PHONOLOGY

CRITICAL CONCEPTS

Edited by
CHARLES W. KREIDLER

ROUTLEDGE
Taylor & Francis Group

PHONOLOGY

Critical concepts

Edited by
Charles W. Kreidler

Volume IV

From Rules to Constraints

江苏工业学院图书馆
藏书章

ROUTLEDGE
Taylor & Francis Group

London and New York

First published 2001
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

Simultaneously published in the USA and Canada
by Routledge
270 Madison Ave, New York, NY 10016

Transferred to Digital Printing 2005

Routledge is an imprint of the Taylor & Francis Group

Editorial material and selection © 2000 Charles W. Kreidler;
individual owners retain copyright in their own material

Typeset in Times by RefineCatch Limited, Bungay, Suffolk
Printed and bound in Great Britain by
TJI Digital, Padstow, Cornwall

All rights reserved. No part of this book may be reprinted or
reproduced or utilized in any form or by any electronic,
mechanical, or other means, now known or hereafter
invented, including photocopying and recording, or in any
information storage or retrieval system, without permission in
writing from the publishers.

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication Data
A catalogue record for this book has been requested

ISBN 0-415-20344-9 (Set)
ISBN 0-415-20348-1 (Volume 4)

Disclaimer
The publishers have made every effort to contact authors/copyright
holders of works reprinted in *Phonology: Critical Concepts*.
This has not been possible in every case, however, and we would
welcome correspondence from those individuals/companies whom we
have been unable to trace.

CONTENTS

VOLUME IV FROM RULES TO CONSTRAINTS

General Introduction 1

53 The origin of sound patterns in vocal tract constraints 5
JOHN J. OHALA

54 Phonologization 32
LARRY M. HYMAN

55 The phonetics of sound change 44
JOHN J. OHALA

56 How intrinsic is content? Markedness, sound change, and 'family universals' 82
ROGER LASS

57 Iwaidja mutation and its origins 111
NICHOLAS EVANS

58 Redundancy rules in phonology 145
RICHARD STANLEY

59 The ordering of phonological rules 195
WALLACE L. CHAFE

60 On the functional unity of phonological rules 227
CHARLES W. KISSEBERTH

61 Equational rules and rule functions in phonology 244
GERALD A. SANDERS

62 **On phonotactically motivated rules** 274
ALAN H. SOMMERSTEIN

63 **Nasal cluster dissimilation and constraints on phonological variables in Gurindji and related languages** 300
PATRICK McCONVELL

64 **Towards a theory of constraint violations** 334
CAROLE PARADIS

65 **The emergence of constraints in generative phonology and a comparison of three current constraint-based models** 373
DARLENE LACHARITÉ AND CAROLE PARADIS

66 **Constraint violation and conflict from the perspective of Declarative Phonology** 398
JAMES M. SCOBBIE

67 **Expressing phonetic naturalness in phonology** 410
SCOTT MYERS

68 **Preservation and minimality in loanword adaptation** 439
CAROLE PARADIS AND DARLENE LACHARITÉ

69 **Generalized alignment and prosodic subcategorization in Korean** 492
HYUNSOOK KANG AND BORIM LEE

70 **Generalized alignment** 508
JOHN J. McCARTHY AND ALAN PRINCE

71 **Constraints, causation, and change** 589
APRIL M. S. McMAHON

此为试读，需要完整PDF请访问：www.ertongbook.com

GENERAL INTRODUCTION

From rules to constraints

According to Ohala (**53**), the ultimate task of phonology is to discover the causes of the behavior of speech sounds, which can be attributed to mind, matter, and manners—speaker intention, physiological and acoustic facts, and the language system of the speaker's community at a particular stage of history. Allophonic variation, historic sound change, dialect differences, morphophonemic alternations, and patterns of segment inventories are all manifestations of the same phenomena at different stages or viewed from different angles.

In selection **54** Hyman notes the roles of intrinsic and extrinsic variations in the speech signal. For instance, the distinction between voiced and voiceless consonants depends on the speaker's control of vocal cord vibration, an extrinsic matter. But a vowel that follows a voiceless consonant generally has a higher pitch than a vowel after a voiced consonant—an intrinsic matter. What is intrinsic may become extrinsic: an allophonic difference becomes a phonemic distinction.

The reconstruction of prehistoric language systems by applying the comparative method to related living languages is a solid achievement of linguistics but, Ohala says (**55**), it has been carried out in an abstract way. Sound changes should be investigated in terms of the physiological and psychological factors that motivate them.

The theory of markedness, based to some extent on the study of universals in languages, has been said to make possible a certain degree of prediction: what is more marked or less usual in a language is likely to be replaced by what is more usual. For example, rounded front vowels are less common in the languages of the world, therefore marked, than unrounded front vowels, which are unmarked; similarly, back unrounded vowels are marked, and back rounded vowels unmarked. Lass (**56**) shows, however, that in several languages and language groups what would appear to be more marked is actually more common.

The comparative method of historical reconstruction is based on finding regular sound correspondences and regular mutations in a group of languages which are presumed to be related. When irregular correspondences show up, the linguist has to find an explanation. Evans (**57**) sets out regular mutations in Iwaidja and a set of forms with other mutations. His explanation for the latter is that Iwaidja has a remnant of an old gender prefix that otherwise has been lost as Iwaidja has lost the ancestral gender system.

Generative Phonology is based on the notion that an abstract phonological representation can be converted to phonetic structures that are directly manifested in speech through the application of rules. The nature of these rules was the topic of much discussion in the 1960s and '70s, including the following five articles, which are still quite relevant.

Languages have redundancy, in phonology and in other parts of the grammar. Halle introduced the notion of Morpheme Structure Rules, of which there are two kinds: segment structure rules capture the redundant co-occurrence of features in a segment; e.g. in many languages sonorant segments are always voiced; sequence structure rules deal with limitations in the order of segments; e.g. in many languages two obstruents in sequence agree in voice. Stanley (**58**) proposes that these should be replaced with Morpheme Structure Conditions. This important article is often cited in more recent writings on underspecification and constraints.

Chafe (**59**) finds problems regarding the order of rules. He examines such rules in Caddo with reference to the historic changes that have been discovered through the comparative method. Some rules (or language changes) are persistent—they apply repeatedly. The author suggests that there are several 'depths': some rules apply at one depth but not another.

Kisseberth (**60**) notes that a good grammar of a language is one which presents the most linguistically significant generalizations in the shortest space. In Generative Phonology the order of rules is important because rules apply to underlying forms and the order of rules determines whether two or more similar rules can be combined into one. So far Generative Phonology has emphasized formal, structural sameness at the expense of functional sameness. But Kisseberth shows an example in one language of rules which are different in form but alike in function.

Sanders (**61**) proposes that there are universal principles of natural language function and accordingly universally determined orders of rule application. A distinction is made between marked and unmarked phoneme occurrences, and a typology of markedness is suggested.

The surface phonetic structures of languages show certain possibilities of what may occur in sequence and, by inference, what may not. If surface structures result from the application of rules, the rules must be motivated in part by these phonotactic possibilities and constraints. Sommerstein (**62**) seeks to formalize the notion of phonotactic motivation of phonological rules. He establishes two basic dichotomies among phonologically motivated rules: one, between positively motivated and negatively motivated rules; the other between particularly motivated rules and generally motivated rules.

McConvell (**63**) describes a constraint in Gurindji and two related languages. A nasal cluster, in this paper, is a sequence of nasal consonant and non-nasal stop. When two nasal clusters occur in sequence, dissimilation occurs, either through conversion of the nasal consonant in the second cluster to a stop (denasalization) or through loss of the nasal consonant (deletion). The author examines the Adjacency Principle and the Relevancy Condition as explanations for the dissimilation.

By analyzing eight constraints in Fula and Guere, Paradis (**64**) seeks to offer a general view of the functions of constraints, the causes of their violations and the processes that repair them, while highlighting the advantages of constraints over a rule-type approach. Constraints have two types of effect: they block a phonological process, or they permit a violation and then trigger a repair strategy.

LaCharité and Paradis (**65**) offer a summary of published work dealing with constraints in a rule-based theory (Section 1), then offer their own theory, which operates with constraints instead of rules. The putative advantages of constraints over rules: constraints reduce the number of sources or causes of phenomena; they link apparently unrelated facts; and they make more predictions. The authors compare Declarative Phonology, Optimality Theory, and their own Theory of Constraints and Repair Strategies and introduce a Minimality Principle. (For a different view of McCarthy's *r*-insertion rule, which they discuss, compare McMahon, **71**.)

Scobbie (**66**) introduces a theory which he calls Declarative Phonology. Like other constraint-based theories, it makes use of faithfulness constraints and negative constraints. Faithfulness constraints are motivated by consideration of the listener; negative constraints are motivated by the difficulty speakers have in any motor task. In Optimality Theory the surface structure does not necessarily conform to every constraint; rather, constraints are ranked. In Declarative Phonology all constraints are equal but the more specific has precedence over the more general (an example of what Kiparsky has called the Elsewhere Condition).

Myers (**67**) maintains that Optimality Theory is better able to express the correspondence between phonetically natural phonological patterns and their phonetic counterparts than derivational models and hence is better suited to distinguish natural phonological patterns from unnatural ones. In Myers' view a phonological representation is a phonetic object and its elements are phonetic targets. A constraint in Optimality Theory is a statement that a given array of phonetic targets is undesirable for some reason.

When words are borrowed from one language into another, certain adaptations, preservations and deletions of segments and sequences occur. Paradis and LaCharité (**68**) seek to show that these are predictable, given the system of the borrowing language. Analyzing words borrowed into Fula from French, they find adaptations that are explainable in view of the Fula phonological system. They introduce a preservation principle and a minimality principle—the borrowing language changes as little as possible and in the slightest way possible.

It has been widely accepted that morphological and phonological constituents are not necessarily isomorphic and that some phonological rules are sensitive to phonological constituents, not morphological constituents. Kang and Lee (**69**) argue that prosodic constituents which are different from morphological ones are necessary for Sino-Korean words. A common phenomenon of Korean is the interchange of [l], [n], and [r] indifferent occurrences of the same morphemes. They show that phonetic realizations of such morphemes depend on their positions in a prosodic constituent.

McCarthy and Prince (**70**) present a theory of categorial alignment and offer it as a better explanation of linguistic data than previous attempts of different kinds because it is a unified theory. They use two notions taken from Optimality Theory: a hierarchic ranking of constraints; the evaluation of candidate output forms.

McMahon (**71**) offers the best critique to date of constraint-based analyses. She examines certain synchronic variations in light of the historic processes that caused them. She suggests that both rules and constraints are necessary and that the functions of rules and constraints need to be distinguished.

Disclaimer

References within each chapter are as they appeared in the original complete work.

53

THE ORIGIN OF SOUND PATTERNS IN VOCAL TRACT CONSTRAINTS

John J. Ohala

Source: P. F. MacNeilage (ed.) *The Production of Speech*, New York, etc.: Springer-Verlag, 1983, pp. 189–216

I Introduction

The ultimate task of phonology is to discover the causes of the behavior of speech sounds. To do this phonologists must refer to the way speech is created and used by humans, including how it is stored in the brain, retrieved, executed, perceived, and used to facilitate social interaction among humans. The domain of phonology is therefore mind, matter, and manners. This chapter is about matter: some aerodynamic and anatomical properties of the vocal tract and how they influence the shape and patterning of speech sounds. A secondary aim of this chapter is to show not only that the study of the physical aspects of speech assists phonology but also that phonology can return the favor: A careful, perhaps inspired, analysis of sound patterns in language can help us to discover and understand some of the complexities of speech production (Ohala, 1975a, 1975b, 1978a, 1978b, 1980, 1981; Ohala & Riordan, 1979; Shattuck-Hufnagel, 1983; MacKay, 1972).

Language is a very complex human activity and, as mentioned, sound patterns can be determined by psychological and social factors as well as physical factors. But such nonphysical factors tend to vary widely from one community to another or even from one individual to another. Thus, their influence on speech sound behavior should be quite different when viewed over widely divergent languages. Physics and human physiology, however, represent a universal substrate on which all speech is built. Therefore, to be sure we are dealing with sound patterns that are due primarily to these universal factors, it is necessary to look for them repeated in several unrelated languages.

In fulfilling this task I will cite what might seem like quite dissimilar pieces of data from different languages: allophonic variation, sound change, dialect variation, morphophonemic alternation (i.e., contextually determined variation in the phonetic shape of a given morpheme within a single language), and patterns in segment inventories. In fact, I believe it is safe to regard all of these as manifestations of the same phenomenon caught at different stages or viewed from slightly different angles. I assume that the allophonic variations cited arise from constraints of the vocal tract, the topic of interest. Some of these allophonic variations become sound changes. If a sound change affects words in one linguistic community but not another, dialect variation results. If the sound change affects a given morpheme in one phonetic environment but not another, then morphophonemic variation results. If one consequence of the sound change is to eliminate a segment from or introduce a segment into the language, then it would influence the language's total segment inventory.

It might be thought that if the same physical factors have been at work shaping all human speech, then all languages should be tending toward the same phonological state. It is true that the more we look at diverse languages' phonologies, the more we find very similar patterns or metapatterns. Thus, although it is surprising to learn from Ladefoged (1983) that one language has some 80 click phonemes in addition to nonclick sounds, in general, none of the phonemes or features utilized in the Khoisan languages requires us to stretch the conceptual and descriptive framework laid down for other languages' sound systems. Nevertheless, languages' phonologies differ very much in details, and there is no detectable trend toward convergence. One reason for this is that there are many degrees of freedom in the design of a vocal-auditory signaling system and that several designs (i.e., phonologies) can serve the primary function of communication and still stay within the bounds set by articulatory (and auditory) constraints. Another reason for diversity in languages is that the psychological and social factors shaping speech may run counter to the influence of purely physical factors.

II Speech aerodynamics

A Preliminaries

The speech production mechanism can be viewed as a device that converts muscular energy into acoustic energy. It does this by creating within the vocal tract direct-current (dc) pressure differences that, when allowed to equalize with atmospheric pressure, create turbulence in the rapidly moving air which in turn produces the alternating-current pressure variations we call sound. It is therefore useful to consider how these dc pressure changes are made.

Figure 9.1 gives a schematic representation of the vocal tract as a collection of pistons, valves, and piston chambers that can produce slowly varying localized pressure changes. There are three pistonlike structures in the

此为试读，需要完整PDF请访问：www.ertongbook.com

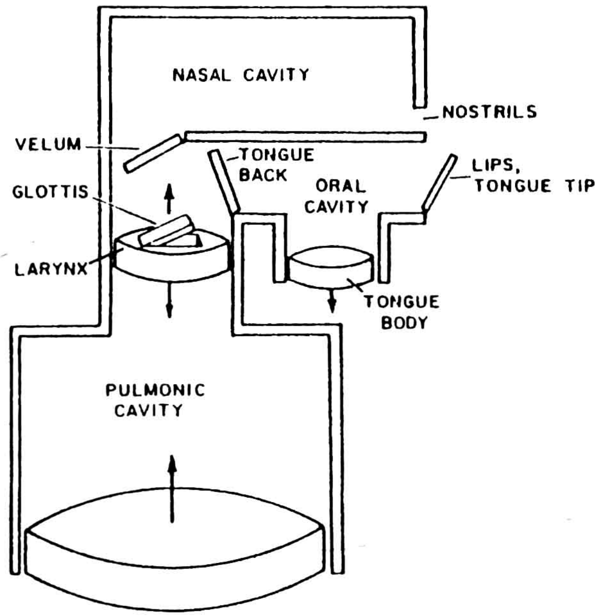

Figure 9.1. Schematic representation of the vocal tract as a device for the production of local dc pressure variations.

vocal tract: the chest wall, the larynx, and the tongue. Sounds created with these three mechanisms as the initiator of the pressure change are called *pulmonic, glottalic,* and *velaric* sounds, respectively. If these pistons compress air in the chamber they are associated with, the sound is said to be *egressive*; if they rarefy the air, that is, create a negative pressure vis-à-vis atmospheric pressure, the sound is called *ingressive* (Ladefoged, 1971; Catford, 1977a).

B Preferred segment types

Although it is physically possible for these three pistons to move in both directions to create both ingressive and egressive sounds, in fact, as indicated by the arrows near these structures in Figure 9.1, only four of the six possible sound types are found in human languages: pulmonic egressives, for example, [p, l, a, ʔ, s];[1] glottalic egressives, or "ejectives," for example, [p', t']; glottalic ingressives or "implosives," such as [ɓ, ɗ, ɠ]; and velaric ingressives or "clicks," such as [ʇ, ʖ]. Pulmonic ingressive vocalization is not found except as a stylistic variant of pulmonic egressive speech, for example, Swedish [ja] (on ingressive voice) "yes" (emphatic), French [wi] (ingressive voice) "yes" (used primarily by females). Velaric egressive sounds are even rarer, being found only (as far as I know) as imitations of animal sounds or flatulence, the latter used for mockery or insults.

Why should two of the possible six sound types not be used? The lack of pulmonic ingressive sounds, if I may speculate, is probably due to the shape of the vocal cords in normal voice (modal register), which, in coronal section (see Figure 9.2), are seen to be asymmetric about the plane that is normal to the airflow and that passes through them at the point of closest approximation. The vocal cords have more bulk below this plane than they do above it. If airflow is egressive, that is, has greater sub- than supraglottal pressure, the upward movement of the vocal cords will necessarily also involve their lateral movement, thus smoothly and effectively opening the valve that vents the subglottal air. If airflow is ingressive, however, it would seem that a downward movement of the vocal cords would involve a slight bulging of the lower tissues, which would not move laterally as easily in order to release an excess of supraglottal pressure. (This argument would not apply to falsetto voice, where the vocal cords are considerably thinned and thus have a more symmetric coronal profile. Accordingly, I find that I can phonate in falsetto voice about as well ingressively as egressively.)

Of course, it is also true that some fricatives, notably sibilants such as [s, ʃ], cannot be produced as well ingressively as egressively. No doubt this is because during ingressive airflow the primary location of the noise source (the point where the air exits and expands from the narrow channel it is forced through) is on the wrong side – the inside – of the oral constriction, which, because it has very high acoustic impedance, does not permit the sound generated to radiate to the atmosphere.

Velaric egressives may not make good speech sounds. I would speculate, because the characteristics of the tongue blade as a valve permit higher

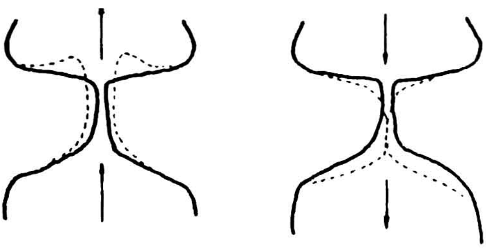

Figure 9.2. Hypothetical coronal sections of the vocal cords showing the pattern of vibratory movement during egressive voice (left) and ingressive voice (right) (arrows show direction of airflow). Solid lines show positions of vocal cords when transglottal pressure is relatively low; dotted lines represent their position as the transglottal pressure builds up to a maximum, that is, as the excess pressure is being vented. Egressive voice, but not ingressive voice, allows lateral movement of the vocal cords and thus easy venting of the excess pressure.

negative pressures (but not positive pressures) to develop and to be released in a suitably abrupt fashion before the seal fails.

Many other constraints on the form of speech stem from the properties of the speech system represented in Figure 9.1. It is evident, for example, that a chamber in which an appreciable pressure change is created ($\Delta p = \pm 5$ cm H_2O), and that has to be vented through one valve in order to create an audible sound, must have all other valves closed. Thus there can be no nasalized [p]. Also, there can be no glottalic sonorants, for example, ejective [m], implosive [l]. This is because any pressure change created by the larynx acting as a piston would equalize immediately by leakage across the rather large valvular openings characteristic of sonorants. For similar reasons, all oral obstruents that are released at the uvular region or farther forward (except clicks) must have the soft palate elevated (i.e., the velopharyngeal valve closed). Pharyngeal or glottal obstruents (the latter including, from a physical point of view, all vowels and voiced sonorants) would not require soft palate elevation – the open velopharyngeal valve does not connect to, and therefore does not vent air pressure in, the pharyngeal or subglottal cavities. (This assumes, of course, that these sounds are not distinctively nasal, e.g., [ĩ].) I will explore below some phonological consequences of this point.

Another sound pattern deducible in part from aerodynamic considerations is that evident in languages' segment inventories. Tables 9.1 and 9.2 give the consonant inventories of Abkhaz and Yala, respectively. On the basis of such data, Hockett (1955, pp. 104 ff.) offered the generalization that the more consonants a language has, the greater is the ratio, *r*, of obstruents to nonobstruents. Yala has 28 consonants, of which 18 are obstruents, giving an *r* of 1.8. In Abkhaz, which has 58 consonants, $r = 7.3$. Salient acoustic signals are those that involve rapid spectral modulations (Stevens, 1980). Obstruents, especially those that involve a transient burst due to the rapid equalization of an appreciable difference in air pressure, create more rapid spectral changes and thus are able to carry more information and make many more distinctive sounds than can nonobstruents. This accounts for Hockett's observation.

C Constraints on the voicing or devoicing of stops

Voicing – vibration of the vocal cords – has two physiological requirements: First, the vocal cords must be in a suitable configuration – typically, lightly adducted; and second, there must be sufficient air flowing past them. If either one or both of these conditions are missing, there will be no voicing. To the extent that both of these conditions are approached during a voiceless segment, the chance of that segment becoming voiced is greater.

There is a well-recognized difficulty in maintaining voicing during a stop (in which, by definition, all exit valves are closed) because the air flowing through the glottis accumulates in the oral cavity, causing oral pressure to

Table 9.1 Consonant inventory of Abkhaz

m	n													
b	d	dʷ					gʲ	g	gʷ					
p	t	tʷ					kʲ	k	kʷ					
p'	t'	tʷ'					kʲ'	k'	kʷ'	qʲ'	q'	qʷ'		
	dz	dzʷ	dʒ		dʐ									
	ts	tsʷ	tʃ		tɕ									
	ts'	tsʷ'	tʃ'		tɕ'									
v	z		ʒ		ʐ	ʐʷ								
f	s		ʃ		ɕ	ɕʷ				ʁʲ	ʁ	ʁʷ		
w			l	r	j	ɥ				χʲ	χ	χʷ	ħ	hʷ

Note: From Catford (1977b).

Table 9.2 Consonant inventory of Yala (Ikom)

m		n		ɲ		ŋ		ŋ͡w
m͡b							ŋ͡mg͡b	
b		d		ɟ		g	g͡b	g͡w
p		t		c		k	k͡p	k͡w
f		s				x		
		s͡j						
	l		r					
				j	ɥ		w	

Note: From Armstrong (1968).

approach subglottal pressure. When this happens the air flowing through the glottis gradually diminishes and voicing is extinguished.

In view of this, it is not surprising to find that of the 706 languages whose segment inventories were surveyed by Ruhlen (1975) 166 have only voiceless stops and 4 have only voiced stops (the remainder using both voiced and voiceless stops). Even if the reliability of such large-scale surveys may be questioned, the decisive "tilt" toward voicelessness in the stops could not be reversed by a few inaccuracies.

The longer the stop closure is held, the greater is the likelihood that voicing will be extinguished. Thus the tendency for long voiced stops (so-called geminates) to become voiceless is particularly strong. Phonological data from Mõré, which illustrates this, are given in Table 9.3. (See also Jaeger, 1978, for further evidence on this point.) Conversely, the shorter a stop closure is, the more likely it is to remain voiced, or if originally voiceless, to become voiced. There is, therefore, a very widespread tendency among languages to have voiced stops (or voiced obstruents in general) shorter than their voiceless counterparts (Lehiste, 1970, pp. 27 ff.).

There is also extensive evidence that voicing sits more comfortably on stops, pulmonic or implosive, made at some places of articulation rather than at others (Greenberg, 1970; Gamkrelidze, 1975; Sherman, 1975). Table

Table 9.3 Morphophonemic variation in Mõré

Morphophonemic form	*Phonemic form*	*French gloss*
pabbo	> papo	*frapper*
daw-ba	> dapa	*hommes* (w < b, cf. dibla, *petit mâle*)
bad + do	> bato	*corbeilles*
lug + gu	> luku	*enclos*
boγ + γo	> boko	*trou* (γ < g)

Note: From Alexandre (1953); transcription simplified.

Table 9.4 Stop inventories of Thai (Abramson, 1962), Kalabari (Ladefoged, 1964), and Efik (Ward, 1933) showing absence of voiced velars

Thai			*Kalabari*					*Efik*				
p	t	k	p	t		k	k͡p		t	k	k^w	k͡p
p^h	t^h	k^h	b	d	j	g	g͡b	b	d			
b	d		ɓ	ɗ								

9.4 provides some representative data, the stop inventories from three languages. Sherman conducted one of the most extensive surveys on this pattern; out of over 570 languages whose stop inventories were examined (these did not include implosives), he found 87 that had gaps. The distribution of these "stop gaps" are shown in Table 9.5 (some languages had more than one gap). From such data it is clear that velar stops and voicing show the greatest incompatibility, labial stops and voicing the greatest compatibility. (These data also show that voicelessness does not sit well on bilabial stops. Although to some extent this may be a reflection of the greater hardiness of [b] over [p], or that [p] has a greater tendency to become voiced and thus merge with [b], it is also likely that acoustic-auditory factors are a more important determinant of this pattern: As Stevens (1980) has pointed out, [p] has the lowest amplitude and spectrally most diffuse burst of any of the voiceless stops and is thus less salient auditorily.)

It was once thought that the relative volumes of the oral cavities of the stops [b, d, g] were responsible for this pattern of stop gaps (Greenberg, 1970; Smith, 1977). It was reasoned that the larger volume of the oral cavity for [b] would accommodate more glottal airflow before pressure built up to the point where the transglottal pressure drop fell below the level necessary to maintain voicing, and conversely, that the smaller oral volume for [g] would accommodate less air, thus causing voicing to cease relatively soon. This reasoning is technically correct but the magnitude of the effect of initial oral cavity volume on the length of voicing during stops is negligibly small. Calculations suggest that if the oral volume does not change during the stop

Table 9.5 Incidence of stop gaps according to place or articulation and voicing in 87 languages

	Labial	*Apical*	*Velar*
Voiceless	34	0	0
Voiced	2	21	40

Note: From Sherman (1975).

closure, voicing can be maintained for approximately 10 msec during [g] and 15 msec during [b] (Catford, 1977a, p. 74; Ohala & Riordan, 1979).

Such periods of voicing are negligible in comparison with the typical duration of voiced stops (ca. 70 msec; Lehiste, 1970, pp. 27 ff.). Clearly, initial oral volume by itself cannot explain why [b] is more common than [g] (Ohala, 1975a, 1976; Javkin, 1977). Voicing can be maintained beyond the limits cited if the oral volume increases *during* the stop closure, that is, expands to accommodate the accumulating glottal airflow (Ohala, 1975a, 1976). Such oral cavity enlargement can be accomplished *passively*, that is, as a result of the natural compliance of the walls of the oral cavity; or *actively*, by lowering the larynx, the mandible, and so on (see Chao, 1936; Javkin, 1977; Catford, 1977a).

Ohala and Riordan attempted to determine how long voicing would last if only passive expansion of the vocal tract took place. They had an adult male American English speaker say $V_1C{:}V_2$ utterances where $V_1 = V_2 =$ [i, u, e, a] and C: was an abnormally prolonged voiced stop [b, d, g]. The stop could be prolonged indefinitely because the oral pressure built up during the stop was vented through a nasal catheter. At unpredictable moments, however, a solenoid-activated valve closed the catheter so that oral air pressure would rapidly rise and voicing would be extinguished. The duration of voicing beyond the moment of complete closure was measured on signals from a throat microphone and an air pressure transducer that sensed oral air pressure. The results are presented graphically in Figure 9.3. Over all conditions the median duration of voicing was 64 msec, but it was greatest for [b] (82 msec), least for [g] (52 msec). Moreover, with one exception, the stops coarticulated with the high vowels [i, u] permitted voicing to continue longer than those coarticulated with low vowels. The one exception was that [b] coarticulated with [a] had the longest stretch of voicing (91 msec), presumably because only this combination of consonant and vowel involved passive oral cavity expansion by the highly compliant cheeks.

These results can be accounted for by considering the net compliance of the surfaces on which oral air pressure impinges during the production of the stops. For velar stops only the pharyngeal walls and part of the soft palate can yield to the air pressure; in dentals, these surfaces plus the greater part of the tongue surface and all of the soft palate are involved; and in labials, these

此为试读，需要完整PDF请访问：www.ertongbook.com