) gives [a] which becomes phonetic [ā] by rule (89) in General American *cot, conic* (p. 167).

Summarizing these facts, we can formulate the Rounding Adjustment Rule as (93):

(93)

$$\begin{bmatrix}\alpha\text{round}\\+\text{back}\end{bmatrix} \rightarrow [-\alpha\text{round}] \;/\; \left\{\begin{array}{ll}\left[\begin{array}{l}\\-\text{tense}\end{array}\right] & \text{(a)}\\ \left[\begin{array}{l}\\ \beta\text{low}\\ \beta\text{round}\\ +\text{tense}\end{array}\right] & \text{(b)}\\ \text{---V} & \text{(c)}\end{array}\right.$$

Case (a) of (93) accommodates (92e–h), which are the only lax back vowels that appear in derivations at the stage when the Rounding Adjustment Rule applies. Case (b) of (93) applies to the tense back vowels which have the same values for the features "low" and "round," that is, to the low round vowel [ɔ̄] and the two nonlow nonround vowels [ɨ̄] and [ʌ̄]. It thus accommodates cases (a), (b), and (d) of (92). Case (c) of (93) corresponds to case (c) of (92). The vowel [ā] is, in fact, the only one that is followed by a vowel at this stage so that the simplification of (92c) to (93c) is appropriate. To see why this is so, notice first that the only back vowels that can be followed by vowels at this stage are the low vowels [ā] and [ɔ̄].[51] But note further that the ordering of the three cases of (93) is conjunctive. Therefore, there will be no cases of [ɔ̄V] at the point where case (c) applies, since all cases of [ɔ̄] will have been unrounded by case (b). Therefore, (93c) has precisely the effect of (92c).

Although the three cases of (93) are conjunctively ordered, it is impossible for case (b) to apply to a segment to which case (a) has applied since the contexts are disjoint, and it is impossible for both case (c) and case (a) to apply since there are no nontense back vowels followed by vowels. It is possible, however, for case (c) to apply to a segment formed by case (b). This possibility is illustrated by the derivation of the vocalic nucleus [ɔ̄ʌ] from underlying /ū/. To clarify what is involved, we repeat (73), the derivations of *mountain* and *maudlin*, with the final step of Rounding Adjustment now made explicit in terms of rule (93):

(94)

mūntən	mūdlin	
mūwntən	mūwdlin	DIPHTHONGIZATION
	mūudlin	GLIDE VOCALIZATION (74)
mɔ̄wntən	mɔ̄odlin	VOWEL SHIFT
	mɔ̄ʌdlin	RULE (93a)
māwntən	māʌdlin	RULE (93b)
	mɔ̄ʌdlin	RULE (93c)

We see, then, that the Rounding Adjustment Rule (93) has just the desired effects, covering the cases summarized in (92) in such a way as to account for the fact that [ɔ̄] remains rounded before a centering glide but not before a labializing glide.

The joint effect of the Rounding Adjustment and Backness Adjustment Rules is to centralize the vowels originating from underlying /ɨ̄/ and /ū/. Our analysis postulates that

[51] Recall that lax vowels have been tensed in prevocalic position by rule (20) and that glides have been inserted after all tense vowels by the Diphthongization Rule. Consequently, the only cases of VV are those in which the second V results from a [w] glide by rule (74), the rule of Glide Vocalization. As we have seen, Glide Vocalization applies only after the vowels [æ], [ā], and [ū]. The first of these is irrelevant, being nonback at this stage of derivation. The vowel [ū] has become [ɔ̄] by Vowel Shift. Consequently, only [ā] and [ɔ̄] can fall under (93c).

these processes of centralization follow Vowel Shift. An alternative analysis that deserves consideration would be to place the centralization rules before the Vowel Shift Rule in the ordering. We have investigated this possibility in some detail (following a suggestion by R. Stockwell) and have come to the tentative conclusion that it is not workable. The reasons are of some interest. The major phenomena for which the Vowel Shift and centralization rules are designed (namely, alternations such as *divine–divinity*, *profound–profundity*) can, in fact, be handled about as well with either analysis. But the subsidiary phenomena that we have discussed in the last few sections—specifically, the irregular verbs that can be explained in terms of double application of Vowel Shift (e.g., *drive–drove*; see p. 202), the various minor back vowel alternations, etc.—cannot, so far as we can see, be subsumed under even partial generalizations if the alternative ordering is accepted. These observations would tend to suggest that the ordering is determined not by the basic class of examples but by the subsidiary and marginal cases that can be brought under partial generalizations with one ordering but not the other.

Considerations involving general conditions on plausible phonological rules which we discuss in Chapter Nine suggest that there is a principled reason for the ordering of processes that we propose. Historical aspects of this problem are discussed in Chapter Six.

5. *Further consequences of the Vowel Shift Rule*

We have so far discussed the Vowel Shift Rule only in connection with vowel alternations. However, since consonant alternations are determined in part by vocalic context, we might expect to find effects of the Vowel Shift Rule in the consonant system, and this is in fact the case.

Consider alternations such as those illustrated below:

(95)
(a) *criticism–criticize–critical*
(b) *medicine–medical–medicate*
(c) *allege–allegation*
(d) *rigid–rigor*
(e) *regal–regicide*
(f) *analogous–analogize*

In each of the words *criticism*, *medicine*, *rigid*, the consonant in boldface undergoes softening before a nonlow nonback vowel (which may be [e] as well as [i]). This process of Velar Softening, one case of which we gave earlier as (6), we now restate as (96):

(96)
$$\begin{Bmatrix} g \\ k \end{Bmatrix} \rightarrow \begin{Bmatrix} \check{j} \\ s \end{Bmatrix} / \_\_ \begin{bmatrix} -\text{low} \\ -\text{back} \\ V \end{bmatrix}$$

We observe, once again, that (96) can be analyzed into several steps and that it applies only to certain lexically marked elements.

Notice that Velar Softening must precede the Vowel Reduction Rule. After Vowel Reduction the boldface elements of *critical*, *medicine*, *medical*, *rigid*, *rigor* are all followed by the same vowel (which is, furthermore, back). Before the application of the Vowel Reduction Rule, on the other hand, the appropriate context for (96) is still in evidence: the phonological segments which do soften are followed by [i], and those that do not are followed by [æ] or the vowel of the affix *-or*.

Additional information bearing on the position of (96) in the sequence of rules is

provided by the words *criticize*, *regicide*, *analogize*, *medicate*, *allegation* in (95). In these examples we have the [s], [ǰ] variants of /k/, /g/ in the phonetic context ——[āy] and the [k], [g] variants in the phonetic context ——[ēy]. Both cases seem to contradict the Velar Softening Rule (96). However, we observe that in these examples the underlying forms are [kritikīz], [rēgikīd], [ænæləgīz], [medikāt], [ælegātiVn], respectively. Thus, in the underlying forms, the velars that soften are followed by nonback nonlow vowels, and those that do not soften are followed by vowels that are back or low. We conclude, then, that rule (96) must also precede the Vowel Shift Rule, which changes the nonlow vowel [ī] to low [ǣ], and low [ǣ] to nonlow [ē]. Thus we have derivations such as (97) for the examples of (95):

(97)

(a) rég+æl	(b) rég+i+kìd		
	réǰ+i+sìd	RULE (96)	
	réǰ+i+sìd	LAXING RULE (19b)	
réyg+æl	réǰ+i+sìyd	DIPHTHONGIZATION (21)	
ríygəl	réǰəsə̀yd	VOWEL SHIFT (43), VOWEL REDUCTION	

All three occurrences of phonological velars in (97) appear in the context of a following vowel which, in its phonetic quality, does not permit softening (namely, back [ə] or [ā]). Nevertheless, both velars of (97b) soften by rule (96) because the *underlying* vowel following them is nonback and nonlow, while the velar of (97a) does not soften because the underlying vowel following it is low. Here, then, is new justification for the Vowel Shift Rule, entirely independent of that adduced in Section 4.

Only one further comment is needed concerning the examples of (95). We must account for the softening of the phonological /g/ of *allege*. To soften, this segment must be followed by a nonback nonlow vowel, which drops in final position. Evidently, this must be the vowel [e], which has the appropriate features and which is dropped, when final, by the *e*-Elision Rule (Chapter Three, rule (155)). We conclude, then, that *allege* must have the phonological representation /ælege/.[52] These observations give independent support for the rule of *e*-Elision.

Along the same lines, we can now provide an explanation for the alternation [yūw]–[ʌ], as in *reduce-reduction*.[53] If we take the underlying form to be /re=duke/, where = is the boundary symbol discussed in Chapter Three (p. 94), and the stem is assigned to the category of elements that undergo derivational processes and Velar Softening, then we will have the following derivations:

(98)

re=duke	re=duke+ǣt+iVn	
	re=duk+t+iVn	READJUSTMENT RULES
re=duse		RULE (96)
re=dīse		RULE (77a)
re=dyīse		RULE (50)
re=dyīwse		DIPHTHONGIZATION (21)
	re=dok+t+iVn	VOWEL SHIFT (43), CASE (63)
re=dyūwse	re=dʌk+t+iVn	ROUNDING ADJUSTMENT (93)
rədyūws	rədʌkšən	(RULES TO BE GIVEN LATER)

[52] Alternatively, /ad = lege/ (see p. 222). Either choice will lead to the correct stress assignment by the rules of Chapter Three. Notice that [e] drops here before *-ation*, exactly as in *reduction* (in which case [ǣ] of *-ation* also drops—see p. 201) and many other forms.

[53] In some dialects the alternation is [ūw]–[ʌ] because of the rule deleting [y] which was mentioned in note 27. We return to this matter in Section 6.

The only special feature of *reduce* is that, along with quite a few other verbs, it drops [(V)+æ] when suffixed with *-ation*, giving the second line of (98). To obtain the alternants [rīydyūws] and [rīydʌkšən], the prefix might be represented with tense /ē/; alternatively, the Tensing Rule might be slightly revised.

To conclude this discussion, we discuss one additional example illustrating the Velar Softening Rule (96). We had occasion in Chapter Three (p. 95) to refer to a rule that we restate for now as (99):

(99) $$s \rightarrow [+\text{voice}] \quad / \quad V = \text{——} V$$

Thus, in prefix-stem verbs, for example, we find pairs such as those of (100), where the /s/ of the stems *-sume*, *-serve*, *-sist*, *-sign* is unvoiced in the first column, since the prefix ends in a consonant, but voiced in the second, where the prefix ends in a vowel:

(100)

consume	*resume*
conserve	*preserve, deserve*
consist, insist, persist	*resist*
consign	*resign, design*

Notice, however, that among the prefix-stem verbs there are certain pairs, such as *incite–recite*, *concede–recede*, which seem to contradict rule (99) since phonetic [s] rather than [z] occurs intervocalically following =. We now have an explanation for this. We give the stems *-cite*, *-cede* the underlying representations /kīt/, /kēd/, respectively, assigning them to the category of elements subject to derivational processes and Velar Softening. As we have just observed, Velar Softening precedes Vowel Shift. Thus, after Velar Softening yields [re=sīt], [re=sēd] for *recite*, *recede*, these become [re=sāyt] and [re=sīyd], respectively, by regular processes that we have already discussed. To prevent the voicing of [s] to [z] in these forms, it is necessary only to have rule (99) precede rule (96) (more properly, the last stage of (96), which gives [s]). In these and similar cases, the required phonetic output will be obtained if we enter the forms in the lexicon in the manner suggested by conventional orthography, which here, once again, turns out to be quite close to the correct underlying representation.

Consider next the following forms:

(101)

extend	*contend*
expel	*compel*
exclude	*conclude*
exceed	*concede*
excite	*incite*

It is clear, from the first three pairs, that one of the prefixes of the paradigm we are concerned with is [eks]. We have just seen, furthermore, that the underlying stems in *concede*, *incite*—and, therefore, in *exceed*, *excite*—are /kēd/, /kīt/, with /k/ becoming [s] by Velar Softening. Thus *exceed* and *excite* must, at an intermediate stage of derivation, have the form [eks = sīyd], [eks=sāyt], respectively (after Vowel Shift). These words, however, do not have [ss] sequences phonetically, showing that there must be a rule that simplifies [s=s] clusters to [s]. As we have already seen (cf. rule (156) in Chapter Three, p. 148), this is simply a special case of the general rule of Cluster Simplification that replaces or deletes one C of a CC sequence where the two consonants are identical. Along with the rule (99) of *s*-Voicing, then, there is the rule of Cluster Simplification. In words such as *exceed*, *excel*, we have an

unvoiced phonetic [ks] cluster produced by Cluster Simplification applied to [ks=s] (originally from [ks=k]). A rule voicing prestress [ks] clusters (compare *examine*, *exalt*, etc.—see (119), p. 228) is blocked by the cluster of three consonants.

Among the prefixes are also *ad-*, *ab-*, *sus-*, *sub-*, as in *adhere*, *admire*, *abhor*, *abduce*, *suspect*, *sustain*, *subdue*, *subsist*. Consider now, alongside of the examples of (100), such words as:

(102) *assume*, *assist*, *assign*

In these forms we have phonetic [s] in intervocalic post-boundary position, in apparent contradiction to rule (99). Notice, however, that there are no forms **adsume*, **adsist*, **adsign*, just as there are no **adtest*, **abpear* alongside of *attest*, *appear*. This arrangement of occurring forms indicates that the prefixes *ab-* and *ad-* undergo assimilation of the final consonant under certain conditions, with the resulting clusters later simplifying by the general Cluster Simplification Rule. Thus we have the rule:

(103) $$C \rightarrow C^* \;/\; æ \text{——} = C^*$$

where C and C* are both noncoronal (i.e., labial or velar) or both coronal (i.e., dental or palato-alveolar). Thus [æd=test]→[æt=test]→[ætest] (by Cluster Simplification); [æb=pēr]→[æp=pēr]→[æpīyr] (*appear*); [æd=sist]→[æs=sist]→[æsist] (*assist*); and so on. The [s] in the forms of (102) thus remains unvoiced because the [s=s] sequence blocks (99) and only later simplifies to [s] by Cluster Simplification. In a similar way we can account for sets such as *resemble–dissemble–assemble*, with [z] in the first form, rule (99) having applied, and [s] in the other two forms, rule (99) having been blocked by the cluster which later simplifies.

Quite similar remarks apply to the prefixes *sus-*, *sub-*. Again, we have assimilation (analogous to (103)) and simplification, giving forms such as *suffice*, *support*, *succumb*.

Notice, incidentally, that rule (103) is actually somewhat more general, since we also have partial assimilation of the final nasal of a prefix, as in the words *compel*, *combat* versus *conceive*, *contend*.

Finally, consider the following words:

(104) *accede*, *succeed*, *suggest*

By the symmetry of the paradigms we are considering, these must have the underlying representations of (105), although they have the phonetic representations of (106) (with, possibly, reduction of the vowel in the prefix):

(105) /ab=kēd/, /sub=kēd/, /sub=gest/

(106) [æksīyd], [sʌksīyd], [sʌgǰest]

The phonetic forms of (106) result from the underlying representations of (105) in the following way. First, the Assimilation Rule (103) (with the generalization to *sub-* mentioned above) applies to give the forms of (107):

(107) [æk=kēd], [suk=kēd], [sug=gest]

Next, Velar Softening applies, followed by Diphthongization and Vowel Shift in the usual way, giving, finally, (106). Hence the forms of (106) result from perfectly regular phonological processes and are quite analogous to those of (100), (101), (102), despite superficial differences.

The examples we have discussed in this chapter by no means exhaust the phonology of the English vowel system. However, they do cover what seem to us some of the most difficult and crucial aspects of vocalic phonology, and they illustrate the form that this aspect of a phonological description must apparently assume.

6. *The consonant system of English*

Although it is not without its problems, the consonant system seems less interesting than the vowel system, and we will not treat it in anything like the same detail. We have already discussed the analysis of consonants into true consonants, glides, and liquids, and have pointed out that there is a cross-classification into obstruents and sonorants, the latter category containing nasals, liquids, and glides (along with the vowels). We will be concerned here only with obstruents and their relation to glides.

The obstruents may be analyzed in terms of the features [±coronal] and [±anterior] in a way that corresponds roughly with the traditional analysis into dentals, palato-alveolars, labials, and velars. (See Chapter Seven for further discussion of our conception of the phonetic framework.)

(108)

	+coronal	−coronal
+anterior	dental	labial
−anterior	palato-alveolar	velar

We assume that of the segments listed in Table I, Section 3, the lexicon of English contains the following examples in the four categories of (108):

(109)

dental	t, d		s, z	θ, ð
palato-alveolar	č, ǰ		š, ž	
labial	p, b	f, v		
velar	k, g	k^w, g^w		x (x^w)

Thus each category has stops and continuants, the dental continuants being further divided into [±strident]. Among the velars, the stops are subdivided into [±round]; the labialized (rounded) consonants are interpreted as the sequences [kw], [gw], and [xw], respectively. The velar continuant /x/ becomes phonetic [h]. The palato-alveolars (particularly when voiced), the rounded velars, and the velar continuant have limited distributions in the lexicon, but we will not go into the readjustment rules needed to describe these facts. Recall that there is a further lexical classification of velar stops in terms of the feature [±deriv], specifically, in terms of susceptibility to Velar Softening. We will represent the velar stops that belong to the "derivable" category and undergo Velar Softening as /k^d/, /g^d/, contrasting with /k/ and /g/. Among the readjustment rules, there are many that apply to specific derivable formatives; for example, the rule (110):

(110)

$$t \rightarrow d \;/\; = \begin{Bmatrix} mi \text{——} +ive \\ ver \text{——} +ion \end{Bmatrix}$$

This will account for the spirantization of /t/ in *submissive* (by rule (120a) below, with subsequent devoicing) and the voicing of /t/ in *subversion* (which then becomes [ž] by later rules). There will be no further discussion of these readjustment rules.

We will present here what seems to be the core of the system of rules involving consonants, listing the rules in the order in which they appear, with a few comments about each. Several illustrative derivations will follow the presentation of the rules.

If it is correct to take /x/ and /x^{w}/ as the segments underlying [h] and [hw], as might be suggested on grounds of lexical simplicity (see also p. 234), then we must add a rule converting the velar fricative into a glide:

(111) $$\begin{bmatrix} -\text{cor} \\ -\text{ant} \\ +\text{cont} \end{bmatrix} \rightarrow \text{h}$$

We must now give a rule inserting [w] after rounded velars, that is, after /k^{w}/, /g^{w}/, and [h^{w}] (resulting from (111)):

(112) $$\phi \rightarrow \text{w} \; / \begin{bmatrix} +\text{round} \\ \text{C} \end{bmatrix} ——$$

Rule (112) inserts [w] after the velar in words such as *square*, *language*, and (in some dialects) *when* [hwen]. This rule might be combined with (91), which also inserts [w].

We turn next to the Velar Softening Rule, which has been discussed several times (see (96)). This rule converts /g/ to [ǰ] and /k/ to [s]. To convert /g/ to [ǰ], we must modify /g/ with respect to the features "coronal" and "strident." Thus the rule affecting /g/ is (113):

(113) $$\text{g}^{\text{d}} \rightarrow \begin{bmatrix} +\text{cor} \\ +\text{strid} \end{bmatrix} / —— \begin{bmatrix} -\text{back} \\ -\text{low} \\ -\text{cons} \end{bmatrix}$$

If we were to generalize rule (113) simply by extending it to /k^{d}/, then it would convert /k^{d}/ to [č], which would fall together with the original /č/ of *chair*, *chastity*, *church*, etc. We therefore instead amend rule (113) so that it assigns to /k^{d}/, but not to /g^{d}/, the feature [+anterior] as well as the features [+strident], [+coronal]. (As mentioned in Section 3, the features "high," "back," and "low" play no crucial role in the consonant system of English, within the present framework, and will in general not appear in the rules of this section. See however, Chapter 9, Section 4, for a reformulation of the Velar Softening Rule in a revised framework.)

(114) VELAR SOFTENING

$$\begin{bmatrix} -\text{cont} \\ -\text{ant} \\ +\text{deriv} \\ \langle -\text{voice} \rangle \end{bmatrix} \rightarrow \begin{bmatrix} +\text{cor} \\ +\text{strid} \\ \langle +\text{ant} \rangle \end{bmatrix} / —— \begin{bmatrix} -\text{back} \\ -\text{low} \\ -\text{cons} \end{bmatrix}$$

Rule (114) abbreviates two rules, the first of which changes /k^{d}/ to [c] (i.e., the dental affricate) and the second of which converts /g^{d}/ to [ǰ]. The change of [c] to [s], which will complete the process of velar softening for /k^{d}/, will be effected by a later rule. Observe that rule (114) converts /k^{d}/ into a segment which is distinct from every other segment.

The rules mentioned so far must be quite early in the ordering. As we shall see later, they must precede the rules of Tensing and *e*-Elision, among others. We may, in fact, place them either before or immediately after the rules of stress assignment. Notice, however, that these are rules of word phonology, not cyclic rules.

At this point in the ordering, then, we reach the rules of the stress cycle discussed in the preceding chapter. Of particular relevance here are two rules that were dealt with in Chapter Three, one of which (rule (130), p. 130) converts [y] to [i] and the other of which (rule (57), p. 87) converts [i] to [y]. We restate these two rules as (115) and (116), respectively:

(115) $$y \rightarrow i \;/\; C \text{——} [-seg]$$

(116) $$i \rightarrow y \;/\; \begin{bmatrix} +cor \\ C \end{bmatrix} + \text{——} V$$

Rule (115) converts formative-final /y/ to [i] (ultimately, [īy]) in words such as *industry*, *oligarchy*, *industrial*, *industrious*. As we noted in Chapter Three, rule (115) must be in the cycle (and must clearly follow the rules of stress assignment if *-y* is to assign stress in the appropriate way). Thus the word *felonious*, for example, will have the underlying representation $[_A[_N$felən+y$]_N$ əs$]_A$. In the first cycle, primary stress is assigned to the first syllable and /y/ becomes [i] by rule (115). Thus we begin the second cycle with the form $[_A$fél^{1}ən+i+əs$]_A$, and the rules of stress assignment, together with those discussed earlier in this chapter, give the phonetic representation [fələ́wnīyəs].

Now consider rule (116). As noted in Chapter Three, this rule too must be in the cycle, to account for the placement of primary stress in words such as *convéntional*. Therefore both rule (115) and rule (116) must be in the cycle, after the rules of stress assignment.

Rule (115) seems correct as it stands, but rule (116) requires somewhat closer study. As given it converts [i] to [y] in the context C+——V, where C is a dental or palato-alveolar. It does not apply where C is a labial (cf. *oblivion*, *champion*, *marsupial*, etc.)[54] or a velar (*Kentuckian*, *tracheal*—recall that velars of the phonological category [+deriv] have, at this point, become dentals if unvoiced or palato-alveolars if voiced). But when the consonant is dental or palato-alveolar, the situation is fairly complex. Thus the rule converting [i] to [y] applies to the words in Column I of (117) but not to those in Column II:

(117)

	I	II
(a)	*rebellious*	*punctilious*
	bilious	*familial*
	Pennsylvania	*Lithuania*
(b)	*pavilion*	*quaternion*
	battalion	*accordion*
	onion	*enchiridion*
	companion	*collodion*
		ganglion
(c)		*colonial*
		testimonial
		felonious
		ignominious
(d)	*religious*	*criterion*
	admonition	*clarion*

(*continued*)

[54] The word *savior* is an exception, if pronounced [sAvyər].

(117) *continued*

(e)	*partial*	*cardial*
	officious	*invidious*
	Russian	*lithium*
(f)	*invasion*	
	confession	

Furthermore, there is nearly free variation in forms such as *mammalian*, *marginalia*, *Mendelian* and near contrasts such as *ingenious* versus *genial*.

Such facts suggest that the applicability of rule (116) is rather idiosyncratic and that there must be a feature [±rule (116)] that categorizes certain formatives containing [i]. The worst possible case would be that this feature is entirely free. However, closer inspection of examples such as those in (117) suggests that there are redundancies that can be exploited.

Consider first the examples under case (a). It seems that in the items of Column I there is some motivation for a formative boundary before the segment [i] that is subject to the rule, while in the items of Column II there is no reason to place a formative boundary in this position. These cases, therefore, are already taken care of by rule (116), which applies only to items with + in the appropriate position, and we can limit the feature [±rule (116)] to formatives that begin with [i]. It will then follow that rule (116) will not apply to words such as those of Column II, case (a), if the underlying forms are /puNktili+ɔs/, /fæmily+æl/,[55] /liθuæniæ/. If correct, this is a considerable improvement.

Consider now case (b) of (117). Notice first that there is good motivation for assuming that all of these words are phonologically represented in the form /...iVn/ rather than /...yVn/. There are two reasons for this: first, the representation /...yVn/ would violate otherwise valid restrictions on the distribution of /y/ in the lexicon; second, the placement of stress requires the analysis with /iVn/. Furthermore, except for the words *quaternion* and *ganglion*, all words with terminal *-ion*, where this is not a nominalization element, fall into Column II when the consonant is [d] and into Column I when it is any other consonant. Therefore, continuing with the assumption made in connection with case (a), we can add a readjustment rule assigning formative boundary in the context C——*iVn*, when C ≠ [d]. The only exceptions, then, are *quaternion* and *ganglion*. These are also the only examples in which the segment [i] which is subject to the rule follows a CS cluster (where S is a sonorant). We therefore restrict the readjustment rule that inserts formative boundary to the context φC——*iVn*, where φ is a vowel if C is a sonorant. With this rule, no classification with respect to rule (116) is necessary for the examples of case (b).

The examples of case (c), which are representative, indicate that the formative [i] or [y] takes the categorial feature [−rule (116)] when it follows [n]. The right-hand column of case (d) illustrates the fact that after [r], [i] is always assigned [−rule (116)]. Alternatively, we could modify the readjustment rule introducing + in the context C——*iVn* to exclude [r] as well as [d]. The reason for assuming that rule (116) applies in the examples of (d) of Column I is that there must be a later rule that deletes [y] after nonliquid palato-alveolars (rule (122)), as in the boldface positions of words such as *religious*, *admonition* (presumably

[55] Supporting evidence comes from comparing *familial* [fəmilīyəl] with *familiar* [fəmilyər]. The underlying form of the latter is /fæmil+i+æl/. A very general rule converts *-al* to *-ar* in the context *l*(+*i*)—— (cf. *similar*, *molecular*, etc.) Rule (116) then gives the cited phonetic form for *familiar*. If there is no formative boundary after /l/ in *familial*, the rule converting *-al* to *-ar* will not apply, and rule (116) will not apply. Thus both of the phonetic differences between *familiar* and *familial* are determined by the presence or absence of formative boundary.

from /ædmənіš/, although such examples as *punish–punitive* might suggest a close relation between [š] and [t] in these forms). Case (e) demonstrates that the formative [i] is assigned [−rule (116)] after [d] (cf. case (b)) and also after nonstrident continuants. Case (f) shows that the nominalization affix *-ion* always undergoes rule (116), so that no categorization is necessary in this case.

It seems, then, that the feature [±rule (116)] can be predicted for the formatives /i/ and /iVn/ and that the position of formative boundary will otherwise determine its applicability in accordance with rule (116), with only a few ad hoc rules (e.g., case (b)) and marginal exceptions.[56]

With these observations, we can return to the problem of how to formulate rules (115) and (116). Since these are rather similar in form and since both must be in the cycle, it is clear that they fall together as indicated in (118):

$$(118) \qquad \begin{bmatrix} -\text{back} \\ +\text{high} \\ -\text{cons} \end{bmatrix} \rightarrow \begin{Bmatrix} [+\text{voc}] \;/\; \text{C} \text{——} [-\text{seg}] & \text{(a)} \\ [-\text{voc}] \;/\; \begin{bmatrix} +\text{cor} \\ \text{C} \end{bmatrix} + \text{——} \begin{bmatrix} \alpha\text{stress} \\ \text{V} \end{bmatrix} & \text{(b)} \end{Bmatrix}$$

Case (a) restates (115); case (b), (116). The redundancy rules sketched above determine the correct applicability of (118b).

Let us now consider how rule (118) is ordered with respect to the other rules of the cycle, and, in particular, what the condition is on α in (118b). In the examples we have given so far, it was always the case that $\alpha = -$. Furthermore, it is quite clear that when $\alpha = 1$, rule (118b) does not apply. Thus consider the words *peculiar, familiar*. Since they terminate in phonetic [...lyər], the underlying forms must be /pekul+i+æl/, /fæmil+i+æl/, respectively. The rule mentioned in note 55 converts the final /l/ of *-al* to [r]. Rule (118b) then converts [i] to [y] in the expected way. But consider the forms *familiarity, peculiarity*. In one major dialect these terminate in phonetic [...lEærətE]. Therefore it must be that in the final cycle, after stress is assigned to *-ar* and [y] becomes [i] before *-ar* by rule (118a), rule (118b) is blocked by the primary stress on the following vowel. Thus the segment [i] remains, and becomes [E] by familiar processes.

These facts show that rule (118) must follow the rules of stress assignment and that α must meet the condition $\alpha \neq 1$ in rule (118b). We see so far, then, that when $\alpha = -$, the rule is applicable, and when $\alpha = 1$, the rule is inapplicable.

Now consider the case in which the segment [i] is followed by a vowel in the [+stress] category with stress weaker than 1. Examples of this are *auxiliary, beneficiary*. The former will have the form [ūksil+i+ār+i] at the point when (118b) is to apply, as we shall see directly. If this rule does not apply, we will derive, finally, the form [ɔ̄gzilEerE], by application of the other rules of this and the preceding chapter. If (118b) does apply, we derive [ɔ̄gzilyərE], the penultimate vowel reducing in immediate poststress position by the Auxiliary Reduction Rule (118d) of Chapter Three. In precisely the same way, we will derive for *beneficiary* the phonetic form [benəfišEerE] (from underlying /benefik+i+ār+y/) if (118b) does not apply, and [benəfišərE] if (118b) does apply.

[56] It may be noted, moreover, that such words as *órientate, álienate, améliorate, detériorate* are apparent exceptions to the Alternating Stress Rule if they are pronounced with [īy] rather than [y] in the position V́C——. Notice that the exceptional behavior could be accounted for by extending (116) to cover these cases, with a later rule, following the Alternating Stress Rule, converting [y] once again to [i].

The applicability of rule (118b) in these cases depends on the condition on α. If the condition is $\alpha = -$, then rule (118b) will not apply; if the condition is $\alpha \neq 1$, then rule (118b) will apply. As we have noted in Chapter Three (p. 123), both cases are possible. The dialectal variation, then, depends on how the condition on α is given in rule (118b). We note, incidentally, that in the dialect with the condition $\alpha \neq 1$ in rule (118b), this rule must precede the Auxiliary Reduction Rule that assigns to an immediately post-tonic vowel the features [−tense], [−stress] in certain contexts so that it becomes subject to reduction.

The position of rule (118) in the ordering is still more narrowly constrained than this, as we can see by considering forms such as *emaciate*. The only phonetic realization in this case is [Em$\overset{1}{\text{A}}$šE$\overset{3}{\text{A}}$t]. But consider the dialect with the condition $\alpha \neq 1$ in rule (118b). Since this rule does not apply to *emaciate*, it must be that [At] in *emaciate* has primary stress at the point in the derivation when we reach (118b); that is to say, it must be that the form is [*emac*+*i*+$\overset{1}{A}t$]. Evidently rule (118b) must precede the Alternating Stress Rule, which converts the preceding form to [*emac*+*i*+$\overset{1}{\underset{2}{A}}t$]. Therefore rule (118b) must follow the Main Stress Rule and precede the Alternating Stress Rule (and, therefore, the Auxiliary Reduction Rules).

Summarizing, then, rule (118b) is in the cycle, following the Main Stress Rule and preceding the Alternating Stress Rule, and the condition on α is $\alpha \neq 1$ for one dialect (in which this ordering is determined) and $\alpha = -$ for another dialect.

At this point we reach the main rules of word phonology discussed earlier in this chapter, in particular, the Laxing and Tensing Rules. After the Tensing Rules, we come to the rule of *s*-Voicing that was mentioned earlier in this chapter (rule (99)) and in the preceding chapter. Rule (119) is a somewhat more accurate version of this rule:

$$(119) \qquad \begin{bmatrix} +\text{cor} \\ +\text{strid} \\ +\text{cont} \end{bmatrix} \rightarrow [+\text{voice}] \; / \; \begin{Bmatrix} \text{V} = \text{——} \text{V} & \text{(a)} \\ \begin{bmatrix} +\text{tense} \\ \text{V} \end{bmatrix} \text{——} \text{V} & \text{(b)} \\ \text{Vk——}\acute{\text{V}} & \text{(c)} \end{Bmatrix}$$

As it stands, rule (119) slightly extends rule (99) of Section 5. Case (a) applies in words such as *resume*, *reside*, *resident*, *design*, *resolute*. Case (b) applies in words such as *music*, *rosary*, *miser*, *gymnasium*, *Cartesian*, *Asia*, *usual*, from underlying /musik/, /rōsVry/, /mīsVr/, /gimnæsi+Vm/, /kærtes+i+æn/, /æs+iæ/, /usuæl/ (with a further rule of palatalization for the last three forms). Notice that voicing does not take place in *issue* (from underlying /isue/), *asylum*, *misogyny*, *philosoph*(*-y*, *-ical*), etc., because the preceding vowel is lax. However, as the rule now stands, there are quite a few exceptions (e.g., *basic*, *isolate*, *masonite*, *gruesome*, *awesome*).[57] Case (c) applies where the orthography has *x* in such words

[57] Many apparent exceptions to rule (119) can be accounted for by taking the source of [s] to be /k^{d}/ rather than /s/. Recall that original /k^{d}/ before [i], [e], [y], [ɛ] is now [c], at this stage of derivation (by Velar Softening (114)) and therefore is not voiced by rule (119). The last two examples listed—*gruesome* and *awesome*—suggest a readjustment rule exempting /s/ from rule (119) after formative boundary. Notice that the first three examples given as exceptions are also exceptions to the Laxing Rule (19b). Perhaps, then, we should say that these words undergo laxing and are therefore exempt from *s*-Voicing, and that their irregularity consists in the fact that they undergo subsequent idiosyncratic tensing. Certain other exceptions to (119), particularly to case (b), can be accounted for by lexical redundancy; for example, /s/ is exempt from this rule in the few words of the lexical form / . . . VsV/(e.g., *virtuoso*, *Caruso*, *Medusa*). Others will be accounted for by rule (124a), which devoices [z] in certain positions.

Notice that rule (118b), which converts the [i] in *Cartesian* to [y], applies before (119). The rightmost V in the context of (119b) should therefore be generalized to [—consonantal]. As the present discussion is rather informal, however, we shall not incorporate this consequence into the rule.

as *exist, examine, auxiliary, exasperate.* In poststress position, as in *axis* and *maxillary*, the cluster remains unvoiced. Notice, however, that the rule does not apply in *hexameter, toxicity, annexation*, and, in general, whenever the [ks] cluster is final in the formative. This exception requires a readjustment rule which assigns the feature [−rule (119)] to /s/ in the context *k*——+.[58] Perhaps case (c) should be extended to other C*s* clusters, as in *absolve, absorb, observe.* Notice that the voicing of [k] in the context ——*z* is by a later rule of voicing assimilation. Clearly there is a great deal more to the matter of voicing of [s] (and probably [f] and [θ] as well—see p. 232) that deserves more careful investigation.

Underlying stops and [c] which derives from /k^{d}/ become strident continuants before [i] or [y] under circumstances that we state as rule (120):

(120) SPIRANTIZATION

$$\begin{bmatrix} +\text{cor} \\ +\text{ant} \\ -\text{sonor} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{cont} \\ +\text{strid} \end{bmatrix} \Big/ \left\{ \begin{array}{ll} \left[\begin{array}{c}\text{———} \\ +\text{voice}\end{array}\right] + ive & \text{(a)} \\ \left[\begin{array}{c}\text{———} \\ -\text{voice}\end{array}\right] + \begin{bmatrix} -\text{cons} \\ -\text{back} \\ -\text{stress} \end{bmatrix} [-\text{seg}] & \text{(b)} \\ \text{——} + \text{y} & \text{(c)} \\ \left[\begin{array}{c}\text{———} \\ +\text{strid}\end{array}\right] & \text{(d)} \end{array} \right.$$

Rule (120) converts dental stops to [s] if unvoiced or to [z] if voiced. Case (a) applies in words such as *corrode+ive, evade+ive*, giving, ultimately, *corrosive, evasive* by a later devoicing rule (see (124)). Case (b) applies in words such as *partiality, ingratiate*, in the boldface positions; in *democracy, controversy, residency* (from underlying forms in /...t+y/, with /y/ becoming [i] by rule (118a) and [ī] by the Tensing Rule); and to the parallel forms *confidence, residence*, etc., with final /+ɛ/ (see Chapter Three, p. 161), which, in contrast to final /y/, does not become [+vocalic] by rule (118a). Rule (120b) does not apply to *remedy* (where the dental is voiced) or to *difficulty, modesty* if we derive these from /difikult+ty/, /mɔd+est+ty/, as seems natural for nominalized adjectives (cf. *loyalty, royalty*, etc.) It does apply, however, to the /t/ in words such as *partial, Egyptian, expeditious*, the augment /i/ having become [y] by rule (118b). (The continuant formed by rule (120), in these cases, will palatalize by rule (121).) Rule (120c) applies in words such as *contrition*, from underlying /kɔntrit+iVn/, and *division*, from underlying /divīd+iVn/, the /i/ of /iVn/ having become [y] by rule (118b). Notice that the Spirantization Rule will not apply in *cardial, Canadian, invidious*, etc., in which the augment remains [i]. Case (d) applies to the segment [c] produced by the Velar Softening Rule (114). It constitutes the last stage of velar softening for the unvoiced segment /k^{d}/.

Notice that where [t] is not followed by formative boundary (e.g., all forms in *-ity*, which we have represented as /i+ty/—see p. 33—and words such as *patio, piteous, Antioch, Pontiac*), it does not become [s] (ultimately, [š]) by rule (120).

The Spirantization Rule must follow the rule of *s*-Voicing, since the [s] formed by rule (120) does not voice. It must precede the rule of *e*-Elision so as to account for the spirantization of [t] in *residence* (from underlying /re=sīd+ent+ɛ/), *confidence*, etc. It must also precede rule (50), which inserts the [y] glide of [yūw]. Therefore, we do not have spirantization of [t] in *fact+ual*, etc., by rule (120c). Clearly some further generalization is possible in the statement of (120), but we will leave it in this form.

[58] As in the context + ——; see note 57. Notice that case (b) is also inapplicable before certain affixes (e.g., *dosage, usage*).

We are now at the point in the cycle where rule (50) inserts the [y] glide of [yūw]. This, in turn, is followed by a series of vowel adjustment rules which includes Dipthongization, Vowel Shift, and Rounding Adjustment. We then have a rule that changes dentals to palato-alveolars before [y]. Thus *division* has the form [diviz+yVn] at this stage of the derivation, the underlying /d/ having become [z] by the Spirantization Rule (120). This occurrence of [z] must now become palatal so that we derive, ultimately, [dəvižən], the glide after [ž] dropping by a later rule. Similarly, [s] deriving from underlying /k^{d}/ will become [š] in the boldface positions of words such as *logician*, *musician* (the post-palatal glide again dropping by a later rule), and the same is true of [s] from underlying /t/, as in *controversial*, *partial*, *prohibition*. And [t], [d], [s], and [z] will become [č], [ǰ], [š], and [ž], respectively, before [yūw] in words such as *actual*, *gradual*, *sensual*, *visual*. The process is blocked, however, if the dental consonant in question is followed by a vowel, as in the word *satiety*, which at this stage is represented as [sæt+ā́y+i+tīy], or if it is followed by [yV́], as in *fortuitous*, *endure*, *ensue*, *resume* (cf., for example, *perpetual* [pərpéčūwəl] versus *perpetuity* (pərpətyū́wətīy]). To describe these and several other facts, we give the Palatalization Rule in the following form:

(121) PALATALIZATION

$$\begin{bmatrix} -\text{sonor} \\ +\text{cor} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{ant} \\ +\text{strid} \end{bmatrix} / \text{——} \begin{bmatrix} -\text{back} \\ -\text{voc} \\ -\text{cons} \end{bmatrix} \begin{bmatrix} -\text{cons} \\ -\text{stress} \end{bmatrix}$$

In the form given above, the Palatalization Rule applies to a dental obstruent followed by *y*V̌, where V̌ is a stressless vowel. Thus the rule will not apply to the segments in the boldface positions in *society*, *perpetuity*, or the verb *associate*, which are represented as [səsā́yitīy], [pVrpetyū́witīy], and [æsṓwsīyè̀yt], respectively, at this stage of derivation.

The last example, *associate*, points to an inadequacy in the analysis presented. Although the phonetic segment [s] is fairly common in the boldface position, we also commonly find [š]; and, in certain forms (for example, *emaciate*, *beneficiary*), it seems that the phonetic realization of underlying /k^{d}/ is [š] in all dialects. The facts are unclear. Thus Kenyon and Knott give only [š] for *emaciate* and *associate*, and both [s] and [š] for *emaciation*, *association*, *sociology*. To account for [š] in this position, we must extend the rule to the context $\begin{bmatrix} \text{———} \\ +\text{continuant} \end{bmatrix} \bar{\imath}y \begin{bmatrix} \alpha\,\text{stress} \\ -\text{consonantal} \end{bmatrix}$, requiring that $\alpha \neq 1$ in dialects that have [š] in *associate* and [s] in *association*. Since these variants seem to coexist or to be distributed in various ways in many styles of speech, we must assume a considerable degree of arbitrary lexical categorization or of dialect mixture. Pending further analysis, we leave the question in this state.[59]

Since palatalization in dentals takes place by rule (121) only before glides, we do not have palatalization of the stops in the boldface positions of *primordial*, *remedial*, *medium*, *piteous*, *Pontiac*, etc. In all of these words, the segment following the dental consonant in question is the vowel [ī], not the glide [y], at the point when the Palatalization Rule (121) applies.

[59] We have made no systematic attempt to investigate the *s–š* alternation in these positions or to collect other exceptions to these rules. However, the following are among those that come to mind: *mature* [məčū́r] in many dialects, instead of expected [mətū́wr] or [mətyū́wr]; *luxurious* [lʌgžū́rīyəs] instead of expected [lʌgz(y)ū́rīəs] (cf. *exude*, *exuberant*, in which palatalization does not take place).

One additional complication must be noted. Although the processes just described that convert [Di] to [Py] (where D is a dental and P the corresponding palato-alveolar) apply in the boldface positions in words such as *Cartesian*, *Russian*,[60] *prejudicial*, they do not apply in the boldface positions of *potassium*, *magnesium*, *gymnasium*. Thus we have phonetic contrasts such as [kārtEžən]–[ǰimnAzEəm]. The dropping of the glide is contingent on Palatalization, as we shall see directly. Palatalization depends on the change of [i] to [y] by rule (118b). Therefore it is sufficient to distinguish pairs such as *Cartesian–gymnasium* in terms of the applicability of rule (118b), as in the examples of (117). Notice that rule (118b) must be blocked only in certain cases of underlying /s/, but not in the case of underlying /k^{d}/, which is represented as [c] at the point in a derivation at which (118b) applies. Therefore, at worst a categorization of underlying /s/ is involved. However, notice that rule (118b) applies to [i] only when it is preceded by formative boundary. This suggests that we instead distinguish the cases in question by the presence or absence of formative boundary, with lexical representations such as /kærtes+i+æn/, /gimnæsi+Vm/. In many cases, the formative boundary seems reasonably well motivated. Alternatively, we could add [±rule (118b)] as a new classification of /i/ after /s/.

Next, we must delete glides after palato-alveolars, by rule (122):

$$(122) \qquad \begin{bmatrix} -\text{cons} \\ -\text{voc} \end{bmatrix} \rightarrow \phi \; / \; \begin{bmatrix} +\text{cor} \\ -\text{ant} \\ -\text{sonor} \end{bmatrix} ——$$

This rule applies, in particular, to the [y]-glide inserted by rule (50) before [U], giving phonetic [ækčūwæl] from [ækčyūwæl] (*actual*), [išūw] from [išyūwe] (*issue*), etc. Similarly, the segment [y] from underlying /i/ drops in the boldface position in words such as *religion*, *decision*, *artificial*. Rule (122) is restricted to the position following obstruents. Thus it does not apply after the palatal liquid [r], and we have forms such as *virulent* with [ry], alongside of *pavilion* with [ly] where the liquid is not palatal. There are no glides in this position.

Notice that rule (122) will delete the element in the boldface position in *religion*, *artificial*, but not in *religiosity*, *artificiality*, *emaciate*. The reason is that the following vowel is stressed in the latter group, preventing the boldface segment from becoming a glide. Thus consider the final cycle in the derivation of words such as *religiosity*. The stress assignment rules assign [+stress] in the position following the boldface segment [i]. Rule (118a) converts this segment to [i] (if it was converted to [y] in an earlier cycle). But case (b) of (118) does not apply since the following vowel is stressed. Therefore this segment is not a glide and is not subject to rule (122).

We have observed (see note 27) that in some dialects [y] also drops after dentals and palato-alveolars in certain other positions, as in *residue*, *constitute*, *tune*, *rule*, *rejuvenate*. In such dialects [y] drops in all contexts in which rule (121) has not applied. Thus we have contrasts such as *residue* [rézədūw] – *residual* [rəzíǰūwəl], *constitute* [kánstətūwt] – *constitutive* [kənstíčūwtiv]. Hence, if only dental obstruents were involved, we could state

[60] The fact that the Palatalization Rule applies in *Russian* indicates that rule (121) must follow the rule of Cluster Simplification discussed in Section 5. The underlying form for *Russian* must be /russ+i+æn/; if it were /rus+i+æn/, we would derive *[rUšən] instead of [rʌšən]. Thus, if Palatalization preceded Cluster Simplification, we would derive *[rʌssən], incorrectly. Furthermore, the rule of Cluster Simplification must follow the rule of Spirantization, since underlying /eks=kēd/, which becomes [eks=sēd] by Velar Softening and Spirantization, must then become [eksēd] by Cluster Simplification. The correct order, therefore, is: Spirantization, Cluster Simplification, Palatalization.

simply that [y] drops after dental obstruents, giving no further contextual information. But additional information is needed for instances of [y] following dental and palatal sonorants. Thus [y] never drops after these segments in words such as *virulent*, *annual*, *valuable*. The relevant fact is the stress on the following vowel. Where the stress is other than minus, the glide drops. Thus it drops after such dental obstruents as have not become palatal by rule (121) and after liquids before stressed vowels.

$$(123) \qquad y \rightarrow \phi \; / \begin{bmatrix} +\text{cor} \\ +\text{cons} \end{bmatrix} \text{——} [+\text{stress}]$$

In addition to these rules, there are several other minor modifications needed; for example, that of (124):

$$(124) \qquad z \rightarrow [-\text{voice}] \; / \text{——} + ive$$

Rule (124) accounts for the devoicing in *abusive*, *evasive*. Notice that in the case of *evade*, *corrode*, *divide*, etc., we have a [d]–[ž]–[s] alternation ([EvAd]–[EvAžən]–[EvAsiv]) by a combination of regular processes.

Rule (124) should no doubt be extended to other cases. For example, we pointed out (note 58) that we have [s] rather than [z] in ——+*age*, a fact which can be accounted for by adding *-age* to (124) instead of by a readjustment rule as suggested in note 58. Examples such as *sausage* suggest that devoicing in this position may be more general, not requiring formative boundary. Words such as *kinesis*, *osmosis* suggest either that *-is* be added to (124) or that the underlying forms are *kinet-*, *osmot-*, etc., and that the Spirantization Rule (120) has an additional case involving *-is*. There are, however, questions about the [s]–[t] alternations in pairs such as *galaxy–galactic*, *climax–climactic*, *osmosis–osmotic* that we have not answered. Also relevant here are the well-known morphological processes that determine the voicing of final [f], [s], [θ] in noun-verb pairs and adjective-verb pairs. Thus we have devoicing in the nouns *choice*,[61] *advice*, *breath*, *abuse*, formed from the corresponding verbs, and voicing in the verbs *house*, *clothe*, etc., which are presumably formed from the underlying nouns. Similarly, we have pairs such as *safe–save*, *life–live*, with devoicing in the adjective and noun and voicing in the verb. Whatever the correct analysis of these forms may be, we should have no difficulty incorporating it within the framework so far established, For example, the rule that devoices the final continuant of a noun or adjective derived from a verb can be formulated in terms of a lexical category associated with such derived forms, which becomes a segmental feature [+φ] by the conventions discussed in Section 2.2. We can then add to rule (124) the context $\begin{bmatrix} \text{—} \\ +\varphi \end{bmatrix}$. If, alternatively, the suggestion of note 46 can be realized and the voicing of [f], [s], [θ] can be determined by the context $\begin{bmatrix} +\text{tense} \\ \text{V} \end{bmatrix}$——CV (where tenseness and thus voicing are

[61] If the verb is the underlying form, then we will presumably have to give it the lexical representation /čōz/. The past tense form will be determined correctly as [čōwz] by regular processes. To derive the present tense form [čūwz], we must mark the verb *choose* with the feature that permits double application of the Vowel Shift Rule in its present tense form, in the manner discussed in Section 4.3.5. To derive *choice*, we must subject the underlying form /čōz/ to a unique case of lexical backness adjustment which does not carry with it the automatic rounding adjustment that makes rounding coincide with backness. Thus /čōz/ will, by this process, become [čœz], which becomes [čōyz] in the regular way, and then [čōys] by the devoicing associated with the derivational process of nominalization.

presumably determined by the final /e/, which is later elided), we can omit any consideration of this matter from rule (124), since voicing will be accounted for by the *s*-Voicing Rule (119), extended to the other continuants by dropping the feature [+strident].

A further modification is required in the Spirantization Rule (120). If the rule remains in its present form, words such as *question* and *bastion* will appear in the output as *[kwesšən] and *[bašən], rather than as [kwesčən] and [bačən]. The reason is that (120) spirantizes occurrences of /t/ before the suffix *-ion*. The [s] resulting from (120) is then subject to the Palatalization Rule (121), which yields [š] in the output.[62]

We recall in this regard that Spirantization does not apply in words such as *factual* (see p. 229). In these words the underlying /t/ is reflected in the output as [č], which is precisely what is needed in the case of *question, bastion*. Thus, if the Spirantization Rule can be modified so that it does not apply to the /t/ in *question, bastion*, the correct output will be obtained: the /t/ will be unaffected by Spirantization and will subsequently be changed to [č] by the Palatalization Rule (121), just as in the case of *factual*. The simplest way to achieve this result seems to be to block the application of cases (b) and (c) of the Spirantization Rule in obstruents that are preceded by [s]. In other words, we require that the segment undergoing the relevant cases of Spirantization be preceded by $\begin{Bmatrix}[+\text{sonorant}]\\[-\text{continuant}]\end{Bmatrix}$, that is, by a segment which is either a sonorant or a noncontinuant. The rule will then not apply to the /t/ in *question, bastion*, which is preceded by a continuant obstruent, and the derivations will proceed correctly.

As matters now stand, the examples where Spirantization is blocked involve only the position following [s]. Note, however, that the above modification as stated will prevent the rule from applying after other continuant obstruents as well. This fact has an interesting consequence for a case not yet analyzed. Consider the word *righteous*, which is clearly derived from *right*. If the underlying form for *right* is /rīt/, then *righteous* would be represented as /rīt+i+əs/ on the lexical level. By the Laxing Rule, we derive [rit+i+əs]; and the rules of this section give, finally, *[rišəs]. Thus the correct form, [rāyčəs], deviates from what is expected in two ways: first, in that the first vowel is tense rather than lax; second, in that it has [č] instead of expected [š]. These observations lead us to seek a different analysis for the underlying form for *right*.

Suppose that we represent *right* as /riφt/, where φ is a continuant. Suppose then that we add the ad hoc rules (125) and (126):

(125) $$V \rightarrow [+\text{tense}] \;/\; \text{——}\varphi$$

(126) $$\varphi \rightarrow \phi \;/\; \text{——}C$$

Rule (125) must follow Laxing and precede Vowel Shift: it can therefore be part of the general Tensing Rule. Rule (126) will be one of the late rules of deletion, following (124). With these rules, we derive [rīφt] from underlying /riφt/ by rule (125), and then [rāyt] by Diphthongization, Vowel Shift, Backness Adjustment, and rule (126). But now consider *righteous*, represented /riφt+i+əs/. Considering just the final cycle, we have the derivation shown in (127).

[62] We are grateful to P. Schachter for drawing our attention to certain aspects of this problem.

(127)

riφt+i+əs	
rīφt+i+əs	RULE (125)
rīφt+y+əs	RULE (118b)
rāyφt+y+əs	DIPHTHONGIZATION, VOWEL SHIFT, BACKNESS ADJUSTMENT
rāyφč+y+əs	RULE (121)
rāyφč+əs	RULE (122)
rāyč+əs	RULE (126)
rāyčəs	VOWEL REDUCTION

Thus rules (125) and (126) will account for both of the unexpected features of *righteous*, if we can make an appropriate choice of a continuant for /φ/. Notice that Spirantization, rule (120), is blocked by the continuant preceding [t].

Note that as matters now stand, dental, palato-alveolar, and labial continuants can appear in postvocalic position (e.g., *miss*, *wrist*, *if*, *rift*, *swish*), but the velar continuant /x/ cannot. Filling this phonological gap, we can represent *right* as /rixt/, taking /x/ to be /φ/ in the analysis just suggested. We then replace (125) by (128) and coalesce the rephrased version of (126) with rule (111), which is now placed much later in the ordering, in fact, after (124):

(128) $$V \rightarrow [+\text{tense}] \; / \; \text{——} x$$

(129) $$\begin{bmatrix} -\text{cor} \\ -\text{ant} \\ +\text{cont} \end{bmatrix} \rightarrow \begin{Bmatrix} \phi \; / \; \text{——} C \\ [-\text{cons}] \end{Bmatrix}$$

We then form *righteous* from underlying /rixt+i+əs/ by derivation (127) with /x/ replacing /φ/. Both of the rules (125) and (126) fall together with other already motivated rules (see also (130) below).

The same device might be used to explain various other exceptions to trisyllabic laxing, as in the boldface positions of ***night**ingale* and ***might**ily*. Furthermore, we can use it to explain alternations such as *resign–resignation*, *paradigm–paradigmatic*. Suppose that we add a rule converting [g] to a continuant in the context ——[+nasal]#. Then underlying /re=sign/, /pæræ+digm/ will become [rezign], [pærədigm] before *-Ation*, *-atic*, respectively, but in the forms in isolation, [g] will become [γ] before [+nasal]#. If we simplify rule (128) to the context ——[x, γ], then that rule will convert [re=siγn] and [pæræ+diγm] to [re=sīγn], [pæræ+dīγm], respectively. The tensed vowel becomes [āy] in the familiar way. Rule (129) will delete [γ], giving the forms [rīyzāyn], [pærədāym].

Finally, it has been suggested to us by S. Anderson that the apparently irregular occurrence of [ŋ] instead of [ŋg] in word-medial position, as in *dinghy*, *hangar*, *gingham*, *Birmingham*, may be readily accounted for if the forms are assumed to have underlying representations such as /dinxi/, /xænxr/, etc. The nasal will assimilate the point of articulation of the following velar by a rule that is independently motivated (cf. *think*, *finger*, etc.) Next, (129) deletes [x] by an extension which requires deletion of this segment in the context C——.

These alternations support the choice of [x] over other possibilities for φ in example (127).

The tensing of vowels before velar continuants is apparently restricted to high vowels. Although examples are far from plentiful, cases such as *phlegm–phlegmatic*, *diaphragm–diaphragmatic* seem to suggest that nonhigh vowels do not undergo tensing here.

Moreover, if cases such as *pugnacious–impugn* are also to be handled by this rule, (128) should be reformulated as

(130) $$\begin{bmatrix} +\text{high} \\ \text{V} \end{bmatrix} \rightarrow \begin{bmatrix} +\text{tense} \\ -\text{round} \end{bmatrix} \; / \; \text{——} [\text{x}, \gamma]$$

We can illustrate the rules we have discussed with derivations such as the following. We restrict ourselves to the rules of this section, for the most part.

(131)

logician	*logicism*	*religious*	
lɔg^{d}+ik^{d}+i+æn	lɔg^{d}+ik^{d}+izm	relig^{d}+i+ɔs	
ǰ c	ǰ c	ǰ	RULE (114)
y		y	RULE (118b)
s			RULE (120b)
	s		RULE (120d)
š			RULE (121)
ϕ		ϕ	RULE (122)
ləǰíšən	lā́ǰəsìzm[63]	rəlíǰəs	

(132)

decision	*artificiality*	
de=k^{d}id+iVn	ærtifik^{d}+i+æl+i+ty	
^{1}ī	^{1}i	FIRST CYCLE
c	c	RULE (114)
	^{2}i ^{1}æ	STRESS RULES, SECOND CYCLE
y		RULE (118b)
	s	RULE (120b)[64]
ż		RULE (120c)
s		RULE (120d)[64]
ž	š	RULE (121)[65]
ϕ		RULE (122)
dəsížən	àrtəfìšīyǽlətīy	

(133)

courage	*courageous*[66]	
k^{d}oræg^{d}e	k^{d}oræg^{d}e+ɔs	
	^{1}o	FIRST CYCLE, FOR *courage*
ǰ	ǰ	RULE (114)
^{1}o	^{2}o ^{1}æ	STRESS RULES
	ǣ	TENSING RULE
ϕ	ϕ	*e*-ELISION
kʌ́rəǰ	kərḗyǰəs	

[63] The pronunciation [lōwǰəsizm] requires the underlying form /lōg+ik/, an exception to laxing before *-ic*.

[64] Notice that the segment [i] following [c] in *artificiality* has already been tensed by the Tensing Rule, and the segment [ī] following [c] in *decision* has already been laxed by the Laxing Rule.

[65] Recall the discussion (p. 231) of the [s]–[š] alternation in such forms.

[66] See note 18.

SUMMARY OF RULES

In this chapter we restate the major rules of the phonology as given in the preceding chapters, ordered in the way that is required by the facts cited in the discussion.

In the previous chapters the assumption has been made that the vowels appearing in the abstract underlying representations of English lexical items are monophthongs. Diphthongs—i.e., sequences of a vowel followed by a glide—are the result of phonological rules that insert glides in certain positions.[1] There are six lax vowels in the underlying representations, namely:

	−back −round	+back +round
+high −low	i	u
−high −low	e	o
−high +low	æ	ɔ

In some dialects there is an additional marginal subcategorization of /æ/ (see p. 205).

The tense vowels include the tense correlates of the lax vowels; and there is distinctive rounding for the low tense vowels, so that we have the full set: /ǣ/ /æ̆/ /ā/ /ɔ̄/. The distinctive feature complexes of the individual segments mentioned in the discussion appear in Table 1 of Chapter Four (p. 176).

The rules that we have given fall into two general classes: the rules of the readjustment component and the phonological rules. The former apply before any of the phonological rules. They express properties of lexical formatives in certain restricted syntactic contexts, and they modify syntactically generated surface structures in a variety of ways. The phonological rules are organized in a transformational cycle. A considerable number of phonological rules, however, are limited so that they apply in the cycle only when the level of word boundary has been reached. We have called the latter "rules of word-level phonology."

[1] There are, of course, sequences of vowels in the underlying representations. These may occur across a formative boundary, as in *scient-*, which is phonologically /ski+ent/ (giving *science*, *scientific* by regular processes); or they may occur, marginally, within certain formatives, such as *neo-*, *dia-*, *dial*, *fuel*, *via*.

The cyclic rules fall together in the ordering, and all but rule (16) (which changes *i* to *y* and *y* to *i*) are rules of primary stress assignment. If the ordering were revised so that (17) (the Alternating Stress Rule) and (18) (the Compound, Nuclear Stress, and Stress Adjustment Rules) preceded (16), then the rules that assign primary stress would be consecutive and would collapse into a single schema of the form:

$$V \rightarrow [1 \text{ stress}] \; / \; \ldots$$

We noted that the justification for ordering (16) before (17) is not overwhelming, and there is no relation between (16) and (18). If, furthermore, the analysis is revised in such a way as to drop rule (16) from the cycle, then the cycle would be restricted to a single elaborate schema abbreviating a complex set of rules, with intricate relations of ordering among them, all assigning primary stress in certain positions. In Chapter Three we explained why we were unable to accept this analysis, but it seems sufficiently attractive for more thought to be given to its consequences.

Among the processes of primary stress assignment, there are three that shift stress to the left: the others shift stress to the right, in general. The three processes that shift stress left are the Stressed Syllable Rule (condition (c) of the Main Stress Rule (15)), the Alternating Stress Rule (17), and the Compound Rule of (18). As we have noted several times, it is not impossible that the Compound Rule can be amalgamated with the Stressed Syllable Rule (as the Nuclear Stress Rule can be amalgamated with condition (e) of the Main Stress Rule) in terms of a general notion of "sonority" (see p. 91). Although we rejected this analysis, for reasons indicated earlier, we feel that it still merits attention. It is also worth mentioning the possibility of amalgamating the Stressed Syllable and Alternating Stress Rules, each of which shifts stress to the left within a word before a final stressed syllable (with the modifications presented in the detailed exposition earlier). Such an amalgamation, like the others just noted, has more than a superficial plausibility, but we have rejected it for several reasons. First, there are certain technical difficulties, within our framework, in formulating the schema that would incorporate both these processes. More seriously, a careful analysis of the cases suggests that there really is a fundamental distinction between them. The matter is important, both for synchronic and diachronic study of English, and some additional comment may be useful.

Reducing the Stressed Syllable Rule and the Alternating Stress Rule to their essentials, we see that each defines a context containing a stressed syllable, and each assigns primary stress in a domain that is to the left of this context. The Stressed Syllable Rule interprets this domain in terms of the Romance Stress Rule; thus it assigns primary stress to a final strong cluster or to the syllable preceding a final weak cluster, in this domain. The Alternating Stress Rule, on the other hand, assigns primary stress to the penultimate syllable of the domain, independently of the form of the final syllable of the domain. Thus the Stressed Syllable Rule is responsible for placement of primary stress in the boldface position in *anticip–atory* and *confisc–atory* (where the dash separates the domain from the context); and the Alternating Stress Rule is responsible for the position of primary stress in ***a**necd–ote*. *confisc–ate*, *phi**l**ist–ine*.

It might be supposed that these processes can be amalgamated by assigning the feature [+D], which excludes a syllable from the domain of stress assignment (see p. 138), in the case of the Alternating Stress Rule, just as [+D] was assigned for the Stressed Syllable and Affix Rules in certain instances. At best, this would be unfortunate, since assignment of [+D] is by general rule in the latter cases, whereas in this case it would be entirely

idiosyncratic and ad hoc. Still worse, the proposal will fail because of such words as *extrapol–ate*, in which the penultimate syllable of the domain is weak and noninitial.

There is, however, a still more serious reason for suspecting that the two processes under discussion do not fall together. There is an interesting generalization that must somehow be captured by the rules in question: namely, the Alternating Stress Rule, which does not make use of the strong cluster principle, applies in a given cycle if and only if stress has been assigned to the final syllable in this cycle under one of the conditions (a)–(e) of the Main Stress Rule; whereas the Stressed Syllable Rule, which does make use of the strong cluster principle, applies in a given cycle if and only if stress has been assigned to the final syllable either in an earlier cycle under condition (e) of the Main Stress Rule or in the cycle in question under condition (a) of the Main Stress Rule. This is an important correlation between reliance on the strong cluster principle, on the one hand, and a complex interconnection of rules, on the other. It is precisely this generalization that is expressed by the ordering of condition (c) of the Main Stress Rule between conditions (a) and (e), along with the principles of cyclic application and of disjunctive and conjunctive ordering. This conclusion appears to us to be significant. It leads us to believe that the attempt to amalgamate the Stressed Syllable Rule and Alternating Stress Rule would be misguided, quite apart from any technical considerations, despite the similarity between the two processes.

We turn now to a summary of the rules.

In the list below a few readjustment rules are given first ((1)–(9)), merely as an illustrative sample. They are followed by the phonological rules ((10)–(43)). The rules that are not restricted to the level of word boundary are starred; all rules not starred in this list are rules of word-level phonology. We will give each rule with a citation of the chapter (Roman numeral) and example number of the most recent reference to it; where there are several citations, these refer to relevant comments about the form of the rule. The rules are not necessarily given in the most reduced form.

1. *Readjustment rules*

(1) $$V \rightarrow \begin{bmatrix} -\alpha back \\ -\alpha round \end{bmatrix} / \begin{bmatrix} \text{——} \\ \alpha back \end{bmatrix}$$ in a number of irregular verbs, nouns, and adjectives in certain contexts — IV (75)

(2) $$t \rightarrow [+voice] \; / = \begin{Bmatrix} mi \text{——} +ive \\ ver \text{——} +iVn \end{Bmatrix}$$ — IV (110)

(3) $$C \rightarrow C^* \; / \begin{Bmatrix} æ \\ su \end{Bmatrix} \text{——} = C^*$$ where C and C* are both coronal or both noncoronal — IV (103)

(4) $$V \rightarrow [-\text{rule (20 III)}] \; / \; \text{——} \begin{bmatrix} +cons \\ +ant \\ +cor \end{bmatrix} \begin{bmatrix} +cons \\ +cor \end{bmatrix} \begin{Bmatrix} [-cons] \\ [-seg] \end{Bmatrix}$$ — IV (9)

(5) $\bar{u} \rightarrow [-\text{rule (32)}] \; / \; \text{——} \left\{ \begin{matrix} C_0\# \\ [+\text{nasal}]\,C \\ V \end{matrix} \right\}$ IV (72)

(6) $\bar{a} \rightarrow [-\text{rule (34)}]$ in polysyllables IV (70)

(7) $V \rightarrow \begin{bmatrix} -\text{rule (30)} \\ -\text{rule (32)} \end{bmatrix} \; / \; \text{——} 1$ IV p. 214

(8) $u \rightarrow [-\text{round}] \; / \; \begin{bmatrix} -\text{nasal} \\ +\text{ant} \\ -\text{cor} \end{bmatrix} \text{——} \left\{ \begin{matrix} 1 \left\{ \begin{matrix} 1 \\ \# \end{matrix} \right\} \\ \begin{bmatrix} -\text{ant} \\ +\text{cor} \\ -\text{voc} \end{bmatrix} \end{matrix} \right\}$ IV (66)

(9) $C \rightarrow [+\text{cor}] \; / \; \bar{u} \text{——} [-\text{seg}]$ IV (54)

2. *Phonological rules*

(10) $[u, i] \rightarrow \phi \; / + \text{——} \#$ III (129) and note 84

(11) $\phi \rightarrow u \; / \begin{bmatrix} -\text{cont} \\ -\text{voc} \\ +\text{cons} \end{bmatrix} \text{——} 1 + VC\,[-\text{seg}]$ IV (56)

(12) $\phi \rightarrow w \; / \left\{ \begin{matrix} æ \text{——} \left\{ \begin{matrix} rC \\ \left(\left\{ \begin{matrix} r \\ lm \end{matrix} \right\} \right) \# \end{matrix} \right\} \\ \begin{bmatrix} +\text{round} \\ -\text{voc} \\ +\text{cons} \end{bmatrix} \text{——} \end{matrix} \right\}$ IV (91), (112)

(13) VELAR SOFTENING

$$\begin{bmatrix} -\text{cont} \\ -\text{ant} \\ +\text{deriv} \\ \langle -\text{voice} \rangle \end{bmatrix} \rightarrow \begin{bmatrix} +\text{cor} \\ +\text{strid} \\ \langle +\text{ant} \rangle \end{bmatrix} \; / \; \text{——} \begin{bmatrix} -\text{back} \\ -\text{low} \\ -\text{cons} \end{bmatrix}$$ IV (114)

*(14) $\begin{bmatrix} +\text{tense} \\ V \end{bmatrix} \rightarrow [1\ \text{stress}] \; / + \text{——} C_0\#$ III (158)

*(15) MAIN STRESS

$$\mathrm{V} \rightarrow [1\ \text{stress}] \;/\; \Big[X \text{——} \mathrm{C}_0 \Big(\begin{bmatrix} -\text{tense} \\ \gamma\text{stress} \\ \mathrm{V} \end{bmatrix} \mathrm{C}_0^1 \Big(\begin{bmatrix} \alpha\text{voc} \\ \alpha\text{cons} \\ -\text{ant} \end{bmatrix} \Big) \Big) \qquad \text{III (101), (122), (136), (151)}$$

$$/ \text{——} \Big\langle \Big(\begin{Bmatrix} (fik)At \\ \\ [+\mathrm{D}]\,\mathrm{C}_0 \end{Bmatrix} \Big) \begin{Bmatrix} \langle_1 + \mathrm{C}_0 \rangle_1 \begin{bmatrix} -\text{stress} \\ -\text{tense} \\ -\text{cons} \end{bmatrix} [+\text{cons}]_0 \\ \\ \langle_1 \begin{bmatrix} -\text{seg} \\ \langle_2 - \text{FB} \rangle_2 \end{bmatrix} \rangle_1 \mathrm{C}_0\, [\beta\text{stress}]\, \mathrm{C}_0 \langle_2 \mathrm{V}_0 \mathrm{C}_0 \rangle_2 \end{Bmatrix} \Big\rangle \Big]_{\langle \mathbf{NSP} \langle_1 \mathbf{VA} \rangle_1 \rangle}$$

Conditions: $\beta = \begin{Bmatrix} 2 \\ 1 \end{Bmatrix}$

$\gamma \leq 2$

X contains no internal #

*(16)

$$\begin{bmatrix} -\text{back} \\ +\text{high} \\ -\text{cons} \end{bmatrix} \rightarrow \begin{Bmatrix} [+\text{voc}] \;/\; \mathrm{C} \text{——} [-\text{seg}] \\ [-\text{voc}] \;/\; \begin{bmatrix} +\text{cor} \\ \mathrm{C} \end{bmatrix} + \text{——} \begin{bmatrix} \alpha\text{stress} \\ \mathrm{V} \end{bmatrix} \end{Bmatrix} X \Big] \qquad \text{IV (118)}$$

Conditions: $\alpha = -$, or $\alpha \neq 1$

X contains no internal #

*(17) ALTERNATING STRESS

$$\mathrm{V} \rightarrow [1\ \text{stress}] \;/\; \text{——} \mathrm{C}_0 (=) \mathrm{C}_0 \mathrm{V} \mathrm{C}_0\, [1\ \text{stress}]\, \mathrm{C}_0]_{\mathbf{NAV}} \qquad \text{III (75)}$$

*(18) COMPOUND, NUCLEAR STRESS, STRESS ADJUSTMENT

$$\mathrm{V} \rightarrow [1\ \text{stress}] \;/\; [\#\,\#\,X \begin{bmatrix} \overline{\qquad} \\ 1\ \text{stress} \end{bmatrix} Y \langle \#\,\#\,Z \rangle\, \#\,\#]_{\langle \mathbf{NAV} \rangle} \qquad \text{III (52), (68), (70)}$$

where $Y \neq \ldots [1\ \text{stress}] \ldots$; $Z \neq \ldots \#\,\# \ldots$

(19)

$$[2\ \text{stress}] \rightarrow [3\ \text{stress}] \;/\; \text{——} \mathrm{C}_0 [1\ \text{stress}] \qquad \text{III (117)}$$

(20) LAXING

(I) AUXILIARY REDUCTION—I

$$\mathrm{V} \rightarrow \begin{bmatrix} -\text{stress} \\ -\text{tense} \end{bmatrix} \Big/ \begin{Bmatrix} \langle \mathrm{VC}_0 \rangle \begin{bmatrix} \overline{\qquad} \\ \alpha\text{stress} \\ \langle +\text{tense} \rangle \end{bmatrix} \mathrm{C}_0^1 (=\mathrm{C}_0) \begin{bmatrix} \beta\text{stress} \\ \mathrm{V} \end{bmatrix} \\ \begin{Bmatrix} \begin{bmatrix} \overline{\qquad} \\ \gamma\text{stress} \end{bmatrix} \\ [1\ \text{stress}]\, \mathrm{C}_0 \text{——} \mathrm{C}_0\, [\text{—cons}] \end{Bmatrix} [-\text{stress}]_0\, \# \end{Bmatrix} \qquad \text{III (118)}$$

Conditions: $\beta = 1, 2, 3$

α is weaker than β

γ is weaker than 2

(II) $V \rightarrow [-\text{tense}] \;/\; + \text{——} r + i\,[-\text{seg}]$ — III (142); IV p. 202

(III)[2] $V \rightarrow [-\text{tense}] \;/\; \text{——}\,[+\text{cons}] \begin{bmatrix} +\text{cons} \\ -\text{voc} \end{bmatrix}$ — IV (8)

(IV) $\begin{bmatrix} V \\ \alpha\text{round} \\ \alpha\text{back} \end{bmatrix} \rightarrow [-\text{tense}] \;/\; \text{——} C \begin{Bmatrix} C_0 + ic, +id, +ish \\ (C_1+) \begin{bmatrix} -\text{stress} \\ V \end{bmatrix} C_0\,[-\text{cons}] \end{Bmatrix}$ — IV (19), note 16, and p. 192

(21) $ɔ \rightarrow [3\ \text{stress}] \;/\; \text{——} \#$ — IV (45)

(22) $g \rightarrow [+\text{cont}] \;/\; \text{——}\,[+\text{nasal}]\#$ — IV p. 234

(23) TENSING

(I) $\begin{Bmatrix} æ \\ u \end{Bmatrix} \rightarrow [+\text{tense}] \;/\; \left[\overline{\text{——}}_{1\ \text{stress}}\right] nge$ — IV (60a)

(II) $ɔ \rightarrow [+\text{tense}] \;/\; \text{——}\,CV\,[-\text{seg}]$ — IV (60b)

(III)[3]

$$\begin{bmatrix} -\text{tense} \\ +\text{back} \\ V \end{bmatrix} \rightarrow \begin{bmatrix} +\text{tense} \\ -\text{round} \end{bmatrix} \Bigg/ \begin{Bmatrix} \left[\overline{\text{——}}_{+\text{high}}\right] C_0^1 \left(\begin{bmatrix} \alpha\text{voc} \\ \alpha\text{cons} \\ -\text{ant} \end{bmatrix} \right) [-\text{cons}] \\ \left[\overline{\text{——}}_{\begin{matrix} -\text{high} \\ -\text{low} \end{matrix}}\right] \left\{ \begin{bmatrix} -\text{voice} \\ +\text{cont} \\ +\text{ant} \end{bmatrix} \\ [+\text{sonor}]\,C \right\} \end{Bmatrix}$$

— IV (77), (79), (84)

[2] The preconsonantal laxing rule as given here incorporates a refinement over the formulation in Chapter Four (rule (8)). Laxing does not take place in consonant clusters ending with a liquid. Thus, when a true consonant precedes a liquid, we find both tense and lax vowels: there is *supple*, *bubble*, *calibre*, *massacre*, in which the vowel is lax, as well as *maple*, *noble*, *Cyprus*, *migrate*, *meter* (cf. *metric*), *acre*, in which the vowel is tense.

[3] We have modified this rule and the tensing rule (23IV) that follows it by introducing an optional $\begin{bmatrix} \alpha\text{voc} \\ \alpha\text{cons} \\ -\text{ant} \end{bmatrix}$, just as we did in defining "weak cluster" for purposes of stress placement (cf. Chapter Three, (49)). This was done in order to account for the fact that here, too, a consonant followed by [r] or a glide behaves like a single consonant. With this extension we can account for tensing in the boldface position in words such as ***cupric***, ***putrify***, ***Ukraine***, *inebriate*, *appropriate*, *opprobrium*, *repatriate*, *colloquial*, *obsequious*.

Clearly, we are leaving unexpressed an important generalization, namely, that in many different respects, consonant-liquid and consonant-glide strings function as single consonants. Actually, the situation is still more complex. We recall that we were forced to include the "weak cluster" option not only in the Main Stress Rule and Tensing Rules, but also in the Auxiliary Reduction Rule (120) of Chapter Three (see (24) here). As noted, this repetition indicates that we have failed to capture important properties of strong and weak clusters and thus points to a defect in our theory that merits further attention.

(IV)[4]

$$V \rightarrow [+\text{tense}] \Big/ \left\{ \begin{array}{l} \left[\begin{array}{c}\overline{\quad\quad}\\ \alpha\text{low}\\ \beta\text{stress}\end{array}\right] \left\{ \begin{array}{l} V \\ \left[\begin{array}{l}-\text{seg}\\ -\text{FB}\end{array}\right] \text{where } \beta = + \text{ if } \alpha = + \end{array} \right\} \\ \left[\begin{array}{c}\overline{\quad\quad}\\ -\text{high}\end{array}\right] C_1^1 \left(\begin{array}{l}\alpha\text{voc}\\ \alpha\text{cons}\\ -\text{ant}\end{array} \right) \left[\begin{array}{l}-\text{low}\\ -\text{back}\\ -\text{cons}\\ -\text{stress}\end{array}\right] V \end{array} \right\} \qquad \text{IV (20)}$$

(V)

$$\left[\begin{array}{c}+\text{high}\\ V\end{array}\right] \rightarrow \left[\begin{array}{l}+\text{tense}\\ -\text{round}\end{array}\right] / \text{——} [x, \gamma] \qquad \text{IV (130)}$$

(24) AUXILIARY REDUCTION—II

$$\left[\begin{array}{c}\alpha\text{stress}\\ V\end{array}\right] \rightarrow [2\,\text{stress}] \Big/ \# \left\{ \begin{array}{l} [-\text{stress}]_0 \text{——} C_0 \left(\left[\begin{array}{l}-\text{tense}\\ -\text{stress}\\ V\end{array}\right] C_0^1 \right) \bar{C}_0 \left[\begin{array}{c}\beta\text{stress}\\ V\end{array}\right] \bar{C}_0 \left[\begin{array}{c}\gamma\text{stress}\\ V\end{array}\right] \bar{C}_0 \left\{ \left[\begin{array}{c}\#\\ \delta\text{stress}\\ V\end{array}\right] \right\} \\ C_0 \left\{ \left[\begin{array}{c}\text{——}C_2\\ \overline{\quad\quad}\\ +\text{tense}\end{array}\right] \right\} \end{array} \right\}$$

where $\bar{C}$ is a consonant or a boundary — III (120)

$\alpha \neq 1$

β is weaker than 2

δ is weaker than γ

(25)

$$\left[\begin{array}{l}+\text{cor}\\ +\text{strid}\\ +\text{cont}\end{array}\right] \rightarrow [+\text{voice}] \Big/ \left\{ \begin{array}{l} V = \text{——} V \\ \left[\begin{array}{c}+\text{tense}\\ V\end{array}\right] \text{——} [-\text{cons}] \\ Vk \text{——} \acute{V} \end{array} \right\} \qquad \text{IV (119)}$$

(26) SPIRANTIZATION

$$\left[\begin{array}{l}+\text{cor}\\ +\text{ant}\\ -\text{sonor}\end{array}\right] \rightarrow \left[\begin{array}{l}+\text{cont}\\ +\text{strid}\end{array}\right] \Big/ \left\{ \begin{array}{l} \left[\begin{array}{c}\overline{\quad\quad}\\ +\text{voice}\end{array}\right] + ive \\ \left\{ \begin{array}{l}[+\text{sonor}]\\ [-\text{cont}]\end{array} \right\} \text{——} \Big/ \left\{ \begin{array}{l} \left[\begin{array}{c}\overline{\quad\quad}\\ -\text{voice}\end{array}\right] + \left[\begin{array}{l}-\text{cons}\\ -\text{back}\\ -\text{stress}\end{array}\right] [-\text{seg}] \\ \text{——} + y \end{array} \right\} \\ \left[\begin{array}{c}\overline{\quad\quad}\\ +\text{strid}\end{array}\right] \end{array} \right\}$$

IV (120)
and p. 233

[4] We have extended this rule over (20) of Chapter Four by generalizing the pre-boundary case of tensing to all boundaries other than formative boundary, thus to = as well as #. Recall that = appears in forms such as /pre=tend/, /re=sist/ (cf. Chapter Three, Section 10), where tensing would otherwise not take place in the prefix. See also note 6 below.

(27) $k \rightarrow \phi \;/\; +C_1\bar{i}\text{——}\#$ IV (62)

(28) CLUSTER SIMPLIFICATION

$C \rightarrow \phi \;/\; \text{——}$*identical consonant* III (156); IV p. 222 and note 60

(29) $$\phi \rightarrow y \;/\; \text{——} \begin{bmatrix} +\text{tense} \\ -\text{round} \\ +\text{high} \\ +\text{back} \\ V \end{bmatrix}$$ IV (50) and p. 196

(30) $\bar{\Lambda} \rightarrow [+\text{low}]$ IV (78)

(31) DIPHTHONGIZATION

$$\phi \rightarrow \begin{bmatrix} -\text{voc} \\ -\text{cons} \\ +\text{high} \\ \alpha\text{back} \\ \alpha\text{round} \\ \beta\text{rule 32} \end{bmatrix} \Big/ \begin{bmatrix} +\text{tense} \\ \alpha\text{back} \\ \beta\text{rule 32} \\ V \end{bmatrix} \text{——}$$ IV (21) and p. 208

(32) GLIDE VOCALIZATION

$$\begin{bmatrix} -\text{cons} \\ +\text{back} \end{bmatrix} \rightarrow [+\text{voc}] \Big/ \begin{bmatrix} \alpha\text{round} \\ \alpha\text{high} \\ V \end{bmatrix} \text{——}$$ IV (74)

(33) VOWEL SHIFT

$$\begin{bmatrix} \gamma\text{back} \\ \gamma\text{round} \\ V \end{bmatrix} \rightarrow \left\{ \begin{array}{l} [-\alpha\text{high}] \,/\, \left[\begin{array}{c} \overline{\quad\quad} \\ \alpha\text{high} \\ -\text{low} \end{array}\right] \\ [-\beta\text{low}] \,/\, \left[\begin{array}{c} \overline{\quad\quad} \\ \beta\text{low} \\ -\text{high} \end{array}\right] \end{array} \right\} \Big/ \left\{ \begin{array}{l} \left[\begin{array}{c} \overline{\quad\quad} \\ +\text{tense} \\ +\text{stress} \end{array}\right] \\ \left[\begin{array}{c} \overline{\quad\quad} \\ +\text{F} \end{array}\right] \\ \left[\begin{array}{c} \overline{\quad\quad} \\ -\text{tense} \\ +\text{high} \\ +\text{back} \end{array}\right] \end{array} \right.$$ IV (43); IV (61); IV (63)

(34) ROUNDING ADJUSTMENT

$$\begin{bmatrix} \alpha\text{round} \\ +\text{back} \\ \text{V} \end{bmatrix} \rightarrow [-\alpha\text{round}] \Big/ \left\{ \begin{bmatrix} \text{———} \\ -\text{tense} \end{bmatrix}, \begin{bmatrix} \text{———} \\ \beta\text{low} \\ \beta\text{round} \\ +\text{tense} \end{bmatrix}, \text{——V} \right\} \qquad \text{IV (93)}$$

(35) BACKNESS ADJUSTMENT[5]

$$\begin{bmatrix} +\text{low} \\ \text{V} \end{bmatrix} \rightarrow [+\text{back}] \ / \text{——}[-\text{cons}] \qquad \text{IV (88)}$$

(36)

$$\text{a} \rightarrow [+\text{tense}] \qquad \text{IV (89)}$$

(37) PALATALIZATION

$$\begin{bmatrix} -\text{sonor} \\ +\text{cor} \end{bmatrix} \rightarrow \begin{bmatrix} -\text{ant} \\ +\text{strid} \end{bmatrix} / \text{——} \begin{bmatrix} -\text{back} \\ -\text{cons} \\ -\text{voc} \end{bmatrix} \begin{bmatrix} -\text{cons} \\ -\text{stress} \end{bmatrix} \qquad \text{IV (121)}$$

(38)

$$\begin{bmatrix} -\text{cons} \\ -\text{voc} \end{bmatrix} \rightarrow \phi \Big/ \left\{ \begin{bmatrix} +\text{cor} \\ -\text{ant} \\ -\text{sonor} \end{bmatrix} \text{——}, \begin{bmatrix} +\text{cor} \\ +\text{cons} \end{bmatrix} \begin{bmatrix} \text{———} \\ -\text{back} \end{bmatrix} [+\text{stress}] \right\} \qquad \begin{matrix} \text{IV (122)} \\ \text{IV (123)} \end{matrix}$$

(39)

$$\text{z} \rightarrow [-\text{voice}] \ / \text{——} + \textit{ive} \qquad \text{IV (124)}$$

(40)

$$\begin{bmatrix} -\text{cor} \\ -\text{ant} \\ +\text{cont} \\ -\text{voc} \end{bmatrix} \rightarrow \begin{Bmatrix} \phi \\ \text{h} \end{Bmatrix} / \left\{ \begin{matrix} \text{C——} \\ \text{——C} \end{matrix} \right\} \qquad \begin{matrix} \text{IV (129)} \\ \text{and p. 234} \end{matrix}$$

[5] Note that this formulation of Backness Adjustment is for the dialect with [āw] rather than [æw] as the reflex of underlying /ū/. (See rule (39) and note 48 in Chapter Four.) This rule when stated in its fully general form should incorporate the rule that converts stressed [ā] into [æ] in forms such as *Alabama, alabaster* (see Chapter Three, p. 152). We omit rule (40) of Chapter Four, which, in dialects that have [æw] from [āw], laxes [ǣ] produced by Backness Adjustment.

(41) *e*-ELISION[6]

$$\begin{bmatrix} -\text{back} \\ -\text{high} \\ -\text{low} \\ -\text{cons} \end{bmatrix} \rightarrow \phi \; / \; \text{——} [-\text{seg}] \qquad \text{III (155)}$$

(42) $\phi \rightarrow \text{ə} \; / \; \text{C——} [+\text{sonor}]\# \qquad$ III p. 85

(43) VOWEL REDUCTION[7]

$$\begin{bmatrix} -\text{stress} \\ -\text{tense} \\ \text{V} \end{bmatrix} \rightarrow \text{ə} \qquad \text{III (121)}$$

[6] This rule deserves a more extensive study than we have given it. In particular, its position in the ordering is open to some question. Our only justification for placing it here is that, for reasons mentioned in note 18 of Chapter Four, it may follow Vowel Shift so as to account for nonelision in the boldface position in words such as *simultaneous*. The rule of *e*-Elision should be distinguished from a rule that drops both /e/ and the glides /y/ and /ɛ/ before various affixes, as in *telescopic*, *telescopy*, *harmonic*, and *harmonize*. The latter is, presumably, a lexical rule.

We have noted (see p. 195 of Chapter Four) that the rule of *e*-Elision can be used to account for the fact that the first syllable is short in words such as *issue*, *tissue*, *value*, *menu*. As pointed out to us by S. J. Keyser, it can be used to explain the lax vowel in the first syllable in words such as *pity*, *city*, if we derive these from /piteɛ/, /siteɛ/. Stress will be placed on the first syllable by the usual rule for nouns, and the trisyllabic laxing rule will guarantee that the stressed vowel is lax. The [e]'s will tense, and the glide [ɛ] will elide. By the rule mentioned in note 18, Chapter Four, final [ĕy] will become [ĭy]. This idea has further consequences that might be explored.

[7] We leave open the question of just how the reduced vowel is actualized phonetically in various contexts.