

CAMBRIDGE TEXTBOOKS IN LINGUISTICS

The Phonological Structure of Words

An Introduction

**Colin J. Ewen and
Harry van der Hulst**

THE PHONOLOGICAL STRUCTURE OF WORDS

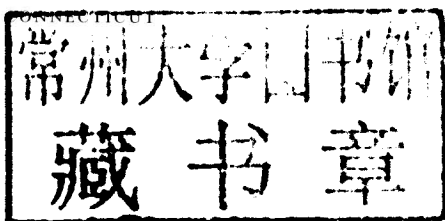
AN INTRODUCTION

COLIN J. EWEN

UNIVERSITY OF LEIDEN

HARRY VAN DER HULST

UNIVERSITY OF CONNECTICUT



CAMBRIDGE
UNIVERSITY PRESS

PUBLISHED BY THE PRESS SYNDICATE OF THE UNIVERSITY OF CAMBRIDGE
The Pitt Building, Trumpington Street, Cambridge, United Kingdom

CAMBRIDGE UNIVERSITY PRESS

The Edinburgh Building, Cambridge CB2 2RU, UK
40 West 20th Street, New York, NY 10011-4211, USA
10 Stamford Road, Oakleigh, Melbourne 3166, Australia
Ruiz de Alarcón 13, 28014 Madrid, Spain

www.cup.cam.ac.uk
www.cup.org

© Cambridge University Press 2001

This book is in copyright. Subject to statutory exception
and to the provisions of relevant collective licensing agreements,
no reproduction of any part may take place without
the written permission of Cambridge University Press.

First published 2001

Printed in the United Kingdom at the University Press, Cambridge

Typeface 9.5/13 pt Times NR [GT]

A catalogue record for this book is available from the British Library

Library of Congress Cataloguing in Publication data

Ewen, Colin J.

The phonological structure of words: an introduction / Colin J. Ewen, Harry van der Hulst.

p. cm. – (Cambridge textbooks in linguistics)

Includes bibliographical references and index.

ISBN 0 521 35019 0 (hardback) – ISBN 0 521 35914 7 (paperback)

1. Grammar, Comparative and general – Phonology. I. Hulst, Harry van der. II.

Title. III. Series.

P217.E94 2000

414 – dc21

00-025958

ISBN 0 521 350190 hardback

ISBN 0 521 359147 paperback

PREFACE

Our aim in writing this book has been to introduce the reader to some of the issues in the representation of the structure of the basic units of phonology. We have approached this by first, in Chapters 1 and 2, considering the ways in which the smallest phonological units, features, characterise the structure of sounds, or, more technically, segments. Chapters 3 and 4 are concerned with larger phonological units, in particular syllables and feet. As the title of the book suggests, we do not consider the representation of phonological units larger than the word, and therefore pay little attention to topics such as intonation.

Most of our analyses are formulated in terms of what has come to be referred to as **non-linear phonology**, as opposed to the 'linear' theories of phonological representation manifested in work in the tradition of Chomsky and Halle (1968). The term 'non-linear phonology' does not refer to a single coherent theory of the representation of phonological structure – whether segment-internal or suprasegmental – rather, since the early 1980s, work in phonology which has been concerned with enriching the structural properties of linear models has dealt with different aspects of these models, so that various apparently distinct theories have grown up. Two of the most familiar of these are **metrical phonology**, originating in the work of Liberman (1975) and Liberman and Prince (1977), and **autosegmental phonology**, which finds its first exposition in Goldsmith (1976). However, in recent years it has become apparent that many of the claims made in the various models are not in fact independent of each other, and that claims made within the framework of one approach are often restatements of those made elsewhere. In this book, therefore, we shall attempt to avoid a strict delineation between different 'sub-theories', and we shall concentrate on presenting what we consider to be the most characteristic aspects of non-linear phonology in general. It has therefore not been our intention to present any of these sub-theories in detail; rather, it has been our concern to show the reader how elements from various approaches might coexist in the characterisation of phonological structure.

The number of issues which might be dealt with in a book on phonological representation is substantial. Here, however, we are concerned with presenting the most important aspects of the subject to the student who is approaching it with little previous knowledge, and we have concentrated on presenting the material in such a way that it is reasonably self-contained, and, we hope, indicates the areas in which the theory makes interesting claims. However, we assume a basic knowledge of phonetic theory and terminology. In addition, some familiarity with basic phonological concepts which do not form an essential part of a specifically non-linear approach to phonology, such as traditional phoneme theory, is also desirable. Where appropriate, we refer to other sources for discussion of topics of a more general phonological nature.

Representation is only one aspect of a fully fledged phonological theory. Such a theory combines a specific view on phonological representations with a view on the relationship between various levels of structure, sometimes referred to as underlying (or lexical) structure and surface structure. More generally, what is the relationship between the most abstract level of representation, the input, and the least abstract, the output? Current views on the relationship between input and output are that the amount of computation required to get from one to the other must be minimal. In some theories, in fact, input and output are non-distinct. More often, however, they are distinct, and are related by a system that either derives the output via a set of (transformational) rules or by a procedure of selecting the correct output from a pool of possible candidates (as in Optimality Theory; see Kager 1999 for an introduction to Optimality Theory). In this book we take no principled stand with respect to these matters. As a matter of convenience we formulate most of the processes we consider in terms of derivational rules, but we are not concerned with the status of these rules in the phonology of the language under consideration; they should be viewed primarily as descriptive devices.

The material used for exemplification has been drawn as far as possible from languages which are likely to be reasonably familiar to many readers, in particular from English. This is in keeping with our aim of making the book accessible to as wide a readership as possible, rather than representing any prejudice on our part. Where evidence from these sources for a particular point does not exist, however, we have drawn our data from less familiar languages.

We hope that this book can be used as a first step towards an understanding of some of the major theoretical issues in modern phonology. As such, it is of interest (and accessible) to students and researchers who either intend to specialise further in phonology or need a thorough grounding in the issues of representation in phonology.

This book has been a long time in the making. The fact that it has been completed is due primarily to the encouragement and patience of the editorial staff – past and present – at Cambridge University Press. We are sincerely grateful to, among others, Judith Ayling, Kate Brett, Penny Carter and Andrew Winnard; we appreciate how lucky we have been. We have been equally fortunate to have Neil Smith as our series editor. Apart from the fact that he has saved us from getting some of our more spectacular errors into print, he has been a fund of useful and relevant advice on content and presentation. Many generations of students have been confronted with earlier versions of parts of this book. We are grateful to all of them, particularly those whose comments have helped us to improve it, and we are equally appreciative of other people who have taken the trouble to comment on the manuscript. Among others, those who have helped us in the latter stages of the book's writing include Véronique van Gelderen, Martina Noteboom, Nancy Ritter, Erik Jan van der Torre and Jeroen van de Weijer. None of them – nor anyone else – is responsible for what we have done with their advice.

CONTENTS

<i>Preface</i>	<i>page xi</i>
1 Segments	
1.1 INTRODUCTION	1
1.2 EVIDENCE FOR INTERNAL STRUCTURE	3
1.3 PHONOLOGICAL FEATURES	8
1.3.1 Major class features	10
1.3.2 Vowel features	14
1.3.3 The vowel-height dimension and related issues	15
1.3.4 Consonantal features	21
1.3.5 The characterisation of grouping	26
1.4 AUTOSEGMENTAL PHONOLOGY	30
1.4.1 Old English <i>i</i> -umlaut	45
1.4.2 Vowel harmony in Turkish	46
1.5 SUMMARY	50
1.6 FURTHER READING	51
2 Features	54
2.1 THE NATURE OF PHONOLOGICAL FEATURES	54
2.1.1 Feature geometry and the nature of features	60
2.2 THE REPRESENTATION OF FEATURE ASYMMETRY	63
2.2.1 Underspecification	65
2.2.2 Redundancy	66
2.2.3 Contrastive specification	68
2.2.4 Radical underspecification	74
2.3 SINGLE-VALUED FEATURES	79
2.4 UMLAUT AND HARMONY PROCESSES	85
2.4.1 Umlaut	85
2.4.2 Vowel harmony in Yawelmani	88
2.4.3 Vowel harmony in Yoruba	93
	vii

2.5	DEPENDENCY WITHIN THE SEGMENT	102
2.6	CONSONANTS AND SINGLE-VALUED FEATURES	105
2.7	LARYNGEAL FEATURES	108
2.7.1	Single-valued laryngeal features	110
2.8	SUMMARY	112
2.9	FURTHER READING	113
3	Syllables	115
3.1	INTRODUCTION	115
3.2	WHY SYLLABLES?	122
3.3	THE REPRESENTATION OF SYLLABLE STRUCTURE	128
3.4	ONSET–RHYME THEORY	129
3.4.1	Rhyme structure	132
3.4.2	Syllabic prepenices and appendices	136
3.4.3	Syllabification	141
3.4.4	Extrasyllabicity and related matters	147
3.5	MORA THEORY	150
3.6	THE REPRESENTATION OF LENGTH	154
3.7	THE INDEPENDENCE OF SYLLABIC POSITIONS	159
3.7.1	/r/ in English	160
3.7.2	Liaison	161
3.7.3	<i>h-aspiré</i>	166
3.7.4	Compensatory lengthening and related processes	169
3.8	LICENSING AND GOVERNMENT	174
3.8.1	Empty positions	184
3.9	SUMMARY	193
3.10	FURTHER READING	194
4	Feet and words	196
4.1	INTRODUCTION: STRESS AND ACCENT	196
4.2	FEET	203
4.3	FIXED ACCENT AND FREE ACCENT SYSTEMS	207
4.3.1	Non-primary accent	213
4.4	METRICAL THEORY	216
4.4.1	Metrical structures	219
4.4.2	Weight-sensitivity	223
4.4.3	Foot typology	225
4.4.4	Degenerate feet	228
4.4.5	Ternary feet	230

4.4.6 Unbounded feet	232
4.4.7 Extrametricality	234
4.5 ENGLISH AND DUTCH COMPARED	237
4.6 SUMMARY	241
4.7 EPILOGUE: LEVELS AND DERIVATIONS	242
4.8 FURTHER READING	244
<i>Appendix</i>	246
<i>References</i>	247
<i>Index</i>	267

I

Segments

1.1 Introduction

The fact that words, or more generally stretches of speech, can be divided up into individual segments, or speech-sounds, is familiar to speakers of languages. Thus speakers of English will generally agree that the word *bat* consists of the three sounds ‘b’, ‘a’ and ‘t’. They will further agree that the spelling system of English, i.e. its orthography, does not correspond in a one-to-one fashion to the ‘sounds’ of the language, so that a word such as *thatch*, although made up of six distinct orthographic symbols, contains only three, or perhaps four, sounds: ‘th’, ‘a’ and ‘tch’ (or perhaps ‘t’ and ‘ch’). This discrepancy means that phoneticians and phonologists require a system of transcription for the units of sound analogous to, but different from, that for the units of spelling. Various such systems have been proposed, and are familiar to the user of any dictionary giving the ‘pronunciation’ of the words of a language. In this book we will generally use the transcription system of the International Phonetic Association (IPA; see Appendix).

The transcription of the sounds of a word is not an entirely straightforward undertaking, and raises interesting theoretical questions in phonology. Thus the transcription of the English word *thatch* requires a decision (implicit or explicit) on the part of the compiler of the system as to whether the sequence *tch* represents two sounds, or **phonological segments** (specifically the two sounds found at the beginning of English *tore* /tɔ:/ and *shore* /ʃɔ:/),¹ or whether it is to be treated as a single sound, normally referred to as an **affricate**. In systems based on the IPA alphabet, the first option is taken, so that *chore* is represented phonemically as /tʃɔ:/ and *thatch* as /θætʃ/, with *ch* or *tch* being

¹ In this book we will in general transcribe English words in the form in which they are realised in RP (Received Pronunciation), the prestige accent of British English. This is a matter of convenience; we are not thereby implying that RP has in any sense a privileged status in terms of its linguistic properties. We will, however, frequently consider other varieties where necessary; in particular we will have occasion to examine data from **rhotic** dialects, i.e. dialects in which postvocalic /r/ is pronounced. RP is non-rhotic, as evidenced by the realisations /tɔ:/ and /ʃɔ:/ for *tore* and *shore*; compare the pronunciations /tɔ:r/ and /ʃɔ:r/ (or /tɔ:ɹ/ and /ʃɔ:ɹ/) in a rhotic dialect such as Scots English.

represented as a sequence of /t/ and /ʃ/ (although the claim that /t/ and /ʃ/ are more closely related than a normal pair of segments can be indicated by the use of a ligature, as in /θæʃ/, or, more commonly, by combining the two symbols, as in /θæʃ/). In North American systems, however, such orthographic sequences are generally treated unambiguously as single segments, so that we find transcriptions such as /θæʃ/.

Notice that the concept of affricate illustrates not only that the relationship between sound and spelling is not entirely straightforward, but also, and perhaps more obviously of relevance for the phonologist, that the relationship between ‘phonetic’ and ‘phonological’ representation is also a matter of analysis. From a purely phonetic point of view, the nature of the relationship between the stop and the fricative in the final cluster of English *thatch* does not seem markedly different from that between the stop and the fricative in the final cluster of *hats*: in both cases we have a *phonetic* sequence of stop + fricative, [tʃ] and [ts], respectively (we adopt the usual convention of giving phonetic representations in square brackets, and phonological ones between slant brackets; the line under [t] in [tʃ] denotes retraction of the articulation, in this case to the postalveolar place of articulation of the [ʃ]). However, while the *tch* sequence is commonly treated as an affricate in phonological analysis, phonologists do not generally make a similar claim for the *ts* sequence of *hats*. On the other hand, the phonetically more or less identical cluster in German *Satz* [zats] ‘sentence’ *is* so treated.

The reasons for these differences (which we will not explore in any detail here) are thus phonological, rather than phonetic, although it is usually claimed that for something to be considered phonologically an affricate it must in any case have the phonetic property of **homorganicity**: i.e. the stop and the fricative must have the same place of articulation, so that [ts] (where both elements are alveolar) and [tʃ] (where both elements are postalveolar) are both conceivable phonological affricates, while a sequence such as [ps] in English *cups* would not be. This claim is associated with the fact that it is just these homorganic sequences which may display a different distribution from ‘normal’ sequences of consonants. Affricates can generally occur *both* in syllable-initial position *and* in syllable-final position in a language, and thus violate the ‘mirror-image’ constraint on syllable structure.² This constraint states that a consonant cluster which can be syllable-initial in a language cannot be syllable-final, while the same cluster with its consonants in reverse order shows the opposite properties. English is typical in having initial /kl-/ and final /-lk/ (*class*, *sulk*), but not initial */lk-/ or final */-kl/ within a single

² We consider syllable structure in Chapter 3.

syllable. Contrast this with the distribution of affricates: /tʃ/ can be both initial and final in English (*chip* /tʃɪp/ and *pitch* /pɪtʃ/), as can /ts/ in German (*Ziel* /tsi:l/ 'goal' and *Satz*). On the other hand, the English sequence /ts/, like other stop + fricative sequences (e.g. /ps/, /ks/), occurs only in syllable-final position (and then almost exclusively as the result of morphological suffixation: e.g. *hats* = HAT + PLURAL).³

A full discussion of the status of affricates would take us much further. We return in §1.4 to the status of segments (or sequences) such as these, which exemplify the problem of dealing with what have been referred to as 'complex segments', and we will see that these phenomena have been the trigger for a great deal of interesting work in theories dealing with representation in phonology. Let us first, however, consider a rather more fundamental question regarding phonological representation: does the phonological segment have any internal structure? That is, is there anything which we can say about the way in which sounds behave by assuming some sort of internal structure which we could not say by having segments as the smallest phonological units?

1.2 Evidence for internal structure

It is not difficult to demonstrate that phonological segments in languages can be grouped together, in the sense that particular sets of segments may undergo what seems to be the same kind of **phonological process**. We are assuming here, fairly non-controversially, that it is reasonable to talk about phonological processes, in which a particular segment, or, more importantly here, a group of segments, is affected in some way. These may be either 'events' in the history of a language or relationships holding between the most abstract phonological representation of a segment or group of segments and its surface phonetic realisation.⁴

One such phonological process is that of **nasal place assimilation**, whereby a nasal consonant has the same place of articulation as a following obstruent (i.e. a stop, fricative or affricate). In English, for example, the effects of this process can be identified in various contexts, as in (1):⁵

³ We indicate morphemes, i.e. minimal syntactic units, by the use of small capitals, as here.

⁴ In the context of this book, however, we will beg the question of exactly what is meant by a surface 'phonetic' representation. For practical purposes, the 'surface' representations we consider will be fairly 'shallow' or 'concrete' *phonological* representations. Nevertheless, we will continue to refer to such representations as phonetic. More generally, as we noted in the Preface, we are assuming a model of phonology which is essentially derivational, in the tradition of Chomsky and Halle (1968). We do not adopt here the constraint-based model of Optimality Theory (see, e.g., McCarthy and Prince 1993; Prince and Smolensky 1993; Kager 1999). This is a matter of convenience, however, as we claim that much of what we have to say about the phonological representation of words is independent of whether we adopt a derivational or a constraint-based approach.

⁵ The asterisks in (1c) denote that a sequence is ill formed.

- | | | | | | | |
|-----|----|-----------|-------------|----------|----------|--|
| (1) | a. | Edinburgh | [ɛmbɾə] | | | |
| | | handbook | [hæmbʊk] | | | |
| | b. | unpopular | [ʌnpɒpjələ] | | | |
| | | unfair | [ʌnfɛə] | | | |
| | c. | camber | [kæmbə] | *[kænbə] | *[kæŋbə] | |
| | | canter | [kæntə] | *[kæmtə] | *[kæŋtə] | |
| | | canker | [kæŋkə] | *[kæmkə] | *[kænkə] | |

(1) shows examples of agreement in place of articulation between the nasal and the following obstruent. (1a, b) involve optional assimilations, particularly associated with fast-speech situations: realisations such as /ɛdɪnbɾə/ and /ʌnpɒpjələ/, which do not show assimilation, also occur, of course. Those in (1b) can be analysed morphologically as involving a prefix ending underlyingly in the alveolar nasal /n/: e.g. UN + FAIR /ʌn + fɛə/. This analysis is supported by the fact that in such cases there are only two possible phonetic realisations of the nasal in the prefix: either as [n] or as the nasal which is homorganic with the following consonant. In addition, if there is no question of a possible assimilation, as in (2), where the following morpheme begins with a vowel or /h/, the only possible realisation is [n]:

- | | | |
|-----|---------|------------|
| (2) | unequal | [ʌni:kwəl] |
| | unhappy | [ʌnhæpi] |

The forms in (1c) demonstrate a general constraint on English intervocalic clusters (at least those immediately following a stressed vowel within a single morpheme), which states that a sequence of nasal + stop must be homorganic. These differ from (1a, b), however, in that we are no longer dealing with cases in which, say, the labial nasal can be said to be *derived* from an alveolar nasal, as in [ɛmbɾə] or [ʌnpɒpjələ] – there is no possibility of *camber* or *canker* occurring with /n/, as in *[kænbə] or *[kænkə], and there is no internal morphological structure which would lead us to suspect that these words have some kind of prefix CAN-.

Thus the process of nasal place assimilation is instantiated in various ways in English, and indeed in many other languages. However, our concerns here are not primarily with the status of the various different types of examples in the phonology of English; rather they focus on the characterisation of this type of process. In other words, how can we formalise the constraint represented in various ways by the data in (1)? Let us consider first (1a, b), in which we see that a cluster of /n/ followed by a stop may become homorganic in English. If the smallest available phonological units are complete segments, then we might represent the processes as in (3) (for the sake of simplicity, we ignore the case of nasals preceding /f/):

- (3) a. /n/ → [m] / __ {/p/, /b/}
 b. /n/ → [ŋ] / __ {/k/, /g/}

We use here a traditional **linear** type of notation for phonological rules:⁶ the arrow denotes 'is realised as'; the underlying segment is given in slant brackets and its surface phonetic realisation in square brackets; the horizontal line denotes the environment in which the segment affected by the rule occurs, in this case preceding {/p/, /b/}; and the braces denote a set of segments. (3a), then, can be read as: 'Underlying /n/ is realised as phonetic [m] when it precedes either /p/ or /b/.'

There are various objections which can be raised with respect to the formulations of nasal place assimilation in (3). The common core of these objections is that the two parts do not look any more likely to be recurrent phonological rules than, say, any of the processes in (4), which are not likely to occur in any language:

- (4) a. /n/ → [m] / __ {/k/, /g/}
 b. /n/ → [ŋ] / __ {/p/, /b/}
 c. /n/ → [m] / __ {/k/, /d/}
 d. /n/ → [l] / __ {/t/, /d/}

Formally, the various rules in (4) are no more or less complex than those in (3), which express recurrent processes – surely an undesirable state of affairs. More particularly, the type of formulation in (3) and (4) is inadequate in two ways. In the first place, the formalism fails to relate the change characterised by a particular rule to the environment in which it occurs. Thus (4a), in which an alveolar nasal becomes labial in the environment of velar stops, is no more difficult to formulate than (3a), in which the same change takes place in the environment of labial stops. Yet (3a) is a natural process of assimilation, while (4a) is not. Secondly, the formalism does not show that the sets of consonants in the environments in (3a, b) are ones that we would expect to find triggering the same kind of change, whereas that in (4c), a set consisting of a voiceless velar stop and a voiced alveolar stop, would be most unlikely to be responsible for the change in (4c) (or, indeed, any other assimilation process). Again, though, (4c) is no more difficult to formulate than any of the other rules in (3) and (4).

This state of affairs clearly arises because we have neither isolated the phonetic properties which are shared by the set of segments involved in the process – nasality in the case of the input and the output (why should the output of (3a) be [m] rather than, say, [l]?); place of articulation in the

⁶ See the Preface for a discussion of the difference between linear and non-linear approaches to phonological representation.

case of the output and the environment – nor incorporated them in our rule. In other words, we have failed to take account of the fact that it is the phonetic properties of segments which are responsible for their phonological behaviour, i.e. that phonological segments are not indivisible wholes, but are made up of properties, or, as they are usually referred to, **features**, which to a large extent correspond to the properties familiar from traditional phonetic description.

Furthermore, the fact that a change such as (4c) is an unlikely candidate for an assimilation rule shows that the class of segments triggering the process must share a particular property – in the case of (3a), for example, the property of labiality. A further examination of the phonologies of languages of the world would quickly show that a class of segments like this forms what is referred to as a **natural class**, i.e. a set of segments which *recurrently* participates as a class in phonological processes, such as the ones sketched above. Thus a set of segments which shares some phonetic property or combination of properties, to the exclusion of other sets of segments, forms a natural class.

Let us now identify a number of (ad hoc) phonological features which are relevant here, specifically [nasal], [labial], [alveolar] and [velar]. (Features are by convention enclosed in square brackets.)

We can use these features to write a general rule to characterise the assimilation processes illustrated by (3):

- (5) a. $\begin{bmatrix} \text{nasal} \\ \text{alveolar} \end{bmatrix} \rightarrow [\text{labial}] / __ [\text{labial}]$
 b. $\begin{bmatrix} \text{nasal} \\ \text{alveolar} \end{bmatrix} \rightarrow [\text{velar}] / __ [\text{velar}]$

However, we can formulate a rather more general statement about nasal place assimilation in English, which will also incorporate the data in (1c), in which there appears to be no reason to derive [m] and [ŋ] from an underlying /n/. This general statement about the class of nasals is given in (6):

- (6) a. [nasal] \rightarrow [labial] / $__$ [labial]
 b. [nasal] \rightarrow [alveolar] / $__$ [alveolar]
 c. [nasal] \rightarrow [velar] / $__$ [velar]

(6) successfully shows that the rule is a statement about a particular class of segments, nasals, characterised by a single feature which serves to distinguish the class from any other segments in the language. In other words, only nasals undergo the processes characterised by the rule, and no other segments in the language. Furthermore, it shows that the outputs and environments share a feature, namely the feature characterising place of articulation, which

makes just these processes more likely to occur than those in (4), for example. (6) is a non-arbitrary process, then.

Examples like these, which are typical of the way in which phonological processes operate in language, provide evidence for incorporating features in phonological description. It is with the nature of these features, and more particularly the question of whether they are organised in any way in the representation of segments, that we will be largely concerned in the remainder of this chapter.

However, at this point, let us note that the particular formulation in (6) will turn out to be far from adequate on a number of grounds, which do not, however, affect the validity of the points just made. Let us consider here just two of the problems.

(6) appears to consist of three sub-processes, whereas, as we have seen, nasal place assimilation is a single process in English. In traditional linear phonology, it is usual to 'collapse' rules like those in (6), all of which share the same input, to give (7):

$$(7) \quad [\text{nasal}] \rightarrow \left\{ \begin{array}{l} [\text{labial}] / _ [\text{labial}] \\ [\text{alveolar}] / _ [\text{alveolar}] \\ [\text{velar}] / _ [\text{velar}] \end{array} \right\}$$

The three expressions contained in braces are to be seen as alternatives; i.e. nasals are labial before labials, alveolar before alveolars and velar before velars. Thus the 'shared' part of the rule – the input – is mentioned only once.⁷

However, conventions such as that used in (7) still permit the collapse of unrelated rules, as well as rules which apparently belong together. Thus some languages have a rule whereby a nasal consonant becomes voiceless preceding a voiceless (aspirated) consonant. In some dialects of Icelandic, for example, *hempa* /hemp^ha/ 'cassock' is realised as [hɛmpa], with devoicing of the /m/. There seems to be no formal reason why the rule characterising this process cannot be collapsed with (7), especially as Icelandic also has nasal place assimilation processes:

$$(8) \quad [\text{nasal}] \rightarrow \left\{ \begin{array}{l} [\text{labial}] / _ [\text{labial}] \\ [\text{alveolar}] / _ [\text{alveolar}] \\ [\text{velar}] / _ [\text{velar}] \\ [\text{voiceless}] / _ [\text{voiceless}] \end{array} \right\}$$

In other words, we have still failed to show that the features involved in the nasal assimilation process, i.e. [labial], [alveolar] and [velar], are related to

⁷ A fuller formulation of the rule in question would also involve reference to other features; we ignore this here, as before.

each other in some way, i.e. that they characterise place of articulation, whereas [voiceless] is not related to any of the other three in this way.

A second problem is that, merely by incorporating features in our rules, rather than the segments of (3) and (4), we have not removed the possibility of formulating what are sometimes referred to as 'crazy rules'. Thus (9) is as easy to formulate as (7):

$$(9) \quad [\text{nasal}] \rightarrow \left\{ \begin{array}{l} [\text{labial}] / _ [\text{alveolar}] \\ [\text{alveolar}] / _ [\text{velar}] \\ [\text{velar}] / _ [\text{labial}] \end{array} \right\}$$

Underlying these criticisms of the formal conventions of linear phonology is the belief that a phonological theory should be as restrictive as possible, in the sense that an ideal system should be able to represent only phonologically natural events and states, and should not be able to characterise unnatural events such as (4) or (9). This belief underpins many **non-linear** alternatives to the formulations above, alternatives which we will begin to consider in §1.4. For the moment, however, we turn in greater detail to the nature of the features which will be required in phonology.

1.3 Phonological features

The idea that segments are made up of phonological features has a long tradition, and received its first comprehensive formalisation in Jakobson *et al.* (1951). The most widely known system is that proposed by Chomsky and Halle (1968; henceforth *SPE*), which differs from the Jakobsonian model in a number of respects, most notably in that the later features are based entirely on articulatory parameters, whereas those of Jakobson *et al.* were defined primarily in terms of acoustic properties. A second important difference involves the fact that many of the Jakobsonian features were relevant to the description and characterisation of both vowels and consonants, while the *SPE* system used largely separate sets of features. Feature theory is not unique to linear approaches to phonology; indeed, much work within non-linear phonology adopts the set of features proposed in the linear framework of *SPE*. However, non-linear phonology typically differs from linear accounts of the segment in incorporating a greater degree of internal structure than a simple list of features, as we shall demonstrate later in this chapter.

As there is a great deal of discussion of individual features available in the literature (e.g. Kenstowicz and Kisseberth 1979; Lass 1984a: chs. 5–6; Keating 1988a; Clements and Hume 1995), we shall not attempt to provide a comprehensive account of the features which would be required to characterise the segments making up the phonological system of English, for example. Rather,