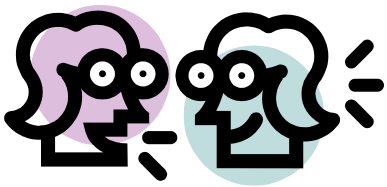
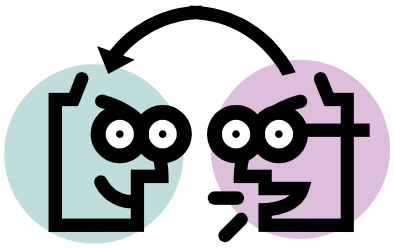
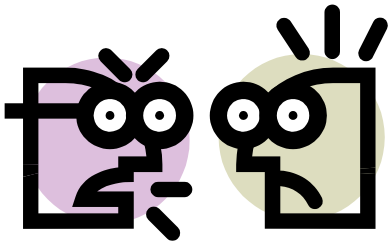


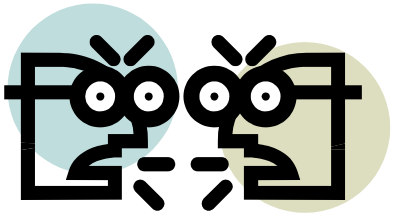
SEGMENTAL

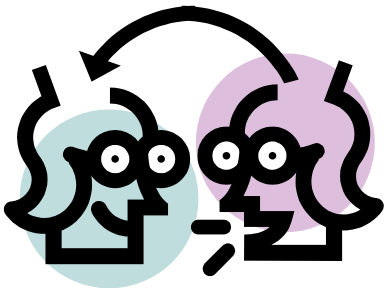


PHONOLOGY



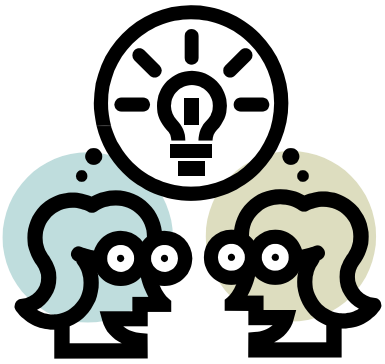
DARIN HOWE





HOWED UCALGARY.CA

UNIVERSITY OF CALGARY



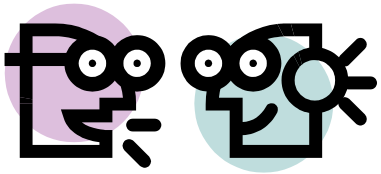


Table of contents

Acknowledgments

For their support I wish to express my most heartfelt gratitude to my colleagues in the Department of Linguistics at the University of Calgary (α order) John Archibald, Craig Chambers, Michael Dobrovolsky, Martha McGinnis, Robert Murray, Amanda Pounder, Betsy Ritter, Hotze Rullmann, Linda Toth, and Doug Walker.

The phonology students at the University of Calgary have been a source of energy and inspiration for me. Many thanks especially to (α order) Rebecca Hanson, Jen Mah, Jodi McIntosh, Cory Sheedy, Corey Telfer, and Sheena van der Mark.

Of the many who have affected how I think about phonology, I wish to single out my undergraduate phonology instructor Henrietta Hung (MIT), my stellar graduate advisors Pat Shaw (UBC), Doug Pulleyblank (UBC) and Emmon Bach (UMass), as well as (α order) John Alderete (Rutgers), Sue Blake (UBC), Laura Downing (SAS), Morris Halle (MIT), Sharon Hargus (UWashington), Ellen Kaisse (UWashington), Michael Kenstowicz (MIT), John Kingston (UMass), Robert Kirchner (UAlberta), Greg Lamontagne (Rutgers), John McCarthy (UMass), Ian Maddieson (Berkeley), Joe Pater (UMass), Ted Pulleyblank (UBC), Grazina Rowicka (SAS), Lisa Selkirk (UMass), Donca Steriade (MIT), Charles Ulrich (SFU), and Su Urbanczyk (UVictoria).

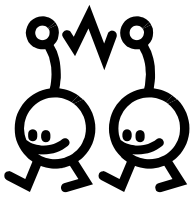
1. Introduction

A game of chess is like an artificial realisation of what language offers in a natural form.
Ferdinand de Saussure, 1916, *Course in General Linguistics*, I, Ch. 3.

Phonology is the study of sound patterns in languages.[1] The term is also often used to refer to the sound system, or pronunciation, of particular languages, e.g., 'the phonology of French'.

As a core discipline in modern (generative) linguistics, phonology has two main goals. First, to discover the universals concerning sound patterns in language, i.e., the common elements of all phonological systems. Second, to place these elements in a theoretical framework that will describe sound patterns that occur in speaker's heads, and also predict what sound patterns cannot occur in speakers' heads.

The current view of phonology —as the study of an aspect of human cognition rather than the study of an external, social reality— originated during the late 1950's and early 1960's with Morris Halle and Noam Chomsky who were hired at the Massachusetts Institute of Technology amid concerns that the Russian KGB were close to being able to use telepathy.[2] While phonology has never been used for telepathy (to my knowledge!), it now has, to be sure, many other applications outside linguistics. For instance, it is of great consequence to language instructors and has received attention among educators because of its importance to reading. It is important to pathologists who treat individuals with abnormal speech. It has a place in the development of software for high-technology businesses (e.g., speech recognition, voice synthesis). It is used by writers, especially poets. And it even has forensic applications.[3]



...if you look at sign language, it doesn't have a single channel. It has multiple channels, but articulated language does have a single channel. That is a limitation of our sensorimotor apparatus and it forces things to be ordered. If we had the ability to communicate by telepathy, let's say (so that we didn't have to make sounds), there might be no word ordering in language at all.
Chomsky, *The Architecture of Language* (Oxford, 2000)

[1] In this course I focus on the phonology of spoken languages, but you should keep in mind that there is also the phonology of sign languages. (See comment by Chomsky on this page.) Researchers report deep similarities of phonological structure in both modalities, such that sign language phonology and general phonological theory have proved to be mutually relevant. The first important book in this area is Stokoe (1960). Other books include Sandler (1989) and Brentari (1999). Incidentally, local Plains First Nations had sign language(s) before European contact (Wurtzburg & Campbell 1995).

[2] A recent overview of the history of phonological theory in the twentieth century is available in a special issue of *Folia Linguistica*, XXXIV/1-2 (2000), 'The History of Phonology in the Twentieth Century' edited by John Goldsmith and Bernard Laks.

[3] A classic example is the Prinzivalli case. Following a series of telephoned bomb threats made to the Los Angeles airport in 1984, Paul Prinzivalli, a cargo handler originally from New York, was arrested and spent ten months in the LA County Jail, until he was acquitted on the basis of a linguist's testimony at trial that the phonological structure of the recorded threats proved that the caller was from Boston, not New York.

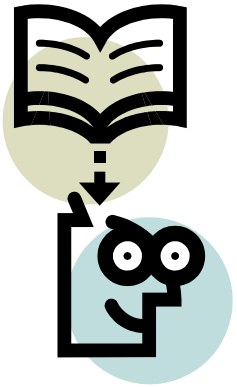
2. Intrasegmental phonology

This chapter treats the *paradigmatic* component of segmental phonology, that is, the part of grammar that establishes the *inventory of phonemes* in a given language.

2.1. Introduction

This section introduces the notion of *phonemes*, their status and number with *inventories*, and their *featural* basis.

2.1.1. The phoneme inventory



Language exists in the form of a sum of impressions deposited in the brain of each member of a community, almost like a dictionary of which identical copies have been distributed to each individual.
Ferdinand de Saussure, 1916, Course in General Linguistics, Intro, Ch. 4.

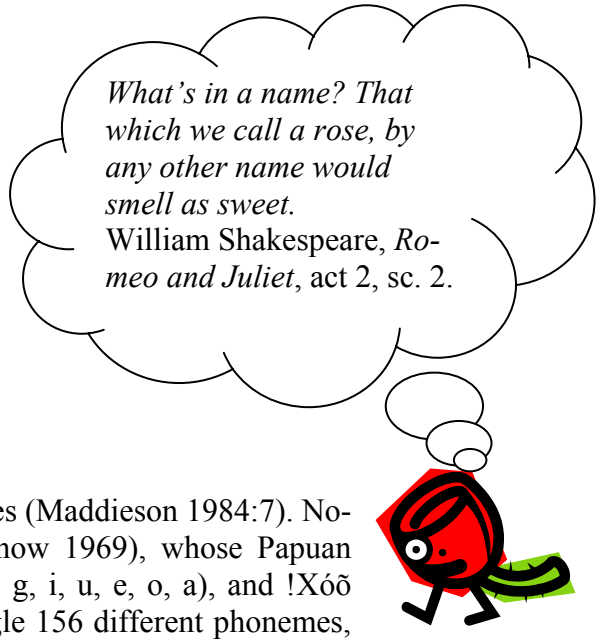
At some level in the speaker's mental dictionary (*lexicon*), the typical entry (*lexeme*) entails a linear arrangement of *phonemes* —relatively abstract units of vocalisation distinguished by native speakers of a given language. Unlike non-human animal vocalisations, phonemes are by themselves meaningless but acquire meaning in combination. For instance, the four phonemes /æ/, /k/, /t/, and /s/ are used in various sequences to form words in English: /ækts/ 'acts', /kæts/ 'cats', /skæt/ 'scat', /stæk/ 'stack', /tæks/ 'tax', /tæsk/ 'task', /kæst/ 'cast', /ækst/ 'axed'. Shorter English words built on these phonemes include /kæt/ 'cat', /tæk/ 'tack', /ækt/ 'act', /sæk/ 'sack', /sæt/ 'sat', /æs/ 'ass', and /æt/ 'at'. We can also reassemble these phonemes to coin new English words such as /kæs/ 'cass' (?), /tæs/ 'tass' (?), and /æk/ 'ack' (?). Needless to say, a great deal more English words —both actual and potential— are easily obtained by combining and recombining these and other segments into longer strings. Such handy assembly and reassembly of phonemes illustrates a unique *design feature* of human language, known as "duality of patterning" (Hockett 1960), which affords unlimited vocabulary power to humans. Thus any speaker

(1) *Canadian English segment inventory*

p		t	tʃ	k	
b		d	dʒ	g	
f	θ	s	ʃ		
v	ð	z	ʒ		
m		n		ŋ	
		l	ɹ		
			j	w	h
			i	u	
			ɪ	ʊ	
			e	o	
			ɛ	ʌ	
			æ	ɑ	
			ə		

who learns the 35 phonemes of (Canadian) English, shown in (1), can —in principle at least— learn to use and recognise any of the 650,000 different entries in the Oxford English Dictionary (www.oed.com), or any of the millions of scientific or technical terms which are normally left out from ordinary dictionaries. Consider this: there are over four million insect species (31 million according to some entomologists!) and 1.4 million of them have already been named (*Nature*, April 25, 2002).

In actuality, chances are you have between 75,000 and 100,000 words in your speaking vocabulary (Oldfield 1963; cf. Miller 1991) —still nothing to balk at. These are words that you *really* know. Indeed you are probably able to recognise and repeat the words dəstɹojd, bɹɛst, dæmp, ditɛktɪv, toz, ok, lowəst, fajɹd, səbmɪtəd, kæst in spite of their being some of the least frequent words of present-day spoken English; they are used approximately once every 100,000 words (Leech et al. 2001). You acquired about a third of your vocabulary as a child, starting around your first birthday, at an average rate of one word every waking hour (Pinker 1994). Children everywhere are able do this without training or feedback. It has been found that a word mentioned in passing to a child is typically retained two weeks later (ibid.). As Bloom (2000:2) states: "There is nothing else — not a computer simulation, and not a trained chimpanzee — that has close to the word learning abilities of a normal 2-year-old child." Again, this remarkable capacity derives in large part from the duality of levels in human language: every native speaker learns to distinguish meaningless but *discrete* phonemes in his/her language, which he/she is able to combine *productively* into sequences which he/she is also able to pair *arbitrarily* with meanings.[4]



There is doubtless a lower bound on the number of phonemes needed to make up the lexicon of any given language, and there is also presumably an upper bound on the number of phonemes that speakers of any given language can handle. So in practice languages average about 31 phonemes in their inventories; about three quarters of the world's languages have between 20 and 37 different phonemes (Maddieson 1984:7). Notable exceptions include Rotokas (Firchow & Firchow 1969), whose Papuan speakers get by with just 11 segments (p, t, k, β, ɾ, g, i, u, e, o, a), and !Xóõ (Snyman 1970, 1975), whose Khoisan speakers juggle 156 different phonemes,

[4] Carstair-McCarthy (2002:18): 'Some relatively long words, such as *catamaran* and *knickerbocker*, may consist of just one morpheme; on the other hand, a single-syllable word, such as *tenths*, may contain as many as three morphemes (*ten*, *-th*, *-s*). What this shows is that the morphological structure of words is largely independent of their phonological structure …'

including the voiceless pulmonic ingressive nasal /ŋ̊!^{h}/ —"among the most difficult articulations that we know of in common words in the world's languages" (Ladefoged & Maddieson 1996:280). In Canada, too, languages of some families such as Iroquoian and Algonquian tend to have small phoneme inventories, while languages from other language families such as Athapaskan and Wakashan boast rather large phoneme inventories.

(2) *Cree (Alberta, Algonquian)*

p	t	t^{s}	k		i, iː	
	s			h	eː	oː, oːː
m	n				aː, aːː	
		j	w			

(3) *Cayuga (Ontario, Iroquoian)*

t	t^{s}	k		ʔ	i		
s						e	o
n						ẽ	õ
r						a	
	j	w	h				

(4) *Segment inventory of Chipewyan (Alberta, Athapaskan)*

p	t^{θ}	t	t^{s}	t^{ɬ}	t^{ʃ}	k	k^{w}		ì	ù	ǐ	ů̀
	t^{θh}	t^{h}	t^{sh}	t^{ɬh}	t^{ʃh}	k^{h}	k^{wh}		è	ò	ě	ǒ̀
	t$^{θ'}$	t'	t$^{s'}$	t$^{ɬ'}$	t$^{ʃ'}$	k'	k$^{w'}$	ʔ		ə		
	θ		s	ɬ	ʃ	x	x^{w}			à		ů̀
	ð		z		ʒ	ɣ						
m		n							í	ú	ǐ	ů́
			r	l					é	ó	ě	ǒ́
					j		w	h		á		ů́

(5) *Segment inventory of Oowekyala (BC, Wakashan)*

p	t	t^{s}	t^{ɬ}	k	k^{w}	q	q^{w}				
b	d	d^{z}	d^{l}	g	g^{w}	ɢ	ɢ^{w}		i, iː		u, uː
p'	t'	t$^{s'}$	t$^{ɬ'}$	k'	k$^{w'}$	q'	q$^{w'}$		i̯		u̯
		s	ɬ	x	x^{w}	χ	χ^{w}			ə	
m, mː	n, nː									a, aː	
m̯	n̯									a̯	
		l, lː									
		l̯									
			j	w		h	ḥ				
			j̯	w̯		ʔ	ʔ̣				

2.1.2. Phonemes as feature bundles

The list of speech sounds, or *phones*, below on the next page, while not exhaustive, serves to point up the formidable diversity of sounds that can be drawn upon in defining segment inventories. The world's top ten languages —Mandarin, English, Spanish, Bengali, Hindi, Portuguese, Russian, Japanese, German, and Wu— alone encompass 192 different speech sounds (116 consonants and 76 vowels) (Epstein 2000). Many other languages, such as Irish, Nama, and Arabic, abound in segments that are extremely rare crosslinguistically. The UCLA Phonological Segment Inventory Database (UPSID), which now contains 451 languages, documents 921 different segments (Maddieson 1984, Maddieson & Precoda 1990).

p, ᵐp, b, ᵐb, pʰ, pʼ, bʱ, ɓ, ɓ, ɓ, pʷ, ᵐpʷ, bʷ, ᵐbʷ, pʷʰ, pʷʼ, bʷʱ, ɓʷ, ɓʷ, ɓʷ, pʲ, ᵐpʲ, bʲ, ᵐbʲ, pʲʰ, pʲʼ, bʲʱ, ɓʲ, ɓʲ, ɓʲ, pˠ, ᵐpˠ, bˠ, ᵐbˠ, pˠʼ, bˠʱ, ɓˠ, ɓˠ, ɓˠ, ᵐpˤ, bˤ, ᵐbˤ, pˤʼ, bˤʱ, ɓˤ, ɓˤ, ɓˤ, p͡t, b͡d, p͡tʷ, b͡dʷ, p͡tʲ, b͡dʲ, p͡tˤ, b͡dˤ, p͡c, b͡ɟ, p͡cʷ, b͡ɟʷ, p͡cʲ, b͡ɟʲ, p͡cˤ, b͡ɟˤ, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪ʼ, d̪ʱ, d̪, ɗ, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪ʼ, d̪ʱ, d̪, ɗ, t̪ʷ, ⁿt̪ʷ, d̪ʷ, ⁿd̪ʷ, t̪ʷʰ, t̪ʷʼ, d̪ʷʱ, d̪ʷ, ɗʷ, t̪ʲ, ⁿt̪ʲ, d̪ʲ, ⁿd̪ʲ, t̪ʲʰ, t̪ʲʼ, d̪ʲʱ, d̪ʲ, ɗʲ, t, ⁿt, d, ⁿd, tʰ, tʼ, dʱ, ɖ, ɗ, f, tʷ, ⁿtʷ, dʷ, ⁿdʷ, tʷʰ, tʷʼ, dʷʱ, ɖʷ, ɗʷ, fʷ, tʲ, ⁿtʲ, dʲ, ⁿdʲ, tʲʰ, tʲʼ, dʲʱ, ɖʲ, ɗʲ, fʲ, tˠ, ⁿtˠ, dˠ, ⁿdˠ, tˠʼ, dˠʱ, ɖˠ, ɗˠ, fˠ, tˤ, ⁿtˤ, dˤ, ⁿdˤ, tˤʼ, dˤʱ, ɖˤ, ɗˤ, fˤ, t͡p, d͡b, t͡pʷ, d͡bʷ, t͡k, d͡g, t͡kʷ, d͡gʷ, ʈ, ⁿʈ, ɖ, ⁿɖ, ʈʰ, ʈʼ, ɖʱ, ɖ, ɗ, ʈʷ, ⁿʈʷ, ɖʷ, ⁿɖʷ, ʈʷʰ, ʈʷʼ, ɖʷʱ, ɖʷ, ɗʷ, ʈˤ, ⁿʈˤ, ɖˤ, ⁿɖˤ, ʈʰˤ, ʈʼˤ, ɖʱˤ, ɖˤ, ɗˤ, !, tˤʷ, ⁿtˤʷ, qʷ, ⁿqʷ, tʷʰ, tʷʼ, qʷʱ, qʷ, ɗʷ, t͡p, q͡b, t͡pʷ, q͡bʷ, c, ᶮc, ɟ, ᶮɟ, cʰ, cʼ, ɟʱ, ɟ, ɟ, k, ᵑk, g, ᵑg, kʰ, kʼ, gʱ, g, ɠ, ƙ, kʘ, gʘ, kʘʰ, kʘʼ, kʘˀ, k|, g|, k|ʰ, k|ʼ, k|ˀ, k!, g!, k!ʰ, k!ʼ, k!ˀ, k‖, g‖, k‖ʰ, k‖ʼ, k‖ˀ, kǂ, gǂ, k‖ʰ, k‖ʼ, k‖ˀ, kʷ, ᵑkʷ, gʷ, ᵑgʷ, kʷʰ, kʷʼ, gʷʱ, gʷ, ɠʷ, ƙʷ, kʷˤ, ᵑkʷˤ, gʷˤ, ᵑgʷˤ, kʷˤʼ, gʷˤ, ɠʷˤ, ƙʷˤ, kʲ, ᵑkʲ, gʲ, ᵑgʲ, kʲʰ, kʲʼ, gʲʱ, gʲ, ɠʲ, ƙʲ, kˤ, ᵑkˤ, gˤ, ᵑgˤ, kˤʼ, gˤʱ, gˤ, ɠˤ, ƙˤ, k͡p, ᵑ͡mk͡p, ᵑk͡p, g͡b, ᵑ͡mg͡b, ᵑg͡b, k͡pʰ, k͡pʼ, g͡bʱ, g͡b, k͡ʛ, k͡pʷ, g͡bʷ, q, ᴺq, ɢ, ᴺɢ, qʰ, qʼ, ɢʱ, ɢ, ɠ, qʘ, ɢʘ, qʘʰ, qʘʼ, qʘˀ, q|, ɢ|, q|ʰ, q|ʼ, q|ˀ, q!, ɢ!, q!ʰ, q!ʼ, q!ˀ, q‖, ɢ‖, q‖ʰ, q‖ʼ, q‖ˀ, qǂ, ɢǂ, qǂʰ, qǂʼ, qǂˀ, qʷ, ᴺqʷ, ɢʷ, ᴺɢʷ, qʷʰ, qʷʼ, ɢʷʱ, ɢʷ, ɠʷ, q͡p, q͡b, ʡ, ʡʷ, pꟳ, ᵐpꟳ, bᵛ, ᵐbᵛ, pꟳʰ, pꟳʼ, bᵛʱ, bᵛ, tᶿ, ⁿtᶿ, dᶞ, ⁿdᶞ, tᶿʰ, tᶿʼ, dᶞʱ, ɖᶞ, tˢ, ⁿtˢ, dᶻ, ⁿdᶻ, tˢʰ, tˢʼ, dᶻʱ, ɖᶻ, tɬ, ⁿtɬ, dɮ, ⁿdɮ, tɬʰ, tɬʼ, dɮʱ, ɖɮ, tᶜ, ⁿtᶜ, dᶻ, ⁿdᶻ, tᶜʰ, tᶜʼ, dᶻʱ, ɖᶻ, tᶜʲ, ⁿtᶜʲ, dᶻʲ, ⁿdᶻʲ, tᶜʲʰ, tᶜʲʼ, dᶻʲʱ, ɖᶻʲ, tʃ, ⁿtʃ, dʒ, ⁿdʒ, tʃʰ, tʃʼ, dʒʱ, ɖʒ, cᶜ, ᶮcᶜ, dʲ, ᶮdʲ, cᶜʰ, dʲʱ, ɖʲ, cᶜˀ, ᶮcᶜˀ, ɟʲ, ᶮɟʲ, cᶜʰˀ, ɟʲʱ, ɟʲ, cᶜʲ, ᶮcᶜʲ, ɟʲˀ, ᶮɟʲˀ, cᶜʲʰ, ɟʲʱˀ, ɟʲˀ, cᶜʲʰˀ, ɟʲʱˀ, ɟʲˀ, kˣ, gʸ, kˣʰ, kˣʼ, kʘˣ, k|ˣ, k!ˣ, k‖ˣ, kǂˣ, kǂˠ, ᵑkǂˠ, gǂˠ, ᵑgǂˠ, kǂʰˠ, kǂʼˠ, gǂʱˠ, ɠǂˠ, kǂʷˠ, ᵑkǂʷˠ, gǂʷˠ, ᵑgǂʷˠ, kǂʷʰˠ, kǂʷʼˠ, gǂʷʱˠ, ɠǂʷˠ, ɸ, β, β̃, β͡ʒ, ɸ͡ɕ, β͡ʝ, ʙ, ʙ̥, f, v, ṽ, fʰ, fʼ, fʷ, vʷ, ṽʷ, fʷʰ, fʷʼ, fʲ, vʲ, ṽʲ, fʲʰ, fʲʼ, fˤ, vˤ, ṽˤ, fˤʼ, f͡s, f͡ʃ, θ, θ̪, θ̃, θ, ð, ð̃, θʰ, θʼ, ðˤ, s̪, z̪, z̪̃, s̪ʰ, s̪ʼ, ɬ, ɮ, ɮ̃, ɬʰ, ɬʼ, ɬˤ, ɮˤ, ɹ̥, ɹ, ɕ, ʐ, ʐ̃, ɕʰ, ɕʼ, ʃ, ʒ, ʒ̃, ʃʰ, ʃʼ, ʃʷ, ʒʷ, ʒ̃ʷ, ʃʷʰ, ʃʷʼ, ʃʲ, ʒʲ, ʒ̃ʲ, ʃʲʰ, ʃʲʼ, ʃˤ, ʒˤ, ʒ̃ˤ, ʃˤʼ, ʂ, ʐ, ʐ̃, ʂʰ, ʂʼ, ç, ʝ, ʝ̃, çʰ, çʼ, ɧ, ɻ̊, ɻ, x, ɣ, ɣ̃, xʰ, xʼ, xʷ, ɣʷ, ɣ̃ʷ, xʷʰ, xʷʼ, xʲ, ɣʲ, ɣ̃ʲ, xʲʰ, xʲʼ, χ, ʁ, ʁ̃, χʰ, χʼ, χʷ, ʁʷ, ʁ̃ʷ, χʷʰ, χʷʼ, ħ, ʕ, ʕʼ, ħʷ, ʕʷ, ʕʷʼ, ʜ, ʢ, ʜʷ, ʢʷ, m, m̥, m̃, mʷ, m̥ʷ, m̃ʷ, mˠ, mʲ, mˠ, mˤ, ɱ, n̪, n̥, ñ̪, ñ̥, n̪, n̥, ñ̪, ñ̥, nʷ, n̥ʷ, ñ̪ʷ, ñ̥ʷ, nʲ, nˠ, nˤ, n͡m, n̪͡mʷ, n̪, n̥, ñ̪, ñ̥, nʷ, n̥ʷ, ñ̪ʷ, ɳ, ɳ̊, ɳ̃, ɳʷ, ɳ̊ʷ, ɳ̃ʷ, ɳ͡m, ɳ̊͡mʷ, ɲ, ɲ̊, ɲ̃, ɲ̊, ɲ, ɲ̊, ɲ̃, ŋʘ, ŋ̊ʘ, ˀŋʘ, ŋ̊ʘʰ, ŋǀ, ŋ̊ǀ, ˀŋǀ, ŋ̊ǀʰ, ŋǃ, ŋ̊ǃ, ˀŋǃ, ŋ̊ǃʰ, ŋ‖, ŋ̊‖, ˀŋ‖, ŋ̊‖ʰ, ŋǂ, ŋ̊ǂ, ˀŋǂ, ŋ̊ǂʰ, ɳʷ, ŋ̊ʷ, ɳ̃ʷ, ɲʲ, ŋ̊ʲ, ŋ͡m, ŋ̊͡mʷ, ɴ, ɴ̥, ɴ̃, ɴʷ, ɴ̥ʷ, ɴ̃ʷ, ɭ̊, ɭ̃, ɭ̊̃, ɭ̊̃, ɭʷ, ɭ̃ʷ, ɭ̊ʷ, ɭ̊̃ʷ, ɭʲ, ɭ̃ʲ, ɭ̊ʲ, ɭ̊̃ʲ, ɭˠ, ɭ̃ˠ, ɭ̊ˠ, ɭ̊̃ˠ, ɭˤ, ɭ̃ˤ, ɭ̊ˤ, ɭ̊̃ˤ, ɭʷ, ɭ̃ʷ, ɭ̊ʷ, ɭ̊̃ʷ, ʟ, ʟ̃, ʟ̥, ʟ̥̃, ʟʷ, ʟ̃ʷ, ʟ̥ʷ, ʟ̥̃ʷ, ɻ, ɻ̃, ɻ̊, ɻ̊̃, ɻʷ, ɻ̃ʷ, ɻ̊ʷ, ɻ̊̃ʷ, ɻˠ, ɻ̃ˠ, ɻ̊ˠ, ɻ̊̃ˠ, ɻˤ, ɻ̃ˤ, ɻ̊ˤ, ɻ̊̃ˤ, ɻʷ, ɻ̃ʷ, ɻ̊ʷ, ɻ̊̃ʷ, ɻ, ɻ̃, ɻ̊, ɻ̊̃, ɻʷ, ɻ̃ʷ, ɻ̊ʷ, ɻ̊̃ʷ, ʎ, ʎ̃, ʎ̥, ʎ̥̃, ɬ, ɬ̃, ɬ̥, ɬ̥̃, ɬʷ, ɬ̃ʷ, ɬ̥ʷ, ɬ̥̃ʷ, ʟ, ʟ̃, ʟ̥, ʟ̥̃, ʟʷ, ʟ̃ʷ, ʟ̥ʷ, ʟ̥̃ʷ, ʟˠ, ʟ̃ˠ, ʟ̥ˠ, ʟ̥̃ˠ, ʟˤ, ʟ̃ˤ, ʟ̥ˤ, ʟ̥̃ˤ, ʟʷ, ʟ̃ʷ, ʟ̥ʷ, ʟ̥̃ʷ, ʁ, ʁʷ, ʁ, ʁʷ, ʊ, ʊ̃, ʊ̥, ʊ̥̃, ʊ̆, j, j̃, j̥, j̥̃, jʷ, j̃ʷ, j̥ʷ, j̥̃ʷ, jˤ, ɥ, ɥ̃, ɥ̥, ɥ̥̃, ʍ, ʍ̃, ʍ̥, ʍ̥̃, wˤ, w̆, ɯ, ɯ̃, ɯ̥, ɯ̥̃, ɯʷ, ɯ̃ʷ, ɯ̥ʷ, ɯ̥̃ʷ, h, hʷ, hʲ, hˤ, ɦ, ɦʷ, ɦʲ, ɦˤ, ɦ, ɦʷ, ɦʲ, ɦˤ, ʔ, ʔʷ, ʔʲ, ʔˤ, i, ĩ, i̥, ĩ̥, y, ỹ, y̥, ỹ̥, ɨ, ɨ̃, ɨ̥, ɨ̥̃, ʉ, ʉ̃, ʉ̥, ʉ̥̃, ɯ, ɯ̃, ɯ̥, ɯ̥̃, u, ũ, u̥, ũ̥, ɪ, ɪ̃, ɪ̥, ɪ̥̃, ʏ, ʏ̃, ʏ̥, ʏ̥̃, ʊ, ʊ̃, ʊ̥, ʊ̥̃, e, ẽ, e̥, ẽ̥, ø, ø̃, ø̥, ø̥̃, ɘ, ɘ̃, ɘ̥, ɘ̥̃, ɵ, ɵ̃, ɵ̥, ɵ̥̃, ɤ, ɤ̃, ɤ̥, ɤ̥̃, o, õ, o̥, õ̥, ə, ɛ, ɛ̃, ɛ̥, ɛ̥̃, œ, œ̃, œ̥, œ̥̃, ɜ, ɜ̃, ɜ̥, ɜ̥̃, ɞ, ɞ̃, ɞ̥, ɞ̥̃, ʌ, ʌ̃, ʌ̥, ʌ̥̃, ɔ, ɔ̃, ɔ̥, ɔ̥̃, æ, æ̃, æ̥, æ̥̃, ɐ, ɐ̃, ɐ̥, ɐ̥̃, a, ã, ḁ, ḁ̃, ɶ, ɶ̃, ɶ̥, ɶ̥̃, ɑ, ɑ̃, ɑ̥, ɑ̥̃, ɒ, ɒ̃, ɒ̥, ɒ̥̃, etc.

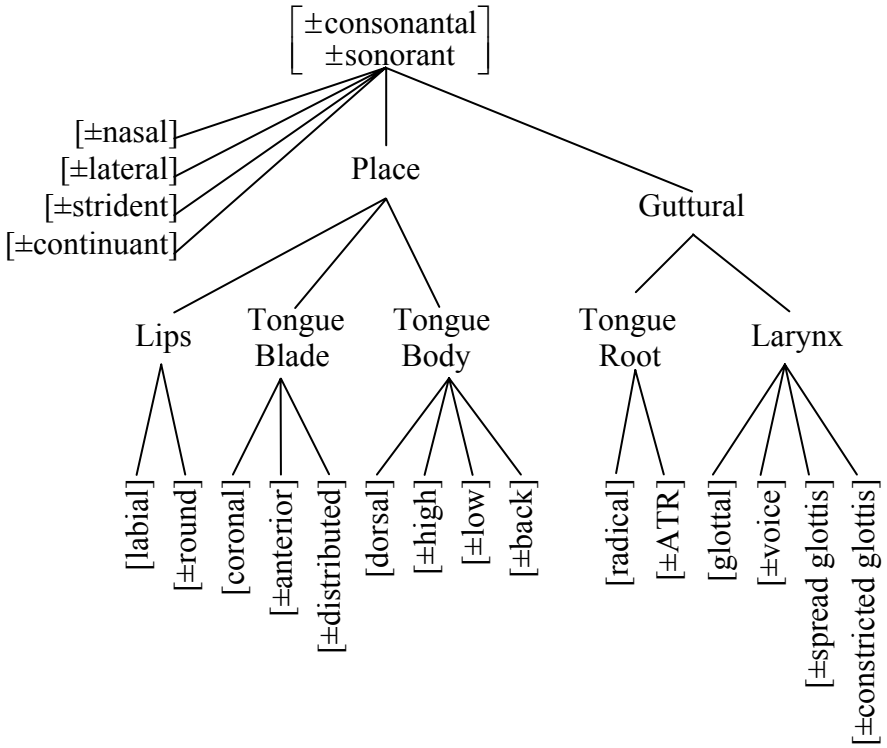
Until the mid-twentieth century the diversity of human speech sounds seemed unbounded, but today's phoneticians are no longer intimidated. As Ladefoged and Maddieson (1996:2) explain:

> The 'global village' effect means that few societies remain outside the scope of scholarly scrutiny. In all probability there will be a sharp decrease in the rate at which previously unknown sounds are drawn to the attention of phoneticians. ... We think it probable ... that any new sounds [to be discovered or even to be created in the future] will be similar to those that now have a linguistic function and

will be formed by re-arrangements of properties of sounds that have been previously observed in linguistic usage. In other words, we feel that a basis exists for discriminating between linguistic and non-linguistic sounds.

In fact, most phonologists now believe that just twenty or so *features* are sufficient to characterise any phoneme. The most widely accepted set of phonological features is presented here in a hierarchical format known as "the feature tree" (cf. Halle, Vaux & Wolfe 2000):

(6) *Feature Geometry*



The features represented here are mostly drawn from Chomsky and Halle's (1968) monumental *The Sound Pattern of English*, whose articulatory features were developed from the auditory-acoustic distinctive feature theory of Jakobson, Fant and Halle (1952). Note that in this course all features are assumed to be **binary** (Trubetzkoy 1939, Chomsky & Halle 1968, Lombardi 1996) in the sense that each can assume one of two possible values (typically represented as + and –), excepting the **articulator features** which are considered terminal **unary** (a.k.a. **monovalent**, **singulary**, **privative**) elements, after Halle, Vaux & Wolfe (2000): unlike other features, articulator features do not take values (such as + or –); they can only be either present or absent. Note, too, that the **Tonal** node is not represented above as its status within feature geometry is highly controversial. Below, tone will be discussed following laryngeal features (see Avery & Idsardi 2001).

2.2. Articulator-free features

Most phonological features are related to some specific *articulator*. For example, in later sections we will see that [±round] is executed by the lips, [±anterior] is executed by the tongue blade, [±high] is executed by the tongue body, [±ATR] is executed by the tongue root, [±spread glottis] is executed by the larynx, etc. But some features have no necessary relation to a particular articulator. Such *articulator-free* features include the *major class* features [±consonantal] and [±sonorant] (section 2.2.1), as well as [±lateral], [±strident], and [±continuant] (section 2.2.2).

2.2.1. Major class features

If you have ever played with a puppet, you will know that you can make it "talk" by repeatedly opening and closing your hand (more technically, four fingers remain stationary while the thumb goes up and down). The puppet looks like it is talking because its mouth is opening and closing, and indeed the most basic behaviour of the vocal tract during speech is a cycle of opening and closing. During open phases, air flows out freely from the lungs; during closed phases, the airflow is obstructed in the vocal tract and pressure may be built up, depending on the kind of obstruction. As Chomsky and Halle (1968:302) remark, *vowels* and *glides* are associated with the "open phases" of speech production, while *consonants* are associated with the "closed phases" —*obstruents* or *sonorants*, depending on whether air pressure builds up in the vocal tract. The features used to distinguish between these major classes of speech sounds are [±consonantal] and [±sonorant].

2.2.1.1. [±consonantal]

2.2.1.1.1. Definition

This feature distinguishes primarily between [+consonantal] consonants, which involve a radical constriction in the oral tract, and [–consonantal] vowels and glides, which lack such a drastic constriction (Chomsky & Halle 1968:302). Since Jakobson, Fant and Halle (1952), this feature is considered the most important of any phonological system. As Kaisse (1992: 315) remarks, "a segment with no specification for consonantality one way or another...is hard...to imagine." Similarly, Halle (1995:12) states: "The distinction between [+consonantal] and [–consonantal] phonemes is at the heart of the phoneme system of every language," insofar as "the feature [consonantal] must be included in the representation of every phoneme" (ibid., p. 3).[5]

The following types of phonemes are considered [+consonantal], because in each of them an oral articulator —the lips, the tongue blade, or the tongue body; see section 2.3, pp. 36ff— "makes full or virtual contact with a stationary part of the vocal tract so as to create a cavity effectively closed at both ends" (Halle 1995:7).

[5] Hume and Odden (1996) propose that [±consonantal] be abandoned in favour of using separate consonant features and vowel features (e.g., C-Place vs. V-Place). For more information on this approach to features, see Clements & Hume (1995).

(7) [+consonantal]

a. **Stops**, e.g., p, ᵐp, b, ᵐb, pʰ, p’, bʱ, b̰, ɓ, ɓ, pʷ, ᵐpʷ, bʷ, ᵐbʷ, pʷʰ, pʷ’, bʷʱ, b̰ʷ, ɓʷ, ɓʷ, pʲ, ᵐpʲ, bʲ, ᵐbʲ, pʲʰ, pʲ’, bʲʱ, b̰ʲ, ɓʲ, ɓʲ, pˠ, ᵐpˠ, bˠ, ᵐbˠ, pˠ’, bˠʱ, b̰ˠ, ɓˠ, ɓˠ, ᵐpˤ, bˤ, ᵐbˤ, pˤ’, bˤʱ, b̰ˤ, ɓˤ, ɓˤ, p͡t, b͡d, p͡tʷ, b͡dʷ, p͡tʲ, b͡dʲ, p͡tˤ, b͡dˤ, p͡c, b͡ɟ, p͡cʷ, b͡ɟʷ, p͡cʲ, b͡ɟʲ, p͡cˤ, b͡ɟˤ, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪’, d̪ʱ, d̰, ɗ, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪’, d̪ʱ, d̰, ɗ, t̪ʷ, ⁿt̪ʷ, d̪ʷ, ⁿd̪ʷ, t̪ʷʰ, t̪ʷ’, d̪ʷʱ, d̰ʷ, ɗʷ, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪’, d̪ʱ, d̰, ɗ, t̪ʷ, ⁿt̪ʷ, d̪ʷ, ⁿd̪ʷ, t̪ʷʰ, t̪ʷ’, d̪ʷʱ, d̰ʷ, ɗʷ, tʲ, ⁿtʲ, dʲ, ⁿdʲ, tʲʰ, tʲ’, dʲʱ, d̰ʲ, ɗʲ, tˠ, ⁿtˠ, dˠ, ⁿdˠ, tˠ’, dˠʱ, d̰ˠ, ɗˠ, tˤ, ⁿtˤ, dˤ, ⁿdˤ, tˤ’, dˤʱ, d̰ˤ, ɗˤ, t͡p, d͡b, t͡pʷ, d͡bʷ, t͡k, d͡g, t͡kʷ, d͡gʷ, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪’, d̪ʱ, d̰, ɗ, t̪ʷ, ⁿt̪ʷ, d̪ʷ, ⁿd̪ʷ, t̪ʷʰ, t̪ʷ’, d̪ʷʱ, d̰ʷ, ɗʷ, ʈ, ⁿʈ, ɖ, ⁿɖ, ʈʰ, ʈ’, ɖʱ, ɖ̰, !, ʈʷ, ⁿʈʷ, ɖʷ, ⁿɖʷ, ʈʷʰ, ʈʷ’, ɖʷʱ, ɖ̰ʷ, t͡p, d͡b, t͡pʷ, d͡bʷ, c, ᶮc, ɟ, ᶮɟ, cʰ, c’, ɟʱ, ɟ̰, ɟ, k, ᵑk, g, ᵑg, kʰ, k’, gʱ, g̰, ɠ, ƙ, kʘ, gʘ, kʘʰ, kʘ’, kʘˀ, k|, g|, k|ʰ, k|’, k|ˀ, k!, g!, k!ʰ, k!’, k!ˀ, k‖, g‖, k‖ʰ, k‖’, k‖ˀ, k‡, g‡, k‡ʰ, k‡’, k‡ˀ, kʷ, ᵑkʷ, gʷ, ᵑgʷ, kʷʰ, kʷ’, gʷʱ, g̰ʷ, ɠʷ, ƙʷ, kʷˤ, ᵑkʷˤ, gʷˤ, ᵑgʷˤ, kʷˤ’, g̰ʷˤ, ɠʷˤ, ƙʷˤ, kʲ, ᵑkʲ, gʲ, ᵑgʲ, kʲʰ, kʲ’, gʲʱ, g̰ʲ, ɠʲ, ƙʲ, kˤ, ᵑkˤ, gˤ, ᵑgˤ, kˤ’, gˤʱ, g̰ˤ, ɠˤ, ƙˤ, k͡p, ᵑ͡mk͡p, ᵑk͡p, g͡b, ᵑ͡mg͡b, ᵑg͡b, k͡pʰ, k͡p’, g͡bʱ, g̰͡b, k͡p̰, k͡pʷ, g͡bʷ, q, ᴺq, ɢ, ᴺɢ, qʰ, q’, ɢʱ, ɢ̰, ɢˤ, qʘ, ɢʘ, qʘʰ, qʘ’, qʘˀ, q|, ɢ|, q|ʰ, q|’, q|ˀ, q!, ɢ!, q!ʰ, q!’, q!ˀ, q‖, ɢ‖, q‖ʰ, q‖’, q‖ˀ, q‡, ɢ‡, q‡ʰ, q‡’, q‡ˀ, qʷ, ᴺqʷ, ɢʷ, ᴺɢʷ, qʷʰ, qʷ’, ɢʷʱ, ɢ̰ʷ, ɢˤʷ, q͡p, q͡b, ʡ, ʡʷ, etc.

b. **Affricates**, e.g., pᶠ, ᵐpᶠ, bᵛ, ᵐbᵛ, pᶠʰ, pᶠ’, bᵛʱ, b̰ᵛ, tᶿ, ⁿtᶿ, dᶞ, ⁿdᶞ, tᶿʰ, tᶿ’, dᶞʱ, d̰ᶞ, tˢ, ⁿtˢ, dᶻ, ⁿdᶻ, tˢʰ, tˢ’, dᶻʱ, d̰ᶻ, tɬ, ⁿtɬ, dɮ, ⁿdɮ, tɬʰ, tɬ’, dɮʱ, d̰ɮ, tᶜ, ⁿtᶜ, dᶻ, ⁿdᶻ, tᶜʰ, tᶜ’, dᶻʱ, d̰ᶻ, tᶜʲ, ⁿtᶜʲ, dᶻʲ, ⁿdᶻʲ, tᶜʲʰ, tᶜʲ’, dᶻʲʱ, d̰ᶻʲ, tʃ, ⁿtʃ, dʒ, ⁿdʒ, tʃʰ, tʃ’, dʒʱ, d̰ʒ, cᶜ, ᶮcᶜ, dʲ, ⁿdʲ, cᶜʰ, dʲʱ, d̰ʲ, cᶜˤ, ᶮcᶜˤ, ɟʲ, ⁿɟʲ, cᶜʰʲ, ɟʲʱ, ɟ̰ʲ, cᶜˤʲ, ɟˤʲ, ⁿɟˤʲ, cᶜˤʰʲ, ɟˤʲʱ, kˣ, gˠ, kˣʰ, kˣ’, kʘˣ, k|ˣ, k!ˣ, k‖ˣ, k‡ˣ, kᵏˣ, ᵑkᵏˣ, gᴸ, ᵑgᴸ, kᵏʰ, kᵏ’, gᴸʱ, g̰ᴸ, kᵏʷ, ᵑkᵏʷ, gᴸʷ, ᵑgᴸʷ, kᵏʷʰ, kᵏʷ’, gᴸʷʱ, g̰ᴸʷ,

c. **Fricatives**, e.g., ɸ, β, β̃, β͡ʒ, ɸ͡ç, β͡ʝ, ʙ, ʙ̰, f, v, ṽ, fʰ, f’, fʷ, vʷ, ṽʷ, fʷʰ, fʷ’, fʲ, vʲ, ṽʲ, fʲʰ, fʲ’, fˠ, vˠ, ṽˠ, fˤ’, f͡s, f͡ʃ, θ, ð, ð̰, θ, ð, ð̰, θʰ, θ’, ðˠ, s̪, z̪, z̪̃, s̪ʰ, s̪’, ɬ, ɮ, ɮ̃, ɬʰ, ɬ’, ɬˠ, ɮˠ, ɬˤ’, ɻ, ɻ, ɕ, ʑ, ʑ̃, ɕʰ, ɕ’, ʃ, ʒ, ʒ̃, ʃʰ, ʃ’, ʃʷ, ʒʷ, ʒ̃ʷ, ʃʷʰ, ʃʷ’, ʃʲ, ʒʲ, ʒ̃ʲ, ʃʲʰ, ʃʲ’, ʃˤ, ʒˤ, ʒ̃ˤ, ʃˤ’, s̪, z̪, z̪̃, s̪ʰ, s̪’, ç, ʝ, ʝ̃, çʰ, ç’, ɧ, ʟ̝, ʟ̝̊, x, ɣ, ɣ̃, xʰ, x’, xʷ, ɣʷ, ɣ̃ʷ, xʷʰ, xʷ’, xʲ, ɣʲ, ɣ̃ʲ, xʲʰ, xʲ’, χ, ʁ, ʁ̃, χʰ, χ’, χʷ, ʁʷ, ʁ̃ʷ, χʷʰ, χʷ’, etc.

d. **Nasals**, e.g, m, m̥, m̃, mʷ, m̥ʷ, m̃ʷ, mˠ, mʲ, mˠ, mˤ, ɱ, n̪, n̥, ñ̪, n̪, n̥, ñ̪, nʷ, n̥ʷ, ñ̪ʷ, nʲ, nˠ, nˤ, n͡m, n͡mʷ, ɳ, ɳ̊, ɳ̃, ɳʷ, ɳ̊ʷ, ɳ̃ʷ, ɳ, ɳ̊, ɳ̃, ɳʷ, ɳ̊ʷ, ɳ̃ʷ, ɳ͡m, ɳ͡mʷ, ɲ, ɲ̊, ɲ̃, ŋ, ŋ̊, ŋ̃, ŋʘ, ŋ̊ʘ, ˀŋʘ, ŋ̊ʘʰ, ŋ|, ŋ̊|, ˀŋ|, ŋ̊|ʰ, ŋ!, ŋ̊!, ˀŋ!, ŋ̊!ʰ, ŋ‖, ŋ̊‖, ˀŋ‖, ŋ̊‖ʰ, ŋ‡, ŋ̊‡, ˀŋ‡, ŋ̊‡ʰ, ŋʷ, ŋ̊ʷ, ŋ̃ʷ, ŋʲ, ŋˤ, ŋ͡m, ŋ͡mʷ, ɴ, ɴ̊, ɴ̃, ɴʷ, ɴ̊ʷ, ɴ̃ʷ, etc.

e. **Liquids**, e.g, l̪, l̃, l̥, l̪̊, l̃̊, lʷ, l̃ʷ, l̥ʷ, l̪̊ʷ, l̃̊ʷ, lˠ, l, l̃, l̥, l̪̊, lʲ, l̃ʲ, l̥ʲ, l̪̊ʲ, lˤ, l̪, l̃, l̥, l̪̊, lʷ, l̃ʷ, l̥ʷ, l̪̊ʷ, l̃̊ʷ, l, l̃, l̥, l̪̊, lʷ, l̃ʷ, l̥ʷ, l̪̊ʷ, ʎ, ʎ̆, ʎ̥, ʎ̪̊, ɬ, ɬ̃, ɮ, ɮ̃, ɬʷ, ɬ̃ʷ, ɮʷ, ɮ̃ʷ, ʟ, ʟ̃, ʟ̥, ʟ̪̊, ʟʷ, ʟ̃ʷ, ʟ̥ʷ, ʟ̪̊ʷ, ɻ, ɻʷ, ɾ, ɾ̃, rʷ, rʲ, rˠ, rˤ, ɾ, ɾ̃, ɾʷ, ɾʲ, ɾˠ, ɾˤ, ɹ, ɹʷ, ɾ̪, ɾ̪ʷ, ɽ, ɽ̃, ɽʷ, ɽ̃ʷ, ʁ, ʁʷ, ʁ, ʁʷ, etc.

Conversely, the following phonemes are considered [–consonantal] because their oral constriction is not “drastic” enough (vowels, semivowels), or because they are articulated primarily with the larynx (glottals), the tongue root (pharyngeals), or the velum (nasal glides), and as such, are incapable of forming a cavity closed at both ends.

(8) [–consonantal]

a. **Vowels**, e.g., i, ĩ, i̪, i̯, y, ỹ, y̪, y̯, ɨ, ɨ̃, ɨ̪, ɨ̯, ʉ, ʉ̃, ʉ̪, ʉ̯, ɯ, ɯ̃, ɯ̪, ɯ̯, u, ũ, u̪, u̯, ɪ, ɪ̃, ɪ̪, ɪ̯, ʏ, ʏ̃, ʏ̪, ʏ̯, ʊ, ʊ̃, ʊ̪, ʊ̯, e, ẽ, e̪, e̯, ø, ø̃, ø̪, ø̯, ɘ, ɘ̃, ɘ̪, ɘ̯, ɵ, ɵ̃, ɵ̪, ɵ̯, ɤ, ɤ̃, ɤ̪, ɤ̯, o, õ, o̪, o̯, ə, ɛ, ɛ̃, ɛ̪, ɛ̯, œ, œ̃, œ̪, œ̯, ɜ, ɜ̃, ɜ̪, ɜ̯, ɞ, ɞ̃, ɞ̪, ɞ̯, ʌ, ʌ̃, ʌ̪, ʌ̯, ɔ, ɔ̃, ɔ̪, ɔ̯, æ, æ̃, æ̪, æ̯, ɐ, ɐ̃, ɐ̪, ɐ̯, a, ã, a̪, a̯, ɶ, ɶ̃, ɶ̪, ɶ̯, ɑ, ɑ̃, ɑ̪, ɑ̯, ɒ, ɒ̃, ɒ̪, ɒ̯, etc.

b. **Semivowels**, e.g., ʊ, ʊ̃, ʊ̪, ʊ̯, ʊ̆, j, j̃, j̪, j̯, jʷ, j̃ʷ, j̪ʷ, j̯ʷ, jˤ, ɥ, ɥ̃, ɥ̪, ɥ̯, w, w̃, ʍ, ʍ̯, wˤ, w̃ˤ, ɯ, ɯ̃, ɯ̪, ɯ̯, ɯʷ, ɯ̃ʷ, ɯ̪ʷ, ɯ̯ʷ, etc.

c. **Glottals**, e.g., h, hʷ, hʲ, hˤ, h̃, h̃ʷ, h̃ʲ, h̃ˤ, ɦ, ɦʷ, ɦʲ, ɦˤ, ʔ, ʔʷ, ʔʲ, ʔˤ, etc.

d. **Pharyngeals**, e.g., ħ, ʕ, ʕ’, ħʷ, ʕʷ, ʕʷ’, etc.

e. **Nasal glide**, e.g. N[6]

From the preceding list it will be clear to you that [±consonantal] does not distinguish between *consonants*, that is, glides (oral, nasal, pharyngeal, or laryngeal) as well as true consonants on the one hand, and *vowels* on the other. The latter distinction is psychologically real, yet it is not based not on the feature [±consonantal], but rather on *syllabicity*. Unlike vowels, consonants are normally not *syllabic*, that is, they do not usually constitute the *nucleus* or *peak* of a syllable. Still, it is not the case that consonants are never syllabic. On the one hand, glides can occupy the peak position of a syllable, at which point they become vowels. For example, the glides /w, ɥ, j/ regularly “become” the vowels [u, y, i] respectively, when syllabic. To see this, compare the glides and vowels in the following examples from French:

(9) *Vowels vs. glides in French*

a.	[il ʒu]	il joue	‘he plays’	
	[ʒwe]	jouer	‘to play’	
	[ʒwɑ̃]	jouant	‘playing’	
b.	[il ty]	il tue	‘he kills’	([ɥ] is the symbol used for [y] in non-nuclear position, in parallel with [w] for [u], and [j] for [i].)
	[tɥe]	tuer	‘to kill’	
	[tɥɑ̃]	tuant	‘exhausting’ (lit. killing)	
c.	[il li]	il lie	‘he ties’	
	[lje]	lier	‘to tie’	
	[ljɑ̃]	liant	‘tying’	

On the other hand, even true consonants can be syllabic. For example, the consonants /l, ɹ, m, n/ are arguably syllabic in the second syllables of *bottle*, *potter*, *bottom*, and *button*, respectively. Chomsky and Halle (1968:354) originally proposed the feature [±syllabic] to distinguish vowels and syllabic consonants from other segments, but this feature has been abandoned in favour of syllable structure in current phonological theory: a segment is syllabic if it occurs in the peak position of a syllable, and it is nonsyllabic if it occurs in the margins of syllable. You can find out all about this in the next phonology course!

[6] N is a nasal glide which lacks a fixed place of articulation. It is also known as Sanskrit *anusvāra* (Trigo 1988, Trigo 1991:124, Halle 1995). See section 2.4.1 below.

2.2.1.1.2. Lenition

The feature [±consonantal] is most frequently implicated in a general process known as *weakening* or *lenition* (from Latin *lenis* 'weak'). Specifically, it commonly occurs that a consonant turns into a vowel (*vocalisation*) or a glide (*gliding*). Such lenition essentially amounts to a switch from [+consonantal] to [–consonantal]. As a first example, consider the data in (10), from the Halland dialect of Swedish (Kaisse 1992, Hume & Odden 1996). Observe that the uvular consonant /ʁ/, which is either word-final[7] or prevocalic[8] in the first column, corresponds to [ɑ̯] elsewhere in the second column.[9] This alternation is not so strange as it may at first seem. [ʁ] and [ɑ̯] are both voiced and —as we shall see in section 2.3.3, p. 54ff— they have essentially the same place of articulation (both are [dorsal, –high, +back]). The main difference between them which concerns us here is that [ʁ] is [+consonantal] (its oral constriction is severe) whereas [ɑ] is [–consonantal] (its oral constriction is weak).

(10) *Halland Swedish*

a.	toʁ	'dry'	toɑ̯-t	'dry'
b.	toʁ-a	'dry (sg???)'	toɑ̯-k	'dry (pl.)'
c.	fœʁ-ɸːda	'to devastate'	fœɑ̯-hœja	'to enhance'

Such lenition effects can be quite general. For example, in Child English (before 5;0) as well as in disordered speech, [+consonantal] liquids /l, ɹ/ are regularly replaced by [–consonantal] vowels (e.g., [tebu] *table*, [diə] *deer*) or by glides [w, j] (e.g., [jɛg] *leg*, [wɛd] *red*). Similarly, the "dark" lateral consonant [ɬ] always weakens to a glide [w] in noneastern dialects of Polish, e.g. *łaska* 'grace' is pronounced [waska] in noneastern dialects (Rubach 1984). And in some varieties of southern Brazilian Portuguese, palatal nasals and laterals /ɲ, ʎ/ are always realised as palatal glides, [j̃, j], respectively.

(11) *Brazilian Portuguese* (Harris 1990:266)

Northern	*Southern*		*Northern*	*Southern*	
baɲu	bãj̃u	'bath'	veʎa	veja	'old (f.)'
soɲu	sõj̃u	'dream'	paʎa	paja	'straw'
viɲu	vĩj̃u	'wine'	moʎu	moju	'sauce'

More commonly, though, lenition occurs in restricted contexts. For example, in Italian [+consonantal] /l/ changed to [–consonantal] [j], but only after consonants, e.g., *flore* became *fiore*, and *blanco* became *bianco*. Lenition is especially frequent syllable-finally. For example, /ɹ/ weakens to a nonrhotic vowel syllable-finally in African American Vernacular English, e.g., [bɪə] *beer*, [bɛʊ] *bear*, [doʊ] *door* (Pollock & Berni 1996, 1997a, 1997b; Rickford 1999). Haitian Creole lenites /ʒ/ to [j] in syllable-final position (Tinelli 1981). And Georgian lenites /v/ to [w] in syllable-final position (Aronson 1989), as does Persian (Hayes 1986).[10] To illustrate the latter, compare the following word pairs:[11]

[7] At the end of a word.
[8] Before a vowel.
[9] The subscript [̯] indicates that the vowel [ɑ] is short, perhaps like [ʁ].
[10] Actually, the process is more complicated: weakening does not apply to syllable-final *v*'s after long vowels, e.g. *gaʋ* 'bull',

(12) Persian (Hayes 1986)

a.	/nov-ruːz/	→	nowruːz	‘New Year’
	new-day			
	/nov-iːn/	→	noviːn	‘new kind’
	new-SUFF			
b.	/dʒæv/	→	dʒow	‘barley’
	barley			
	/dʒæv-iːn/	→	dʒæviːn	‘made of barley’
	barley-SUFF			
c.	/bo-ræv/	→	borow	‘I am going’
	IMP-go			
	/miː-ræv-æm/	→	miːrævæm	‘I am going’
	PRES-go-1s			
d.	/paː-dæv/	→	paːdow	‘gofer’
	foot-run(ner)			
	/miː-dæv-iːd/	→	miːdæviːd	‘you are running’
	PRES-run-2p			

The change from syllable-final /l/ to a back[12] vowel or glide appears to be particularly widespread. It is found in many varieties of English, especially African American Vernacular English, e.g., [bɛʊ] *bell*, [bɑɯ] *ball*, [bɛɤt] *belt*, [bɑrʊ] *bottle* (Bailey & Thomas 1998, Fasold & Wolfram 1970). It is also reported in the southern Arabian Semitic language Mehri (Johnstone 1975; Walsh 1995), e.g., /ɬlθ/ ‘third’: [ɬoːləθ] ‘third (masc.)’ *vs*. [ɬəwθeːt] ‘third’ (fem.). Historically, too, syllable-final /l/ weakened to *u* in Old French, as can be surmised from a comparison of (orthographic) words in modern French and its Romance sisters.

(13) *Comparative evidence of l-vocalisation in Old French*

Italian	*Spanish*	*Portuguese*	*French*	
Alba	alba	alva	aube	“dawn”
Altare	altar	altar	autel	“altar”
Alzare	alzar	alçar	hausser	“to shrug”
Colpo	golpe	golpe	coup	“hit”
Falso	falso	falso	faux, -se	“false”
Falcone	halcón	falcão	faucon	“falcon”
Feltro	fieltro	feltro	feutre	“felt”
Palmo	palma	palma	paume	“palm (of hand)”
Polmone	pulmón	pulmão	poumon	“lung”
Dolce	dulce	doce	doux	“sweet, soft”
Polvere	polvo	pó, poeira	poudre	“powder, dust”

---

hiːvdæh ‘seventeen’, nor after consonants, e.g. *særv* ‘cypress’, *dʒozv* ‘except’. As Hayes (1986) remarks, such data make clear that it is *v* which changes to *w*, not the other way around.

[11] For present purposes, we can ignore the additional /æ/-backing process which takes /æ/ to [o] before [w].

[12] Observe that syllable-final /l/ in English (and apparently in many other languages as well) is also back ([+back]). You should be able to feel the “bunching” of the Tongue Body in /l/ in your pronunciation of *pill*, *bottle*, etc.

This change occurred more recently in Brazilian Portuguese. Thus European Portuguese distinguishes forms like *mau* [maw] 'bad' vs. *mal* [mal] 'badly', or *cauda* [kawda] 'tail' vs. *calda* [kalda] 'syrup'. In Brazilian Portuguese, such pairs are homophonous: 'bad' and 'badly' are both pronounced [maw]; 'tail' and 'syrup' are both pronounced [kawda].

2.2.1.1.3. Fortition

The feature [±consonantal] is also regularly implicated in the opposite of lenition: *fortition* ("strengthening"). Specifically, a [–consonantal] vowel or glide may turn into a [+consonantal] segment. Fortition, it should be noted, is significantly less common than lenition. Fortition normally occurs syllable-initially, again contrary to lenition (which is favoured syllable-finally). For example, in Porteño Spanish the palatal glide /j/ strengthens to a consonant [ʒ] in syllable-initial position, e.g., convo[j] 'convoy' vs. convo[ʒ]es 'convoys'; le[j] 'law' vs. le[ʒ]es 'laws' (Harris 1983, Hume 1994). That strengthened glides are indeed [+consonantal] is suggested by another area of Porteño Spanish phonology: in the same language, the nasal /n/ adjusts its place of articulation to a following [+consonantal] segment, both within words (a) and across words (14b). By contrast, the nasal does not agree in place of articulation with a following [–consonantal] vowel or glide (14c). However, a glide which undergoes fortition does trigger nasal place assimilation, as shown in (14d). This suggests that strengthened glides are [+consonantal].

(14) Porteño Spanish (Hume 1994:66)

a.	tango	[taŋgo]	'tango'
	tambo	[tambo]	'cow-shed'
	tanto	[tanto]	'so much'
b.	un palo	[um palo]	'a stick'
	un santo	[un santo]	'a saint'
	un gorro	[uŋ goro]	'a cap'
	un mes	[um mes]	'a month'
c.	un arbol	[un aɾβol]	'a tree'
	un oso	[un oso]	'a bear'
	nieto	[njeto]	'grandson'
	nuevo	[nweβo]	'new'
d.	un hielo	[uɲ ʒelo][13]	'a piece of ice'

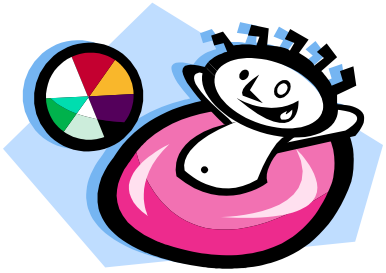
Exercise: Relying on our discussion so far, try to give a simple explanation for the different pronunciations of Malay words in the Standard dialect versus the Kelantan dialect (Trigo 1991, Halle 1995).

Standard	*Kelantan*	
ʔasap	ʔasaʔ	'smoke'
kilat	kilaʔ	'lightning'
masaʔ	masɒʔ	'cook'

[13] The fricative [ʒ] is also regularly strengthened to [d^{ʒ}] after nasal stops, i.e. the end result would be: [uɲ d^{ʒ}elo].

balas	balah	‘finish’
negatef	negatɬh	‘negative’
ʔalem	ʔalɬN	‘pious’
sabon	saboN	‘soap’
dukoŋ	dukoN	‘carry’
batal	bataː	‘cancel’
jujoː	jujoː	‘sincere’
ɣumãh	ɣumõh	‘house’

2.2.1.1.4. “Floating” [consonantal]



So far we have seen that [±consonantal] is useful in characterising the difference between vowels and glides, and in describing and analysing changes such as lenition or fortition. But does [±consonantal] have any psychological reality independent of phonemes? The answer would appear to be yes. Many languages exhibit phonological patterns which suggest that [+consonantal] or [–consonantal] can occur on their own, or “float”, so to speak.

Consider the well-known case of “*h*-aspiré” words of French. These are vowel-initial words (e.g., [ero] ‘hero’, [ibu] ‘owl’, [õt] ‘shame’, [ɛn] ‘hatred’, [aʃ] ‘axe’) that behave phonologically as if they were consonant-initial.[14] For instance, when a noun begins in a consonant, the definite article is [lə] (masc.) or [la] (fem.) in the singular, and [le] in the plural, as shown in (15a). When the noun begins in a vowel, the singular definite article appears to lose its vowel ([ə] or [a]), while the plural definite article appears to gain a consonant [z], as shown in (15b). We needn’t concern ourselves with the motivation behind these changes here, but we will assume for the moment that they occur in order to avoid adjacent vowels[15]: *[lə ɔm], *[le ɔm], *[la ide], *[le ide], etc. Now consider the behaviour of *h*-aspiré words, illustrated in (15c): they are phonetically vowel-initial, yet they behave like consonant-initial nouns in taking the articles [lə]/[la]/[le], rather than [l]/[lez]. No attempt is made to avoid adjacent vowels in their case: *[leʁo], *[lõt], *[lezɛn], etc.

(15)

	singular	*plural*	
a.	lə ʒənu	le ʒənu	‘knee’
	lə kuto	le kuto	‘knife’
	la fam	le fam	‘woman’
	la nɥi	le nɥi	‘night’
b.	l ɔm	lez ɔm	‘man’
	l ami	lez ami	‘friend’
	l ide	lez ide	‘idea’
	l eʁɔin	lez eʁɔin	‘heroine’

[14] As Clements and Keyser (1983:111) state: “[T]his set of words, while varying in membership from speaker to speaker, behaves consistently like consonant-initial words with respect to all the relevant rules of the phonology.”
[15] The technical term for adjacent vowels (e.g., English [keɑs] ‘chaos’) is *hiatus*.

c.	lə eʁo	le eʁo	‘hero’
	lə ibu	le ibu	‘owl’
	la ɔ̃t	le ɔ̃t	‘shame’
	la ɛn	le ɛn	‘hatred’

Also in French, certain adjectives and specifiers have quite distinct forms for different genders. For example, as shown in (16a), the adjective ‘old’ is [vjø] for the masculine but [vjɛj] for the feminine; the adjective ‘nice’ is [bo] for the masculine but [bɛl] for the feminine; and the specifier ‘my’ is [mɔ̃] for the masculine but [ma] for the feminine. Interestingly, when a noun begins in a vowel, the “wrong” gender adjective or specifier may be used, as shown in (16b): feminine [vjɛj] ‘old’ is used with masculine [ɔm] ‘man’ (*[vjø ɔm]); feminine [bɛl] ‘nice’ is used with masculine [ami] ‘friend’ (*[bo ami]); and masculine [mɔ̃(n)] ‘my’ is used with feminine [eʁɔin] ‘heroine’ (*[ma eʁɔin]). We needn’t be concerned with the motivation behind this gender shift, but again we can assume that it occurs in order to avoid adjacent vowels (hiatus): *[vjø ɔm], *[bo ami], *[ma eʁɔin]. Turning now to (16c), observe how the “*h*-aspiré” forms do not trigger this gender shift, thus displaying the behaviour of consonant-initial words.

(16)

a.	vjø ʒənu	‘old (MASC.) knee (MASC.)’
	vjɛj fam	‘old (FEM.) woman (FEM.)’
	bo kuto	‘nice (MASC.) knife (MASC.)’
	bɛl nɥi	‘nice (FEM.) night (FEM.)’
	mɔ̃ fʁɛʁ	‘my (MASC.) brother (MASC.)’
	ma sœʁ	‘my (FEM.) sister (FEM.)’
b.	vjɛj ɔm	‘old (FEM.) man (MASC.)’
	vjɛj istwaʁ	‘old (FEM.) story (FEM.)’
	bɛl ami	‘nice (FEM.) friend (MASC.)’
	bɛl aʁm	‘nice (FEM.) weapon (FEM.)’
	mɔ̃n espwaʁ	‘my (MASC.) hope (MASC.)’
	mɔ̃n eʁɔin	‘my (MASC.) heroine (FEM.)’
c.	vjø eʁo	‘old (MASC.) hero (MASC.)’
	bo ibu	‘nice (MASC.) owl (MASC.)’
	ma ɛn	‘my (FEM.) hatred (FEM.)’
	ma aʃ	‘my (FEM.) axe (FEM.)’

Adapting proposals by Clements and Keyser (1983), Encrevé (1988), and Piggott (1991) among others, we can suggest that unlike other vowel-initial words, *h*-aspiré words begin not with a vowel, but with an “empty” or “invisible” [+consonantal], e.g.:

[–cons]	[+cons]	[–cons]		[+cons]	[–cons]	[+cons]	[–cons]
|	|	|	*vs.*		|	|	|
a	m	i			e	ʁ	o

Morphemes with “empty” consonants, such as the ones we have postulated for French, appear to be relatively widespread crosslinguistically. They are reported in Seri, a Hokan language of Mexico (Marlett & Stemberger 1983; Marlett 1997), in Onondaga, an Iroquoian lan-

guage of New York (Michelson 1985), in Oowekyala, a Wakashan language of British Columbia (Howe 2000), and in the Bantu language Kikamba (Robert-Kohno 1999).

We now consider the possibility of [–consonantal] occurring "on its own". A well-known potential case is that of Polish *yers*, also known as 'mobile vowels' or 'ghost vowels' (Szpyra 1992). Compare the pairs in (17). Yers (in bold) are pronounced [e] in the nominative singular but otherwise remain "invisible" in the genitive singular. In this regard, yers contrast with regular vowels [e], which are realised in both nominative and genitive forms.

(17)	*nom. sg.*	*gen. sg.*	
a.	s**e**n	sn-u	'dream'
	gen	gen-a	'gene'
b.	b**e**z	bz-u	'lilac'
	bez-a	bez	'meringue'
c.	p^{j}**e**s	ps-a	'dog'
	b^{j}es	b^{j}es-a	'devil'
d.	svet**e**r	svetr-a	'sweater'
	seter	seter-a	'setter'
e.	rob**e**r	robr-a	'rubber (in bridge)'
	rower	rower-u	'bicycle'

Next compare the pairs in (18). The yers (again in bold) are vocalised in at least some forms, either nominative or genitive. By contrast, forms without yer show no comparable vocalisation.

(18)	*nom. sg.*	*gen. sg.*	
a.	wal**e**t^{s}	walt^{s}-a	'cylinder'
	walt^{s}	walt^{s}-a	'waltz'
b.	torb-a	tor**e**b	'bag'
	korb-a	korb	'crank'
c.	koj**e**t^{s}	kojt^{s}-a	'play-pen'
	bejt^{s}-a	bejt^{s}	'mordant'
d.	ser-**e**k	ser-k-a	'cheese'
	kark		'nape'
e.	s**i**n-**e**k	s**i**n-k-a	'son'
	sz**i**nk		'pub'
f.	bar**e**k		'bar'
	bark		'shoulder'
g.		par**e**k	'couple'
		park	'park'
h.		sz**i**n**e**k	'ham'
		sz**i**nk	'pub'

To account for contrasts like those in (17-18), yers are often considered "empty" vowels that are variably vocalised. In particular, Bethin (1998) treats each yer as a "floating" [–consonantal]

which is realised as the "default" vowel [e] under certain (syllable-defined) conditions,[16] but otherwise remains unfilled.

2.2.1.2. [±sonorant]

2.2.1.2.1. Introduction

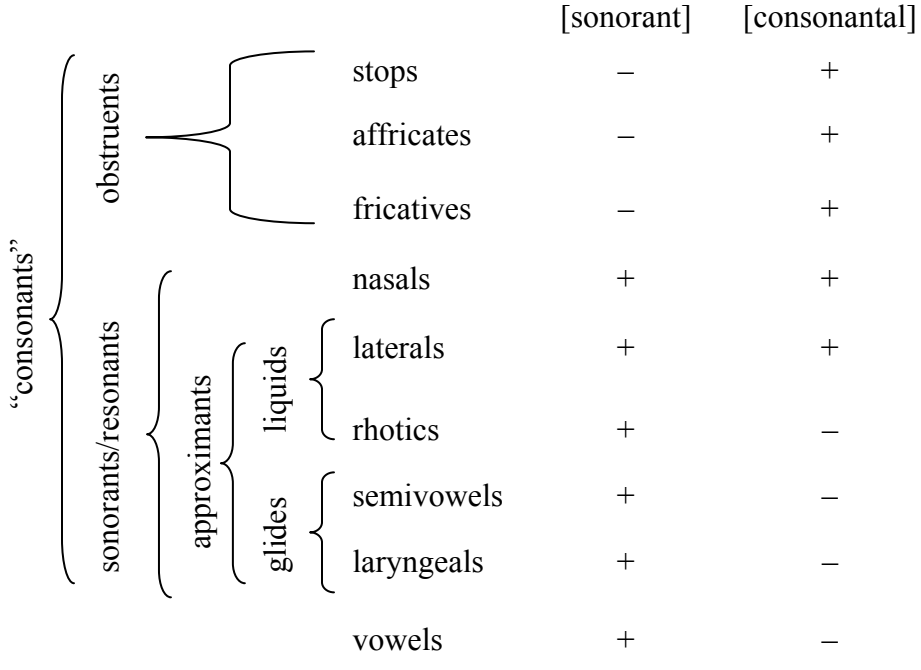
lemon linament
I'm aluminumin' 'um, Mum
which wrist watches are Swiss wrist watches

In the preceding section we discussed the first major class feature, [±consonantal]. Halle (1995:7) defines the second major class feature, [±sonorant], as follows:

> In articulating [+sonorant] phonemes, no pressure must be allowed to build up inside the vocal tract; such pressure must be built up inside the vocal tract in articulating [–sonorant] phonemes. Pressure buildup is produced by an articulator making full or virtual contact with a stationary portion of the vocal tract while no side passage is opened in the vocal tract by dropping the tongue margins or lowering the Soft Palate.

According to Chomsky and Halle (1968), a phoneme is [+sonorant] if it has 'a vocal tract configuration in which spontaneous voicing is possible' (p. 302). Acoustically, sonorants have more periodic acoustic energy than non-sonorants (Lass 1984a:83). Segment types are grouped by both major class features in (19).

(19) Segments by major class features



[16] Also Bauer (1990:299): "other features are filled in by universal as well as language-specific rules. … the mid front vowel is the maximally unmarked or unspecified vowel, and that its place features are filled in by default."

This classification is uncontroversial except for the labeling of laryngeal glides as [+sonorant] which calls for some justification. Languages in which laryngeals are explicitly classified as [+sonorant] include Klamath (Blevins 1993:238-9), Totonac (MacKay 1994:372), St'at'imcets Salish (van Eijk 1997), Dutch (Trommelen & Zonnefeld 1983), and Oowekyala (Howe 2000). The treatment of laryngeals as [+sonorant] is consistent with Chomsky & Halle's (1968:303) conception of this feature (see also Halle & Clements 1983), but is contrary to Hyman's (1975:45) suggestion that laryngeals are always [–sonorant] (see also Lass 1984:83, Lombardi 1997, Gussenhoven & Jacobs 1998, Ewen & van der Hulst 2001:29). As Trask (1996:327) reports, "many [analysts] now prefer to regard [h] and [ʔ] as [+obstruent]" (i.e. [–sonorant]). To be sure, laryngeals are classified as [–sonorant] in many languages, e.g. Nuxalk (Nater 1984:6), Dakota (Shaw 1980:26-7), Odawa (Piggott 1980), Yowlumne (Archangeli 1988), Athapaskan in general (Rice 1995[17]), Oromo (Lloret 1995), and Hawaiian (Elbert & Pukui 1979), but this assumption does not appear to be critical in any of the relevant phonological analyses.

Kean (1980:29) argues that there is an implicational relation between the two major class features (⊃ means 'implies').

(20) [–consonantal] ⊃ [+sonorant]

Whether this implication is ever violated is an interesting empirical question. If violable, [–consonantal] ⊃ [+sonorant] may be viewed as a well-formedness condition that can be outranked on a language-particular basis by other constraints that conspire to give laryngeals an obstruent analysis (e.g., [glottal] ⊃ [–sonorant]). The general issue cannot be resolved here, but we will illustrate the kind of evidence one needs to look for in deciding on the [±sonorant] status of laryngeal glides.

Oowekyala (Howe 2000) is a Wakashan language in which both obstruents and sonorants contrast for glottalisation:

(21)

		labial	alveolar	sibilant	lateral	velar	lab. vel.	uvular	lab. uv.	glottal
[–sonorant] {	Plain	p	t	t^s	$t^ɬ$	k	k^w	q	q^w	
	Glottalised	p'	t'	t^s'	$t^ɬ$'	k'	k^w'	q'	q^w'	
[+sonorant] {	Plain	m	n		l	j	w			h
	Glottalised	m'	n'		l'	j'	w'			ʔ

In this language, the plural of a word is formed through two operations: a copy of the first consonant followed by [i] ("C[i]-reduplication"), and glottalisation of root-initial sonorants (if any), as shown here:

[17] Rice treats [sonorant] as a privative feature which is absent from laryngeals.

(22) Sonorant glottalisation in Oowekyala plural forms

	singular	*plural*	
a.	mam	mim'am	'blanket, bedding, bedcover'
b.	nusa	nin'usa	'to tell stories, legends, myths'
c.	lanca	lil'anca	'to go underwater'
d.	wiːkʷ	wiw'iːkʷ	'eagle'
e.	jəlχa	jij'əlχa	'to rub, smear (body part)'

The following examples illustrate that root-initial obstruents are unaffected by the process of glottalisation, in spite of the fact that they are glottalisable segments in Oowekyala in general (see (21) above).

(23) No glottalisation of obstruents in plural forms

	singular	*plural*	
a.	pais	pipais	'flounder'
b.	təwa	titəwa	'to walk'
c.	qsu	qiqsu	'it is you'

Crucially, laryngeal glides pattern with sonorants in this respect, i.e., root-initial /h/ undergoes glottalisation and changes to [ʔ] in the plural:

(24) Laryngeal glottalisation in Oowekyala plural forms

	singular	*plural*	
a.	husa	hiʔusa	'to count, to tally'
b.	həxtˢ'as	hiʔəxtˢ'as	'singing for the dancers'
c.	həm'gila	hiʔəmgila	'to cook'

This suggests that laryngeal glides /h, ʔ/ are [+sonorant] in Oowekyala (for additional evidence, see Howe 2000).

2.2.1.2.2. Lenition

In the section on [±consonantal] we observed the fact that some languages show a preference for [–consonantal] in certain positions (e.g., syllable-final), such that [+consonantal] phonemes may regularly weaken to become [–consonantal] in those positions. Similarly, some languages show a preference for [+sonorant] in certain positions, such that a phoneme may change from [–sonorant] to [+sonorant], though not necessarily from [+consonantal] to [–consonantal]. For example, "flapping" in North American English (e.g., *writer* [ɹʌjɾəɹ], *rider* [ɹajɾəɹ]) is a type of lenition in which /t, d/ arguably switch from [–sonorant] to [+sonorant], but not obviously from [+consonantal] to [–consonantal].

Another example is provided by the West African language Hausa which has undergone a consonantal change known as *Klingenheben's Law*, whereby "a coda segment must be a sonorant" (Hume & Odden 1995:276). This shift is apparent in the following data: syllable-finally,

labial and velar obstruents turn into [+sonorant] [w], and coronal obstruents turn into [+sonorant] [r]. Note that [r] is [+consonantal], so lenition here cannot be characterised simply as a change to [–consonantal].

(25) Hausa (Hume & Odden 1995)

a.	/dʒibdʒiː/	dʒuwdʒiː	‘trash heap’	cf.	dʒibaːdʒeː	‘pl.’
b.	/tafʃiː/	tawʃiː	‘drum’	cf.	tafaːʃeː	‘pl.’
c.	/talaktʃi/	talawtʃi	‘poverty’	cf.	talaka	‘a poor one’
d.	/hagni/	hawni	‘left side’	cf.	bahago	‘lefthanded one’
e.	/fatke/	farke	‘merchant’	cf.	fataːke	‘pl.’
f.	/maz-maza/	marmaza	‘very fast’			
g.	/k’as-k’as-iː/	k’ark’asiː	‘underside’			

2.2.1.2.3. Russian labial fricatives

Modern Russian (Gussmann 2002) has a well-known restriction whereby obstruents ([–sonorant]) must be voiceless in syllable-final position (26a-d), unless they are followed by a voiced obstruent, in which case both obstruents are obligatorily voiced (26e-i). Note that the labial fricatives /v, vʲ/ behave like ordinary obstruents in this regard, as shown in (26c, g, h, i).

(26)

a.	xleb	[xlʲep]	‘bread’	xleba	[ˈxlʲeba]	‘gen. sg.’
b.	drug	[druk]	‘friend’	drugu	[ˈdrugu]	‘dat. sg.’
c.	trav	[traf]	‘grass, gen. pl.’	trava	[traˈva]	‘nom. sg.’
d.	muž	[muʃ]	‘husband’	muža	[ˈmuʒa]	‘gen. sg.’
e.	mozg	[mosk]	‘brain’	mozgom	[ˈmozgam]	‘instr. sg.’
f.	nadežd	[naˈdʲeʃt]	‘hope, gen. pl.’	nadežda	[naˈdʲeʒda]	‘nom. sg.’
g.	trezv	[tʲrʲesf]	‘sober, masc.’	trezva	[tʲrʲezˈva]	‘fem.’
h.	kro[fʲ] [kʲ]ipit		‘blood is boiling’	kro[vʲ] [d]vojanskaja		‘noble blood’
i.	ro[f] [p]ustoj		‘empty ditch’	ro[v] [g]lubokij		‘deep ditch’

An obstruent is also obligatorily voiceless in syllable-final position even if it is followed by a voiced sonorant consonant, as shown in (27a-c). What is surprising is that /v, vʲ/ pattern with sonorants in this regard: they fail to induce voicing in preceding obstruents, as shown (27d-h). As Gussmann (2002:196) discusses: “[v], although pronounced as a labio-dental spirant, patterns phonologically with sonorants. The expression ‘patterns with’ is a circumlocution: to say that a segment can ‘pattern with’ sonorants is simply to say that it is a sonorant itself. We must, then, nail our colours to the mast and say that in some contexts what sounds like a spirant is a sonorant.”

(27)

a.	bra[t] [r]abotaet	‘the brother works’
b.	vra[k] [nʲ]e spit	‘the enemy is not asleep’
c.	kro[fʲ] [lʲ]ëtsja	‘blood is flowing’
d.	uža[s] [v]ojny	‘horror of war’

e. vku[s] [v^{j}]ina ‘the taste of wine’
f. svi[st] [v^{j}]etra ‘whistle of the wind’
g. goro[t] [v]zjat ‘the town has been taken’ (cf. goro[d]a ‘town, gen. sg.’
h. sapo[k] [v]aš ‘your boot’ (cf. sapo[g]om ‘boot, instr. sg.’)

In other words, Russian labio-dental consonants are really two different phonological objects: they are obstruents ([–sonorant]) when located in syllable-final position, but they are sonorants ([+sonorant]) when located in vowel-initial position.

2.2.2. Other articulator-free features

As discussed above, the features [±consonantal] and [±sonorant] are known as “major class” features because they provide the most basic distinctions between speech sounds: between vowels, glides, and consonants, and between obstruents and sonorants. Three other features will be introduced in this section: [±strident], [±lateral], and [±continuant]. These features are found only in [+consonantal] phonemes (Halle 1995:12) and, as we will see, they are normally executed by a single articulator in a given consonant. Still, they are considered *articulator-free* because they can be executed by different articulators in different segments.

2.2.2.1. [±lateral]

[+lateral] phonemes are produced with an occlusion somewhere along the mid section of the vocal tract but with airflow around one or both sides of the occlusion. [–lateral] phonemes are produced without such a special occlusion. For example, /l/ is [+lateral], and /r/ is [–lateral].

The tongue blade is the most widely used articulator for laterals. For instance, it is used to execute several different laterals in the Australian language Kaititj (Ladefoged & Maddieson 1995:185):

(28) Words illustrating different coronal laterals in Kaititj

laminal dental		*apical alveolar*		*apical post-alveolar*		*laminal post-alveolar*	
l̪inp	‘armpit’	lubiɹ	‘thigh’	l̪aɻiŋk	‘hit’	l̠ukuŋk	‘to light’
al̪uŋ	‘burrow’	aluŋk	‘chase’	aɻat	‘sacred board’	al̠ilk	‘smooth’
albaɻ̪	‘smoke’	irmal	‘fire saw’	aldimaɻ̪	‘west’	kural̠	‘star’

For this reason, Chomsky and Halle (1968:317) believed that “[t]his feature [±lateral] is restricted to coronal consonantal sounds.” This belief is perpetuated in, e.g., McCarthy (1988), Blevins (1994), MacKay (1994), and Grijzenhout (1995).

However, the feature [±lateral] must be considered “articulator-free” because laterals can be produced with articulators other than than the tongue blade.[18] For instance, languages have been reported in West Africa (e.g., Kotoko) and in Papua New Guinea (e.g., Melpa) in which

[18] For arguments that the feature [±lateral] is independent of the Tongue Blade in feature geometry, see Sagey (1986), Shaw (1991b), Rice and Avery (1991), Kenstowicz (1994:156), Clements and Hume (1995:293), Hall (1997). For a different view, see McCarthy (1988), Blevins (1994), and Grijzenhout (1995); also MacKay (1994).

laterals are executed not only with the tongue blade but also with the tongue body (Ladefoged & Maddieson 1995:190). Here are some examples from the Papuan language Mid-Waghi:

(29) Words illustrating laterals in Mid-Waghi

Laminal dental	*Apical alveolar*	*(Dorsal) Velar*
a̪la a̪la	alala	aʟaʟe
'again and again'	speak incorrectly'	'dizzy'

Lateral obstruents appear to be more highly *marked* (i.e., uncommon, unusual) than lateral sonorants (Maddieson 1984, Ladefoged & Maddieson 1996), a fact which suggests a constraint against the combination [–sonorant, +lateral]. If such a constraint existed, it would be lowly ranked in language families like Athapaskan and Wakashan. You may recall from section 2.1.1 that the phoneme inventory of Chipewyan (Athapaskan), for instance, includes the lateral sonorant /l/ as well as the lateral obstruents /tɬ, tɬʰ, tɬʼ, ɬ/. Similarly, the phoneme inventory of Oowekyala (Wakashan) has the lateral sonorants /l, lʼ/ as well as the lateral obstruents /tɬ, dˡ, tɬʼ, ɬ/.[19] These laterals are illustrated in the following words:

(30) Some words with laterals in Oowekyala (Howe 2000)

Voiceless lateral affricate	tɬamu	'ocean perch, shiner'
Voiced lateral affricate	dlaː	'to wedge, to split with a wedge'
Ejective lateral affricate	tɬʼaː	'black bear'
Voiceless lateral fricative	ɬaɢis	'a tent'
Voiced lateral sonorant	lasa	'to plant'
Glottalised lateral sonorant	lʼapa	'to spread apart with the thumbs'

Velar lateral obstruents, while admittedly rare, also exist. Here are some examples from Archi (Ladefoged & Maddieson 1996:206):

(31) Lateral velar obstruents in Archi

Voiceless prevelar fricative	ʟ̝ob	'sheath'
Labialised voiceless prevelar fricative	ʟ̝ʷalli	'large ravine'
Voiced prevelar fricative	naʟ̞dor	'home'
Voiceless prevelar affricate	kʟ̝an	'hole'
Labialised voiceless prevelar affricate	kʟ̝ʷijtʼu	'seventeen'
Prevelar ejective affricate	kʟ̝ʼal	'lamb'
Labialised prevelar ejective affricate	kʟ̝ʷʼas	'to murder'

Changes affecting [±lateral] are relatively common in languages. For example, in Florentine Italian, [+lateral] /l/ regularly switches to [–lateral] [ɾ] in syllable-final positions (Walsh 1995). Thus compare the following words in Standard vs. Florentine Italian:

[19] Nuuchahnulth constitutes a blatant counterexample to putative *[–son, +lat]. This Wakashan language has several lateral obstruents /tɬ, tɬʼ, ɬ/ but no lateral sonorants (e.g., /l, lʼ/).

(32)

	Standard Italian	*Florentine Italian*	
a.	[dolt^{ʃ}e]	[dort^{ʃ}e]	‘sweet, dessert’
b.	[sɔldi]	[sɔrdi]	‘money’
c.	[palkoʃɛniko]	[parkoʃɛniko]	‘stage’

The same state of affairs obtains in Andalusian Spanish, as can be observed from comparing words in Standard Castillian vs. Andalusian Spanish:

(33)

	Standard Castillian	*Andalusian*	
a.	[e.lo.so]	[e.lo.so]	‘the bear’
b.	[el.θo]	[er.θo]	‘the zoo’
c.	[al.baː.ka]	[ar.baː.ka]	‘basil’
d.	[pul.po]	[pur.po]	‘octopus’

Exercise (Kenstowicz 1994)

The liquids [l] and [r] are in complementary distribution in Korean. State the context where each is found. What difficulty is a name such as *Lori Roland* likely to present to the Korean learner of English?

(34)

	mul	‘water’	mal	‘horse’
	mulkama	‘place for water’	malkama	‘place for horse’
	mure	‘at the water’	mare	‘at the horse’
	pal	‘foot’	səul	‘Seoul’
	pari	‘of the foot’	rupi	‘ruby’
	ilkop	‘barber’	ration	‘radio’

That the feature [+lateral] has independent status as a phonological element is strongly suggested by the fact that it can be added to phonemes. Thus, when speakers of Nuuchahnulth (Wakashan; Vancouver Island, BC) tell stories involving the mythical characters Deer or Mink, the fricatives /s, ʃ/ are changed to /ɬ/, and the affricates /t^{s}/ and /t^{s}’/ are changed to /t^{ɬ}/ and /t^{ɬ}’/, respectively. For example, *ʔaːʔaniʔaksajikqat^{s}sa* ‘I believe that I will’ is pronounced [ʔaːʔaniʔakɬajikqat^{ɬ}ɬa], *q^{w}ajaːt^{s}’iːk* ‘wolf’ is pronounced [q^{w}ajaːt^{ɬ}’iːk], *ʕat^{s}’iɬa* ‘persisting’ is pronounced [ʕat^{ɬ}’iɬa], etc. (Stonham 1999:114). In this case the feature [+lateral] is being added to strident phonemes (the feature [+strident] is introduced in the next section).

The feature [+lateral] can also be removed. This happened historically in Totonac dialects of Mexico. The lateral affricate /t^{ɬ}/ is found in some dialects of Totonac, such as that spoken in Xicotepec Juárez. But in Mizantla Totonac, /t^{ɬ}/ has changed to /t/. This can be seen by comparing cognates:

(35) Totonac (MacKay 1994:376, n. 8)

Xicotepec Juárez	*Mizantla*	
puːt^{ɬ}e̱qé	púːtaqɛ́	‘s/he counts’
pa̱t^{ɬ}a̱nan	pa̱tá̱n	‘s/he vomits’

tˡa̰ːwan	tanáːnán	‘s/he walks’
qa̰tˡa	qá̰t	‘big’
tˡa̰ma̰nk	tá̰mḭŋ	‘pot’

In this case, the feature [+lateral] was removed from obstruent stops (the feature [–continuant] will be discussed shortly).

2.2.2.2. [±strident]

The feature [+strident] characterises phonemes that are realised with high frequency frication, that is, high pitch white noise; [–strident] phonemes are realised at lower pitch. Because it is defined on the basis of air turbulence, [±strident] is important only for obstruents ([–sonorant]). As Clements (2001:111) observes: “The feature [+strident] is realized phonetically in the turbulence noise associated with obstruents.”

Historically, [strident] is an acoustic feature descended from Jakobson and Halle’s (1957) original system, wherein it was opposed to the endearing feature [mellow].[20] But it can also be defined articulatorily as “rough-edge articulation” (Hyman 1975:39); the noisy friction comes from “having the air strike and bounce off of two surfaces” (ibid.).

The most common [+strident] phonemes are the fricatives /s, z, ʃ, ʒ/ and the affricates /tˢ, dᶻ, tʃ, dʒ/, often collectively referred to as *sibilants*. In some languages such as Chipewyan (see phoneme inventory in section 2.1.1 above), these are carefully distinguished from [–strident] phonemes such as /θ, ð, tᶿ, dᵟ/.

Much more rarely, [±strident] is also used to distinguish *labiodental* obstruents from *bilabial* obstruents. The former are considered [+strident], the latter [–strident]. The West African language Ewe makes such a distinction among its fricatives.

(36) Ewe (Ladefoged & Maddieson 1996:139)

éɸá	‘he polished’	éfá	‘he was cold’
èβè	‘the Ewe language’	èvè	‘two’
éɸlè	‘he bought’	éflɛ̃́	‘he split off’
èβló	‘mushroom’	évló	‘he is evil’

This contrast is also made in several Southern Bantu languages such as Kwangali and RuGciriku. Purepecha (a.k.a. Tarascan), a language isolate of Mexico, also distinguishes [+strident] /f/ and [–strident] /ɸ/.

Other [+strident] fricatives are the uvulars [χ, ʁ]. Other [–strident] fricatives are the palatals [ç, ʝ] and the velars [x, ɣ]. Precisely because the feature [+strident] can be executed by several different articulators (lips, tongue blade, tongue body), it is considered “articulator-free.”

According to Maddieson’s (1984:45) survey of fricatives, [+strident] /s/ is almost 15 times more common across languages than its [–strident] counterpart, /θ/; [+strident] /z/ is over four times more common crosslinguistically than its [–strident] counterpart, /ð/. Similarly, [+strident] /f/ is over six times more common across languages than its [–strident] counterpart,

[20] Chomsky and Halle (1968:329): “Strident sounds are marked acoustically by greater noisiness than their nonstrident counterparts. ... Stridency is a feature restricted to obstruent continuants and affricates.”

/ɸ/; and [+strident] /v/ is more than twice as common crosslinguistically than its [–strident] counterpart, /β/. As noted above, other [+strident] obstruents, such as /ʃ, $t^{ʃ}$, ʒ, $d^{ʒ}$/, are also very common crosslinguistically. Presumably, [+strident] phonemes are preferred over their [–strident] counterparts because of their inherent noisiness: they are easy to hear and relatively easy to produce.[21]

A strong argument for the autonomous status of the feature [+strident] is provided by the diminutive morpheme ("small, little") in Plains Cree (Algonquian). As illustrated in (37), the primary distinction of diminutives is that "plain" /t/'s become [+strident] affricates [t^{s}]. In some cases, the diminutive is also signaled by a suffix, e.g. -(i)s in (37a,b) or -(i)sis in (37c,d). But as shown in (37e,f), the diminutive can be expressed even in the absence of an overt suffix, simply by adding [+strident] to /t/'s. The diminutive morpheme in Plains Cree can therefore arguably be represented just by the feature [+strident], independently of any phoneme.

(37) Diminutive formation in Plains Cree (Hirose 1997)

	Non-diminutives		*Diminutives*	
a.	atoske-w	's/he works'	at^{s}oske-s-iw	's/he works a little'
	work-3		work-DIM-3	
b.	astotin	'a/the hat'	ast^{s}ot^{s}in-is	'a little hat'
	hat		hat-DIM	
c.	atim	'dog'	at^{s}imo-sis	'a/the little dog'
	dog		dog-DIM	
d.	ni-tem	'my horse'	ni-t^{s}em-isis	'my little horse'
	1-horse		1-horse-DIM	
e.	jot-in	'it is windy'	jot^{s}-in	'it is a little windy'
	windy-0		windy-DIM-0	
f.	wat	'a/the hole'	wat^{s}-a	'(the) little holes'
	hole		hole-DIM-PL	

As another example of [+strident] being added to phonemes, consider the historical development in German of [+strident] affricates from [–strident] stops.[22] This can be demonstrated by a comparison with English (Picard 1999:71):

English	*pool*	*tongue*	*cow*
German	*Pfuhl*	*Zunge*	*Kxuū* (Swiss)
	[p^{f}]	[t^{s}]	[$k^{χ}$]

Notice that in these affricates —the strident stops— there is a small change of articulation in order to effectuate the 'rough edge articulation'. As Ladefoged and Maddieson (1996:90) point out, "[s]ome affricates ... involve a small forward or backward adjustment of the active articulator position." Thus [p^{f}] involves a shift from bilabial to labiodental, and [$k^{χ}$] involves a shift from velar to uvular.[23]

[21] Crosslinguistically the strident uvulars [χ, ʁ] are less common than the non-strident velars [x, ɣ] (Maddieson 1984:45). This likely has to do with the relative difficulty of articulating uvulars vs. velars.

[22] The notion that affricates are simply strident stops dates back to Jakobson, Fant and Halle (1952) and Jakobson and Halle (1956).

[23] [–strident] affricates (e.g., $p^{ɸ}$, $t^{θ}$) do not involve such readjustment. In these, "[a]ffricate releases may involve only a slight

2.2.2.3. [±continuant]

Chomsky and Halle (1968:317) define the feature [±continuant] as follows: "In the production of continuant sounds, the primary constriction of the vowel tract is not narrowed to the point where the flow past the constriction is blocked; in stops the air flow through the mouth is effectively blocked." Since [±continuant] is defined on the basis of near-complete vs. complete blockage in the mouth, this feature is relevant only for [+consonantal] phonemes.

Among sonorants, nasals are [–continuant] while liquid consonants (rhotics and laterals) are [+continuant]. One piece of evidence that nasals are [–continuant] is that epenthetic stops frequently occur between nasals and fricatives, e.g. English *teamster* [timstɹ̩] ~ [timpstɹ̩], *prince* [pɹɪns] ~ [pɹɪnts]; Dutch [lɑŋs] ~ [lɑŋks] 'along'. It is frequently claimed that unlike rhotics, laterals are [–continuant]. This cannot be true in general, since some languages contrast [–cont] laterals (e.g., tˡ) with [+cont] laterals (e.g., ɬ). But there is evidence in some languages that /l/ can behave [–continuant]. For example, /l/ can also trigger stop epenthesis in l+fricative clusters, e.g. *false* [fɑɬs] ~ [fɑɬts]. We will not pursue this issue further here, but see Clements 1987, Kaisse 1998, Kenstowicz 1994:34–8, 480–8).

Among obstruents, fricatives are [+continuant] and stops are [–continuant]. Note, incidentally, that fricatives appear to be more *marked* than stops (Chomsky & Halle 1968:406; Roca & Johnson 1999:585). While all languages have stops, there are languages with no fricatives at all. Maddieson (1984) reports 18 such languages in his sample of 317 languages; Lass (1984:151) reports 21 such languages. Also suggestive is the fact that among normal children "[s]egments specified [–continuant] are acquired earlier than those specified as [+continuant]" (Ueda 1996:17 on Child Japanese; see also Beers 1996 on Child Dutch; Halle & Clements (1983) illustrate the substitution of stops for fricatives in Child English) (see also Morelli 1999:186).Contrasts based on [±continuant] in obstruents are illustrated here with Standard Chinese (Ladefoged & Maddieson 1996:150):

(38) Some [±continuant] contrasts in Standard Chinese (all vowels are high level tone)

a.	sa	'let out'
	tˢa	'take food with tongue'
b.	ʂa	'sand'
	ʈˢa	'to pierce'
c.	ɕa	'blind'
	tᶜa	'to add'

Additional examples are provided here from Oowekyala (Howe 2000):

(39) Some [±continuant] contrasts in Oowekyala

a.	tˢixa	to run, flow, flood (water)
	sixa	to peel (fruits, sprouts, etc.)
b.	tˡiqa	to beat time
	ɬiχa	fringe

widening of the articulatory constriction of the stop, so that stop and fricative components have identical place of articulation." (Ladefoged & Maddieson 1996:90).

c. kata to use a long thing (e.g., log) or put it somewhere
xata to peek, to stretch the head out
d. k^wisa to spit
x^w̟isa to whip, to make a whipping movement
e. qusa bent, crooked
χusa to sprinkle, to splash
f. q^w̟lq^wa to sprain, wrench
$χ^w$̟lq^wa to sharpen with a file

The status of affricates, such as /t^s, d^z, $t^{s'}$, $t^ɬ$, d^l, $t^{ɬ'}$/ in Oowekyala, calls for special comment. In all these phonemes, the tongue tip or blade and the alveolar ridge first come together for a 'stop' and then separate slightly so that a homorganic 'fricative' is made —except perhaps in d^l, where a homorganic sonorant [l] appears to be made (rather than a homorganic voiced fricative [ɮ]).[24] In spite of their phonetics, there are strong indications that affricates are single units in Oowekyala phonology.

First, in spite of their phonetic compositionality, affricates are audibly distinguished from corresponding stop+fricative sequences. In the case of laryngeally unmarked (voiceless nonglottalised) affricates, the frication noise associated with the release is strong, giving the impression of post-aspiration (Lincoln and Rath 1980:6–8). In contrast, corresponding stop+fricative sequences are separated by an easily detected aspirated release of the stop prior to the fricative articulation (ibid.).

(40)	t^s	[t͡s^h]	vs.	ts	[t^{h}s]
	$t^ɬ$	[t͡ɬ^h]	vs.	tɬ	[t^{h}ɬ]

In the case of glottalised affricates, the fricative release and the ejective release appear to be simultaneous, while in the corresponding glottalised stop+fricative sequence, the stop's ejective release is realised before the fricative.

(41)	$t^{s'}$	[t͡s']	vs.	ts	[t's]
	$t^{ɬ'}$	[t͡ɬ']	vs.	tɬ	[t'ɬ]

In the case of voiced /d^z/, the 'fricative' component has no independent status in Oowekyala. That is, the sound [z] does not occur independently of [d^z] (cf. phoneme inventory in section 2.1.1 above). This provides a robust argument in favour of the affricate d^z being a single segment. This illustrates a major difficulty for the analysis of affricates as specified both [–continuant] and [+continuant], as pointed out by Goldsmith (1990:69): "affricates are often found in languages without fricatives (most dialects of Spanish, for example, have a voiceless alveopalatal affricate [t͡ʃ], but no fricative [ʃ])." Indeed, if affricates are composed of a sequence of stop plus fricative, it is surprising that the individuals parts of the affricate —the stop and the fricative— are not both existing units in some languages with affricates.

(42)	d^z	[d͡z]	vs.	d *z	

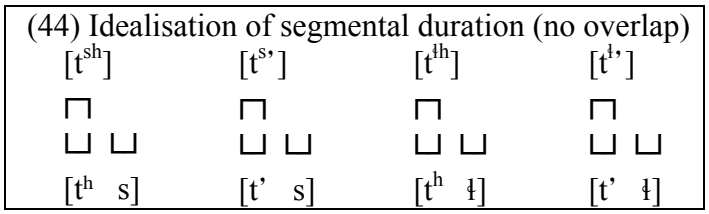
In the case of /d^l/, the 'sonorant' component [l] immediately follows the stop release. By contrast, the corresponding d+l sequence is always separated by schwa; that is, d+l is always pronounced …dəl… in Oowekyala.

(43)	d^l	[d͡l]	vs.	dl	[dəl]

[24] In North America, /d^l/ is found only in North Wakashan. Sherzer (1976:67) reports /d^l/ in several families (e.g., Tlingit, Athapaskan, Penutian), but in these linguistic groupings the sound is actually /$t^ɬ$/, the plain counterpart of phonologically aspirated /$t^{ɬh}$/ and glottalised /$t^{ɬ'}$/ (Campbell & Mithun 1979, Blevins 1993).

Note, too, that impressionistically affricates appear to be significantly shorter in duration than their corresponding stop+fricative sequences. Actual differences in duration have not yet been measured instrumentally, though.

(44) Idealisation of segmental duration (no overlap)



The phonetic differences just described, combined with the relatively permissive phonotactics[25] of Oowekyala, allow lexical contrasts between affricates and matching stop-fricative sequences, as the following pairs illustrate:

(45) Word-initial contrasts between affricate vs. stop+fricative sequence

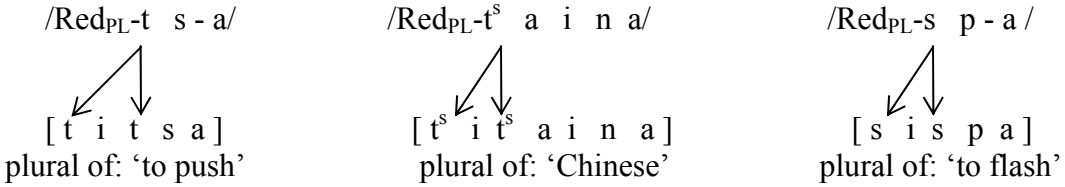
a.	tˢəla	to cut through water
	tsəla	pushing
b.	tˢ'aː	flow of water, creek flowing
	t'sa	to hit sth. with a rock, to bang rocks together, to chip pieces from rocks
c.	tˢtˢila[26]	to do what somebody else does or did
	tstsa	push repeatedly

(46) Word-final contrast between affricate vs. stop+fricative sequence

w̰atˢ'	dog
qʷ'at's	crowded together on the field

Plural reduplication also gives evidence that affricates are single segments in Oowekyala. Recall from section 2.2.1.2.1 above that the plural in this language normally consists of a copy of the first consonant followed by [i] ("C[i]-reduplication"). Crucially, affricates may occur in the onset of the prefix syllable, while no stop+fricative sequence may occur in this position, as illustrated in (47) and (48). The reduplication of forms with unambiguous clusters, e.g. /Ci-sp-a/→[sispa] 'plural of: to flash', make it clear that reduplication copies only one segment, so that copied affricates must be interpreted as single segments.

(47) *Plural reduplication with stop+fricative sequence vs. affricate*



(48) Plural form with word-medial contrasts between affricate vs. stop+fricative

a.	t͡sit͡saina	plural of: chinese
b.	t͡its͡a	plural of: to push
c.	t͡sˢ'it͡sˢ'mː	plural of: index finger
d.	t͡it͡ɬa	plural of: to bait
e.	t'at'ɬa	plural of: to slice fish parallel to the backbone

[25] "Phonotactics" is the set of constraints on sequencing of phonemes in a language.
[26] A sequence like tˢtˢ is doubly released ([t͡sʰt͡sʰ]).

f. t͡ɬ’it͡ɬ’aː plural of: black bear
g. t’it’ɬa plural of: to soak dried fish

The same point can be made with other aspects of morphology (word-formation) in Oowekyala. For example, the suffix -axsala ‘aimlessly’ regularly triggers the emplacement of a vowel [aː] in otherwise vowelless roots, e.g.:

(49) -axsala ‘aimlessly’
a. χʷaːtaxsala cut any way, carelessly
cf. χʷta to cut with a knife
b. gaːlaxsala to crawl aimlessly
cf. gla to crawl, to go on all fours
c. jaːχʷaxsala dance any way with no order/pattern
cf. jχʷa to dance, to make dancing movements

Crucially, the ‘stop’ and ‘fricative’ components of affricates such as /tˢ’/ do not get separated (*[t’aːs...]) by the morphologically-inserted vowel, e.g. (50a,b), whereas stop+fricative sequences such as /ts/ do get separated, e.g. (50).

(50) -axsala ‘aimlessly’
a. tˢ’aːmaxsalaglił to point around indoors
tˢ’ma to point
b. tˢ’aːnaxsala to proceed all over the place
tˢ’na to walk in a group, go in the same direction as others, to parade
c. taːsaxsala push here and there
tsa to push, press against

The advent of nonlinear phonology (Goldsmith 1976) made possible a conception of affricates as contoured segments. For example, according to Leben (1980), Steriade (1982), Archangeli (1984[1988]), Sagey (1986) and others, each affricate is characterised by both values of continuancy: [–continuant] and [+continuant]. This conception persists even in current phonological theory, e.g., Roca (1994), Steriade (1993, 1994), MacKay (1994), Schafer (1995), van de Weijer (1996), Hall (1997:64, n. 23), Gussenhoven & Jacobs (1998:195-6), Zoll (1998:95), Elzinga (1999:46-7), Morelli (1999:108-110). Halle (1995:24), too, treats (nonlateral) affricates as complex segments with two subunits, the second being specified [+continuant]. As Clements (1999:272) observes, “the current literature continues to treat these sounds [i.e. affricates] as contour or complex segments”.

It is doubtful that the affricates in Oowekyala are [[–cont][+cont]], since affricates never pattern with fricatives as a natural class with respect to [+continuant] in this language (or in any language, according to LaCharité 1995). For example, fricatives shun laryngeal contrasts, but affricates (like obstruent stops) do not (see phoneme inventory in section 2.1.1 above).

It is also significant that the feature [+continuant] is not necessary or sufficient to characterise affricates in Oowekyala since they are distinguishable from nonaffricated stops (esp. /t, d, t’/) in terms of two independently-needed features: [+strident] and [+lateral]. Oowekyala has three distinct series of coronal segments: an unmarked series /t, d, t’, n, n’/, a series specified [+strident] /tˢ, dᶻ, tˢ’, s/, and a series specified [+lateral] /t͡ɬ, dˡ, t͡ɬ’, ɬ, l, l’/. Crucially, affricates /tˢ,

d^z, t^s', $t^ɬ$, d^l, $t^ɬ$'/ are properly included in the [+strident] and [+lateral] series, so that the 'fricatives' associated with the release of affricates can be understood as phonetic implementations of these features, not of [+continuant]. The conclusion is that, phonologically, affricates are just stops (Shaw 1989, 1991b; Kim 2001). Here is Clements (1999:272):

> The fact that affricates consist of stop + fricative sequences phonetically is best accounted for at the phonetic level, where phonological feature combinations such as [–continuant, +strident] are spelled out sequentially as a succession of acoustic events.

Having resolved the status of affricates as stops, let us now turn to the *autosegmental* nature of the feature [±continuant]. A clear example is provided by Nuer, a Nilo-Saharan language of Sudan (Crazzolara 1933, Lieber 1987, Akinlabi 1996), where the feature [continuant] signals tense/aspect distinctions. Specifically, as the data in (51) illustrate, the past participle in Nuer is indicated by *spirantisation* —a change from [–continuant] to [+continuant] in the final consonant. In other words, the feature [+continuant] appears to be added to the last consonant of a verb in order to indicate the past participle.

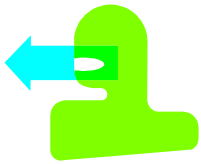
(51)	*Pres. pple. neg.*	*Past pple.*	
a.	còp	cof	'to overtake'
	kɛp	kɛ̀f	'to scoop (food) hastily'
b.	lo̪t̪	loθ	'to suck'
	jæ̪t̪	jæθ	'to wade'
c.	paːt	pàːr̥	'to sharpen'
	wɨt	wɨ̀r̥	'to cut a point'
d.	jaːc	jaːç	'to hit'
	jɟèːc	jɟeːç	'to dismiss a person'
e.	ɟæk	ɟæh	'to throw away'
	jək	jəh	'to find'

Data such as these suggest that the feature [+continuant] can signal a morpheme on its own. As Akinlabi (1996:253) remarks, "the past participial morpheme [in Nuer] ... under any analysis must include the feature [continuant]." In fact, Lieber (1987) and Akinlabi (1996) argue that two other suffixes in Nuer — -kɔ '1st pers. ind. pres. act.' and -ɛ '3rd pers. ind. pres. act.'— each carry a floating [+continuant] feature which has the same *spirantisation* effect as the past participial.

It is worth noting here that *spirantisation*, another form of *lenition*, is a relatively common historical process. Recall from the preceding section that stops had developed into affricates in German (Pfuhl/pool, Zunge/tongue, Kxū/cow), a change that we can interpret phonologically with the feature [±strident]. Subsequently, postvocalic affricates changed into fricatives, as the comparison with English in (52) reveals (Picard 1999:71). Here the feature involved is [±continuant].

(52)		[f]	[s]	[χ]
	German	*hoffen/auf*	*Wasser/es*	*Kuchen/Buch*
cf.	English	*hope/up*	*water/it*	*cake/book*

2.3. Place features



Some consensus exists among phonologists and phoneticians that there are just six articulators involved in the sounds of the world's languages (e.g., Pulleyblank 1988a, 1995; Halle 1992, 1995; Clements and Hume 1995; Ladefoged and Maddieson 1996:44, 371; Halle, Vaux & Wolfe 2000). These articulators and their related features are listed in (53) and discussed in the sections that follow.

(53) Articulators and related features

a.	Lips:	[labial], [±round]
b.	Tongue Blade:	[coronal], [±anterior], [±distributed]
c.	Tongue Body:	[dorsal], [±high], [±low], [±back]
d.	Tongue Root:	[radical], [±ATR]
e.	Soft Palate:	[±nasal]
f.	Larynx:	[glottal], [±constricted], [±spread], [±voice]

Note that the unary features in (53) designate major articulations, i.e., the articulators that realise the articulator-free features such as [±cons], [±son], and [±cont] (section sections above).

2.3.1. Lips

Two features depend on the Lips: [labial] and [±round].

2.3.1.1. [labial]

Peter Piper picked a peck of pickled peppers.

The feature [labial] characterises phonemes which are articulated primarily with the lips. Some languages (e.g., in Iroquoian or Athapaskan) ban the articulator feature [labial], such that they lack labial phonemes entirely. However, most languages allow at least some labial phonemes. For example, Oowekyala consonants with [labial] as their major Place articulator feature are /p, b, p', m, m'/, as illustrated in the following words:

(54)

a.	bat^{ɬ}a	to fathom, measure by using the extended arms or fingers
b.	pat^{ɬ}a	to flatten
c.	p'at^{ɬ}'s	sth. strung out on the ground
d.	mat^{ɬ}a	to shake hands, take by the hand
e.	m'it^{ɬ}a	to miss a shot, to dodge, avoid, or escape from sth., dislike contact

Observe that labial fricatives are absent. This gap in Oowekyala is not haphazard but rather reflects a markedness constraint on the feature combination [labial, +continuant].

(55) $*\begin{bmatrix}\text{labial}\\ +\text{continuant}\end{bmatrix}$ The features [labial] and [+continuant] must not cooccur within a segment.

That (55) is markedness-based is evident typologically. For instance, consider the marking implication in (56), which Sherzer (1976:258) gives on the basis of a large survey of North American Indian languages. Here, X → Y signifies that "if a language has X, then that same language also has Y and that it is the case that X is marked with respect to Y" (Sherzer 1976:256).

(56) A marking implicational (Sherzer 1976:258, 1.3.1)
f, v, φ, β → p

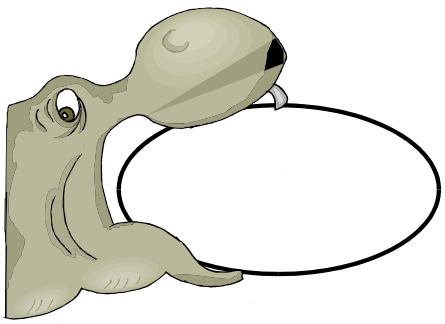
There is also acquisitional evidence that labial fricatives are relatively complex. For example, Beers (1996:36-7) reports that Dutch children acquire labial fricatives (f) 3 to 8 months later than they acquire coronal fricatives (s) and velar fricatives (x).

To illustrate the effect of (55) in Oowekyala grammar, consider the adaptation of English labial fricatives into Oowekyala, as illustrated by the words in (57).[27]

(57) Loan adaptations of labial fricatives in Oowekyala

	Oowekyala	English	
a.	pəlawas	flawə(ɹ)z	'flowers'
b.	kʷabi	kɑfi	'coffee'
b.	sdup	stov	'stove'
c.	bankʷuba	væŋkuvə(ɹ)	'Vancouver'

2.3.1.2. [±round]



Chomsky and Halle (1968:309) define the feature [±round] as follows: "Rounded sounds are produced with a narrowing of the lip orifice; nonrounded sounds are produced without such a narrowing."

As mentioned above, languages which exclude [labial] include many Athapaskan and Iroquoian languages. Note that the grammatical constraint responsible for this exclusion, say *[labial], does not preclude the other Lips-feature [±round] from being active in these languages. For example, the Northern Iroquoian language Oneida lacks all labial consonants (*p, *b, *m, *f, etc.) but it has [+round] phonemes (/w, o, ũ/) (Pepper 1986).

Also, as mentioned above, segments in Oowekyala (as in many other languages) *may not* be specified both [labial] and [+continuant]. But nothing prevents segments from being specified both [+round] and [+continuant], as in /xʷ, χʷ/. The latter segments appear along with other [+round] consonants, in the following examples:

[27] It is a supposition that these English words were adapted directly into Oowekyala. In fact, some words might have been borrowed via Chinook Jargon. The general point remains valid nonetheless, as Chinook Jargon also lacked labial fricatives.

(58) Some labiovelars and labiouvulars in Oowekyala

a.	qʷχʷ	powder	EW
b.	χʷtkʷ	(sth.) cut with a knife	HS
c.	kʷxʷa	hot	HS
d.	kʷχʷbis	noiseless fart, cushion creeper	HS
e.	kʷ'kʷ'χʷsj'akʷ	sth. chopped up, kindling	HS
f.	qʷ'iqʷxʷsm̩	powdery blueberry (Vaccinum ovalifolium)	BC99
g.	k'l̩qʷ'χʷdˡa	incessantly urinating (said of a male)	HS
h.	xʷm̩ɢʷatˢ'i	bee-hive	EW
i.	ɢʷaχʷɢʷalaɲusiwa	Raven-at-the-North-End-of-the-World	DS78
j.	ɢʷiqʷχʷɢʷaχa	plural of: to eat bread	HS