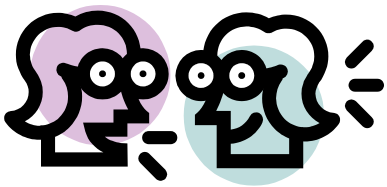

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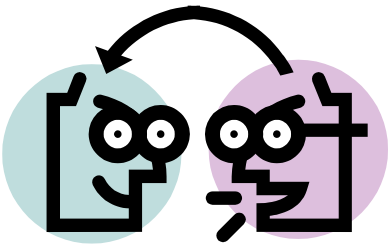

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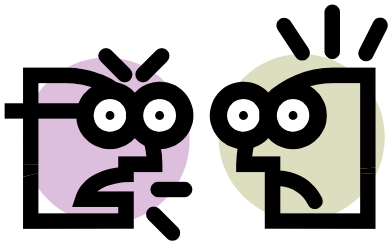

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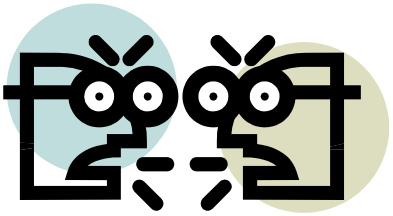

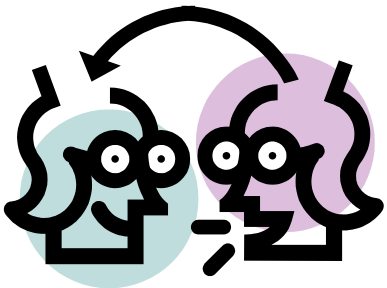

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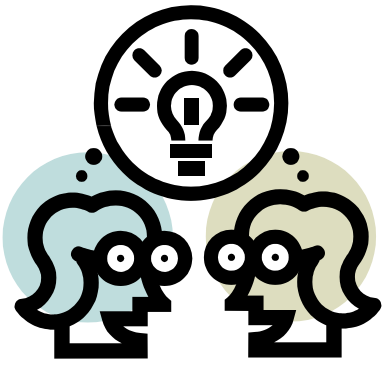

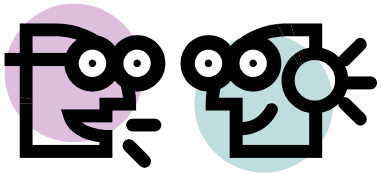

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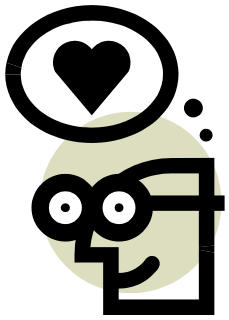

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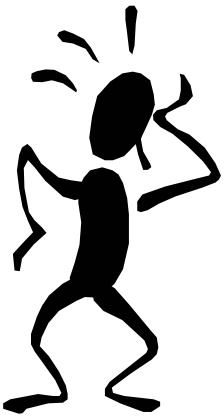


Of course none of those mentioned above are to be held responsible for erroneousnesses below.

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.

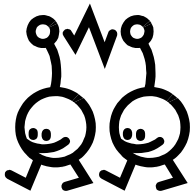
Phonology is the study of sound patterns in languages.[1] The term is also often used to refer to the sound system, or pronunciation, of particular languages, e.g., 'the phonology of French'.

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 speakers' minds, and also predict what sound patterns cannot occur in speakers' minds.

Current phonological theory is sharply divided into two areas: segmental and prosodic. Segmental phonology focuses on "melody": speech sounds (*segments*), their internal composition and external interactions. One of the greatest discoveries in this area is that segments consist of *features*, and it is through these that segments interact with each other (Jakobson 1939, 1941; Trubetzkoy 1939). Segmental phonology is therefore concerned with phonological features: what are they, and how are they organised inside segments and between segments? These questions are addressed in sections 2 and 3 below.

The other major area, prosodic phonology, focuses on aspects of the sound system above the level of segmental sounds, such as pitch, timing, stress and rhythm. Research into the nature and patterning of these phenomena suggests that speech sounds are not just arranged linearly, but are hierarchically organised into prosodic structure: segments into *moras* and *syllables*, syllables into *metrical feet*, metrical feet into *prosodic words*, and so on. A primary objective of prosodic phonology is to spell out the formal properties of this *prosodic hierarchy*, which contributes to the organisational structure of utterances, hence presumably to the overall efficiency of human language. Prosody is discussed in sections 4, 5 and 6 below.

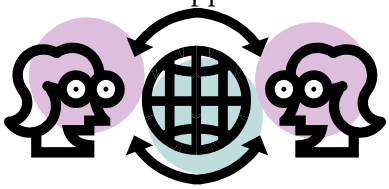
The current view of phonology —as the study of an aspect of human cognition rather than the study of an external, social reality— originated during the late 1950's and early 1960's with Morris Halle and Noam Chomsky who were hired at the Massachusetts Institute of Technology amid concerns that the Russian 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



...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. –Noam Chomsky, 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).

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).[3] It is used by writers and poets. And it even has forensic applications.[4]



2. Intrasegmental phonology

The Swiss linguist Ferdinand de Saussure makes a helpful distinction between *paradigmatic* relations, which refer to the vertical relations between entities, and *syntagmatic* relations, which refer to horizontal relations between entities. In segmental phonology the vertical relations between segments (*p*, *s*, *a*, *m*, etc.) represent paradigmatic alternatives, and the horizontal relations between segments —i.e., the various ways in which they can be combined into speech strings— represent syntagmatic alternatives. Our discussion of segmental phonology is therefore organised around these two dimensions: in this major section ("Intrasegmental phonology") we first adopt a paradigmatic approach by examining phonological features *inside* segments, and later, in section 3 ("Intersegmental phonology"), we take a syntagmatic approach by examining the interactions (of features) *between* segments.[5]

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[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] This place is admittedly diminutive in current practice. Consider Hausser (2001:18): "In computational linguistics, the role of phonology is marginal at best. ... Computational linguistics analyzes natural language at a level of abstraction which is independent of any particular medium of manifestation, e.g., sound."

[4] 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.

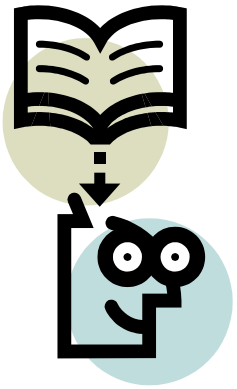
[5] Two other Saussurean distinctions are worthy of mention:

Synchronic vs. *diachronic*: Saussure emphasised the importance of distinguishing between two types of analysis: synchronic, which is the study of a system at one point in time, and diachronic, which is the study of a system over time. Synchronic phonologists want to know what speakers know about the sound systems of their languages. By contrast, diachronic phonologists want to know how each particular sound system evolved: what changes it underwent or is still undergoing.

Langue/competence vs. *parole/performance*: One of the most important distinctions in theoretical linguistics is that between Saussure's *langue* (≈ language), or what Chomsky calls *competence*, and Saussure's *parole* (≈ speech), or what Chomsky calls *performance*. Each language is a cognitive system ("un système où tout se tient"), each has a "basic plan, a certain cut, ... a structural genius" (Sapir 1921:127) which is known by individuals in a community, allowing them to understand speech and be understood. Speech acts, by contrast, are somewhat superficial in the sense that they only reflect the underlying language system. Phonologists study langue/competence, not parole/performance. Anyone who fails to recognise this fact will likely find phonological theory excessively abstract. Indeed a common complaint from first-time students is that phonology is "too mathematical, not tangible enough." I can only confirm such students' fears: "A grammar is a function from, say, underlying to surface representations; it is not a procedure for computing that function nor is it a description of how speakers actually go about computing that function." (McCarthy 1998:269; see also Chomsky 1965:9)

We begin by introducing the notion of *phonemes*, their status and number with *inventories*, and their *featural* basis.

2.1. Phoneme inventories and features



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.

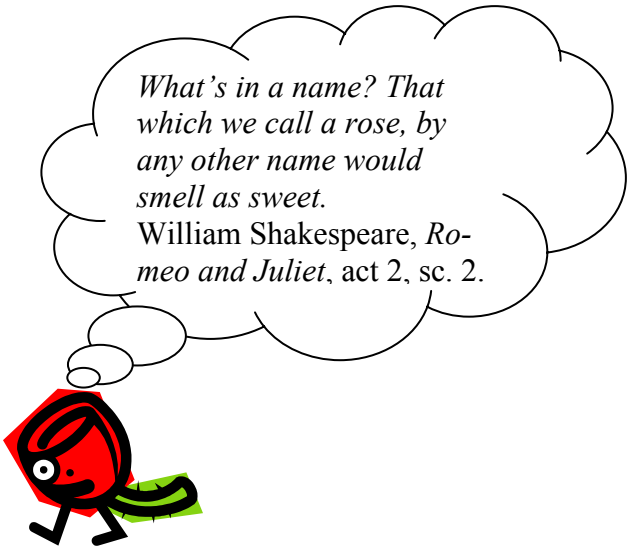
At some level in the speaker's mental dictionary (*lexicon*), the typical entry (*lexeme*) entails a linear arrangement of *phonemes* —relatively abstract units of vocalisation distinguished by native speakers of a given language. Unlike non-human animal vocalisations, phonemes are by themselves meaningless 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 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).

(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		

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 dəstɹʊjd, 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 to 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.[6]



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, including the voiceless pulmonic ingressive nasal /ŋ!^{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	tˢ	k		i, iː	
	s			h	eː	oː
m	n				aː	
		j	w			

(3) *Cayuga (Ontario, Iroquoian)*

t	tˢ	k		ʔ	i	
s					e	o
n					ẽ	õ
r					a	
	j		w	h		

[6] 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 ...'

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

p	t^{θ}	t	t^{s}	$t^{ɬ}$	$t^{ʃ}$	k	k^{w}			ì	ù		ĩ̀	ũ̀
	$t^{\theta h}$	t^{h}	t^{sh}	$t^{ɬh}$	$t^{ʃh}$	k^{h}	k^{wh}			è	ò		ẽ̀	õ̀
	$t^{\theta\text{'}}$	t’	$t^{s\text{'}}$	$t^{ɬ\text{'}}$	$t^{ʃ\text{'}}$	k’	$k^{w\text{'}}$	ʔ			à			
	θ		s	ɬ	ʃ	x	x^{w}				à			ã̀
	ð		z		ʒ	ɣ								
m		n								í	ú		ĩ́	ṹ
			r	l						é	ó		ẽ́	ṍ
					j		w	h			á			ã́

(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, i:		u, u:
p’	t’	$t^{s\text{'}}$	$t^{ɬ\text{'}}$	k’	$k^{w\text{'}}$	q’	$q^{w\text{'}}$				i̯		u̯
		s	ɬ	x	x^{w}	χ	$χ^{w}$					ə	
m, m:	n, n:											a, a:	
m̯	n̯											a̯	
		l, l:											
		l̯											
				j	w			h	ḥ				
				j̯	w̯			ʔ	ʔ̣				

The list of speech sounds (*phones*) below, while far from 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).

(6) *Some possible speech sounds (phones)*

p, ^{m}p, b, ^{m}b, p^{h}, p’, $b^{ɦ}$, b̪, ɓ, ɓ̪, p^{w}, $^{m}p^{w}$, b^{w}, $^{m}b^{w}$, p^{wh}, $p^{w\text{'}}$, $b^{wɦ}$, b̪^{w}, ɓ^{w}, ɓ̪^{w}, p^{j}, $^{m}p^{j}$, b^{j}, $^{m}b^{j}$, p^{jh}, $p^{j\text{'}}$, $b^{jɦ}$, b̪^{j}, ɓ^{j}, ɓ̪^{j}, $p^{ɣ}$, $^{m}p^{ɣ}$, $b^{ɣ}$, $^{m}b^{ɣ}$, $p^{ɣ\text{'}}$, $b^{ɣɦ}$, b̪^{ɣ}, ɓ^{ɣ}, ɓ̪^{ɣ}, $^{m}p^{ʕ}$, $b^{ʕ}$, $^{m}b^{ʕ}$, $p^{ʕ\text{'}}$, $b^{ʕɦ}$, b̪^{ʕ}, ɓ^{ʕ}, ɓ̪^{ʕ}, p̪t̪, ɓd̪, p̪t̪^{w}, ɓd̪^{w}, p̪t̪^{j}, ɓd̪^{j}, p̪t̪^{ʕ}, ɓd̪^{ʕ}, p͡c, ɓ͡ɟ, p͡c^{w}, ɓ͡ɟ^{w}, p͡c^{j}, ɓ͡ɟ^{j}, p͡c^{ʕ}, ɓ͡ɟ^{ʕ}, t̪, ^{n}t̪, d̪, ^{n}d̪, t̪^{h}, t̪’, d̪^{ɦ}, d̪̈, d̪̈, t̪^{w}, ^{n}t̪^{w}, d̪^{w}, ^{n}d̪^{w}, t̪^{wh}, t̪$^{w\text{'}}$, d̪^{wɦ}, d̪̈^{w}, d̪̈^{w}, t̪^{j}, ^{n}t̪^{j}, d̪^{j}, ^{n}d̪^{j}, t̪^{jh}, t̪$^{j\text{'}}$, d̪^{jɦ}, d̪̈^{j}, d̪̈^{j}, t̪^{ɣ}, ^{n}t̪^{ɣ}, d̪^{ɣ}, ^{n}d̪^{ɣ}, t̪$^{ɣ\text{'}}$, d̪^{ɣɦ}, d̪̈^{ɣ}, d̪̈^{ɣ}, t̪^{ʕ}, ^{n}t̪^{ʕ}, d̪^{ʕ}, ^{n}d̪^{ʕ}, t̪$^{ʕ\text{'}}$, d̪^{ʕɦ}, d̪̈^{ʕ}, d̪̈^{ʕ}, ɬp, ɗb, ɬp^{w}, ɗb^{w}, ɬk, ɠ, ɬk^{w}, ɠ^{w}, ʈ, ^{n}ʈ, ɖ, ^{n}ɖ, ʈ^{h}, ʈ’, ɖ^{ɦ}, ɖ̈, !, ʈ^{w}, ^{n}ʈ^{w}, ɖ^{w}, ^{n}ɖ^{w}, ʈ^{wh}, ʈ$^{w\text{'}}$, ɖ^{wɦ}, ɖ̈^{w}, ɖ̈^{w}, ʈ, ^{ɳ}ʈ, ɖ, ^{ɳ}ɖ, ʈ^{h}, ʈ’, ɖ^{ɦ}, ɖ̈, !, ʈ^{w}, ^{ɳ}ʈ^{w}, ɖ^{w}, ^{ɳ}ɖ^{w}, ʈ^{wh}, ʈ$^{w\text{'}}$, ɖ^{wɦ}, ɖ̈^{w}, ɖ̈^{w}, c, ^{ɲ}c, ɟ, ^{ɲ}ɟ, c^{h}, c’, ɟ^{ɦ}, ʃ, ʃ̈, k, ^{ŋ}k, g, ^{ŋ}g, k^{h}, k’, g^{ɦ}, g̈, ɠ, ɠ̈, kʘ, gʘ, kʘ^{h}, kʘ’, kʘ^{ʔ}, kǀ, gǀ, kǀ^{h}, kǀ’, kǀ^{ʔ}, k!, g!, k!^{h}, k!’, k!^{ʔ}, kǁ, gǁ, kǁ^{h}, kǁ’, kǁ^{ʔ}, kǂ, gǂ, kǂ^{h}, kǂ’, kǂ^{ʔ}, k^{w}, ^{ŋ}k^{w}, g^{w}, ^{ŋ}g^{w}, k^{wh}, k$^{w\text{'}}$, g^{wɦ}, g̈^{w}, ɠ^{w}, ɠ̈^{w}, k^{ʕ}, ^{ŋ}k^{ʕ}, g^{ʕ}, ^{ŋ}g^{ʕ}, k^{wʕ}, g^{wʕ}, ^{ŋ}g^{wʕ}, k$^{wʕ\text{'}}$, g^{wʕ}, ɠ^{wʕ}, ɠ̈^{wʕ}, k^{j}, ^{ŋ}k^{j}, g^{j}, ^{ŋ}g^{j}, k^{jh}, k$^{j\text{'}}$, g^{jɦ}, g̈^{j}, ɠ^{j}, ɠ̈^{j}, k^{ʕ}, ^{ŋ}k^{ʕ}, g^{ʕ}, ^{ŋ}g^{ʕ}, k^{ʕɦ}, g^{ʕɦ}, ɠ^{ʕ}, ɠ̈^{ʕ}, k͡p, $^{ŋ͡m}$k͡p, ^{ŋ}k͡p, g͡b, $^{ŋ͡m}$g͡b, ^{ŋ}g͡b, k͡p^{h}, k͡p’, g͡b^{ɦ}, g͡b̈, k͡p̈, k͡p^{w}, g͡b^{w}, q, ^{ɴ}q, ɢ, ^{ɴ}ɢ, q^{h}, q’, ɢ^{ɦ}, ɢ̈, ɠ, qʘ, ɢʘ, qʘ^{h}, qʘ’, qʘ^{ʔ}, qǀ, gǀ, qǀ^{h}, qǀ’, qǀ^{ʔ}, q!, g!, q!^{h}, q!’, q!^{ʔ}, qǁ, gǁ, qǁ^{h}, qǁ’, qǁ^{ʔ}, qǂ, gǂ, qǂ^{h}, qǂ’, qǂ^{ʔ}, q^{w}, ^{ɴ}q^{w}, ɢ^{w}, ^{ɴ}ɢ^{w}, q^{wh}, q$^{w\text{'}}$, ɢ^{wɦ}, ɢ̈^{w}, ɠ^{w}, ɠ̈^{w}, q͡p, q͡b, ʔ, ʔ^{w}, p^{f}, ^{m}p^{f}, b^{v}, ^{m}b^{v}, p^{fh}, p$^{f\text{'}}$, b^{vɦ}, b̪^{v}, t$^{\theta}$, ^{n}t$^{\theta}$, d^{ð}, ^{n}d^{ð}, t$^{\theta}$, t$^{\theta\text{'}}$, d^{ðɦ}, d̪^{ð}, t^{s}, ^{n}t^{s}, d^{z}, ^{n}d^{z}, t^{sh}, t$^{s\text{'}}$, d^{zɦ}, d̪^{z}, t^{ɬ}, ^{n}t^{ɬ}, d^{ɮ}, ^{n}d^{ɮ}, t^{ɬh}, t$^{ɬ\text{'}}$, d^{ɮɦ}, d̪^{ɮ}, t^{ɕ}, ^{n}t^{ɕ}, d^{ʑ}, ^{n}d^{ʑ}, t^{ɕh}, t$^{ɕ\text{'}}$,

dʑʱ, d̰ʑ, tɕʲ, ⁿtɕʲ, dʑʲ, ⁿdʑʲ, tɕʲʰ, tɕʲʼ, tʃ, ⁿtʃ, dʒ, ⁿdʒ, tʃʰ, tʃʼ, dʒʱ, d̰ʒ, cɕ, ᶮcɕ, ɟʝ, ⁿɟʝ, cɕʰ, ɟʝʱ, ɟ̰ʝ, cç, ᶮcç, ɟʝ, ⁿɟʝ, cçʰ, ɟʝʱ, ɟ̰ʝ, cʎ̥, ᶮcʎ̥, ɟʎ, ᶮɟʎ, cʎ̥ʰ, cʎ̥ʼ, ɟʎʱ, ɟ̰ʎ, kˣ, gˠ, kˣʰ, kˣʼ, kʘˣ, k|ˣ, k!ˣ, k‖ˣ, kǂˣ, kʟ̥, ᵑkʟ̥, gʟ, ᵑgʟ, kʟ̥ʰ, kʟ̥ʼ, gʟʱ, g̰ʟ, kʟ̥ʷ, ᵑkʟ̥ʷ, gʟʷ, ᵑgʟʷ, kʟ̥ʷʰ, kʟ̥ʷʼ, gʟʷʱ, g̰ʟʷ, ɸ, β, β̰, β͡ʒ, ɸ͡ç, β͡ʝ, ʙ, ʙ̥, f, v, ṽ, fʰ, fʼ, fʷ, vʷ, ṽʷ, fʷʰ, fʷʼ, fʲ, vʲ, ṽʲ, fʲʰ, fʲʼ, fˤ, vˤ, ṽˤ, fˤʼ, f͡s, f͡ʃ, θ̠, ð̠, ð̰̠, θ, ð, ð̰, θʰ, θʼ, ðˤ, s̠, z̠, z̠̰, s̠ʰ, s̠ʼ, ɬ̠, ɮ̠, ɮ̠̰, ɬ̠ʰ, ɬ̠ʼ, s, ⁿs, z, ⁿz, z̰, sʰ, sʼ, sʷ, zʷ, sʲ, zʲ, sˤ, zˤ, s̪, z̪, z̪̰, s̪ʰ, s̪ʼ, ɬ, ɮ, ɮ̰, ɬʰ, ɬʼ, ɬˤ, ɮˤ, ɬˤʼ, ɹ̝̊, ɹ̝, ɕ, ʑ, ʑ̰, ɕʰ, ɕʼ, ʃ, ʒ, ʒ̰, ʃʰ, ʃ, ʃʷ, ʒʷ, ʒ̰ʷ, ʃʷʰ, ʃʷʼ, ʃʲ, ʒʲ, ʒ̰ʲ, ʃʲʰ, ʃʲʼ, ʃˤ, ʒˤ, ʒ̰ˤ, ʃˤʼ, ʂ, ʐ, ʐ̰, ʂʰ, ʂʼ, ç, ʝ, ʝ̰, çʰ, çʼ, ɧ, ʟ̝̊, ʟ̝, x, ɣ, ɣ̰, xʰ, xʼ, xʷ, ɣʷ, ɣ̰ʷ, xʷʰ, xʷʼ, xʲ, ɣʲ, ɣ̰ʲ, xʲʰ, xʲʼ, χ, ʁ̝, ʁ̝̰, χʰ, χʼ, χʷ, ʁ̝ʷ, ʁ̝̰ʷ, χʷʰ, χʷʼ, ħ, ʕ, ʕʼ, ħʷ, ʕʷ, ʕʷʼ, ʜ, ʢ, ʜʷ, ʢʷ, m, m̥, m̰, mʷ, m̥ʷ, m̰ʷ, mˠ, mʲ, mˠ, mˤ, n̪, n̪̊, n̪̰, n̪̰, n̪̊, n̪̰, n̪ʷ, n̪̊ʷ, n̪̰ʷ, n, n̥, n̰, nʷ, n̥ʷ, n̰ʷ, nʲ, nˠ, nˤ, n͡m, n͡mʷ, n̻, n̻̊, n̻̰, n̻ʷ, n̻̊ʷ, n̰ʷ, ɳ, ɳ̊, ɳ̰, ɳʷ, ɳ̊ʷ, ɳ̰ʷ, ɳ͡m, ɳ͡mʷ, ɲ, ɲ̊, ɲ̰, ŋ, ŋ̊, ŋ̰, ŋʘ, ŋ̊ʘ, ˀŋʘ, ŋ̊ʘʰ, ŋ|, ŋ̊|, ˀŋ|, ŋ̊|ʰ, ŋ!, ŋ̊!, ˀŋ!, ŋ̊!ʰ, ŋ‖, ŋ̊‖, ˀŋ‖, ŋ̊‖ʰ, ŋǂ, ŋ̊ǂ, ˀŋǂ, ŋ̊ǂʰ, ŋʷ, ŋ̊ʷ, ŋ̰ʷ, ŋʲ, ŋˤ, ŋ͡m, ŋ͡mʷ, ɴ, ɴ̥, ɴ̰, ɴʷ, ɴ̥ʷ, ɴ̰ʷ, l̪ˑ, ɬ̪ˑ, l̪̊ˑ, ɬ̪ˑ, l̪ˑʷ, ɬ̪ˑʷ, l̪̊ˑʷ, l̪̰ˑʷ, l̪ˑˠ, l, ɬ, l̥, l̰, lʷ, ɬʷ, l̥ʷ, l̰ʷ, lʲ, ɬʲ, l̥ʲ, l̰ʲ, lˤ, l̻, ɬ̻, ɬ̻, l̰, l̻ʷ, ɬ̻ʷ, ɬ̠ʷ, l̰ʷ, ɭ, ɭ̊, ɭ̊, ɭ̰, ɭʷ, ɭ̊ʷ, ɭ̊ʷ, ɭ̰ʷ, ʎ, ʎ̝̊, ʎ̥, ʎ̰, ɫ, ɫ̥, ɫ̰, ɫʷ, ɫ̊ʷ, ɫ̥ʷ, ɫ̰ʷ, ʟ, ʟ̝̊, ʟ̥, ʟ̰, ʟʷ, ʟ̝̊ʷ, ʟ̥ʷ, ʟ̰ʷ, ɺ, ɺʷ, r, r̃, rʷ, rʲ, rˠ, rˤ, ɾ, ɾ̃, ɾʷ, ɾʲ, ɾˠ, ɾˤ, ɹ, ɹʷ, r̪, r̪ʷ, ɽ, ɽʱ, ɽʷ, ɻ, ɻʷ, ʀ, ʀʷ, ʁ, ʁʷ, ʋ, ʋ̃, ʋ̥, ʋ̰, ʋ̆, j, j̃, j̊, j̰, jʷ, j̃ʷ, j̊ʷ, j̰ʷ, jˤ, ɥ, ɥ̃, ɥ̊, ɥ̰, w, w̃, ʍ, w̰, wˤ, w̆, ɰ, ɰ̃, ɰ̊, ɰ̰, ɰʷ, ɰ̃ʷ, ɰ̊ʷ, ɰ̰ʷ, h, hʷ, hʲ, hˤ, ħ, ħʷ, ħʲ, ħˤ, ɦ, ɦʷ, ɦʲ, ɦˤ, ʔ, ʔʷ, ʔʲ, ʔˤ, i, ĩ, i̥, ḭ, y, ỹ, ẙ, y̰, ɨ, ɨ̃, ɨ̥, ɨ̰, ʉ, ʉ̃, ʉ̥, ʉ̰, ɯ, ɯ̃, ɯ̥, ɯ̰, u, ũ, u̥, ṵ, ɪ, ɪ̃, ɪ̥, ɪ̰, ʏ, ʏ̃, ʏ̥, ʏ̰, ʊ, ʊ̃, ʊ̥, ʊ̰, e, ẽ, e̥, ḛ, ø, ø̃, ø̥, ø̰, ɘ, ɘ̃, ɘ̥, ɘ̰, ɵ, ɵ̃, ɵ̥, ɵ̰, ɤ, ɤ̃, ɤ̥, ɤ̰, o, õ, o̥, o̰, ə, ɛ, ɛ̃, ɛ̥, ɛ̰, œ, œ̃, œ̥, œ̰, ɜ, ɜ̃, ɜ̥, ɜ̰, ɞ, ɞ̃, ɞ̥, ɞ̰, ʌ, ʌ̃, ʌ̥, ʌ̰, ɔ, ɔ̃, ɔ̥, ɔ̰, æ, æ̃, æ̥, æ̰, ɐ, ɐ̃, ɐ̥, ɐ̰, a, ã, ḁ, a̰, ɶ, ɶ̃, ɶ̥, ɶ̰, ɑ, ɑ̃, ɑ̥, ɑ̰, ɒ, ɒ̃, ɒ̥, ɒ̰, 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 on the next page. These features are mostly drawn from Chomsky and Halle's (1968) monumental *The Sound Pattern of English*, whose articulatory features were developed on the basis of the earlier auditory-acoustic distinctive feature theory of Jakobson, Fant and Halle (1952).

(7)

Features	*Articulator*	
[±consonantal] [±sonorant] [±lateral] [±strident] [±continuant]	n/a	*Cavity*
[labial] [±round]	Lips	Oral
[coronal] [±anterior] [±distributed]	Tongue Blade	
[dorsal] [±high] [±low] [±back]	Tongue Body	
[±nasal]	Soft Palate	Nasal
[radical] [±ATR]	Tongue Root	Guttural
[glottal] [±voice] [±spread glottis] [±constricted glottis]	Larynx	

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 **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.

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).[7]

[7] 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).

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. 37ff— "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).

(8) [+consonantal]

a. **Stops**, e.g., p, ᵐp, b, ᵐb, pʰ, p', bʱ, b̪, ɓ, ɓ̪, pʷ, ᵐpʷ, bʷ, ᵐbʷ, pʷʰ, pʷ', bʷʱ, b̪ʷ, ɓʷ, ɓ̪ʷ, pʲ, ᵐpʲ, bʲ, ᵐbʲ, pʲʰ, pʲ', bʲʱ, b̪ʲ, ɓʲ, ɓ̪ʲ, pˠ, ᵐpˠ, bˠ, ᵐbˠ, pˠ', bˠʱ, b̪ˠ, ɓˠ, ɓ̪ˠ, ᵐpˢ, bˢ, ᵐbˢ, pˢ', bˢʱ, b̪ˢ, ɓˢ, ɓ̪ˢ, p̪t̪, b̪d̪, p̪t̪ʷ, b̪d̪ʷ, p̪t̪ʲ, b̪d̪ʲ, p̪t̪ˢ, b̪d̪ˢ, p̪c̪, b̪ɟ, p̪c̪ʷ, b̪ɟʷ, p̪c̪ʲ, b̪ɟʲ, p̪c̪ˢ, b̪ɟˢ, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪', d̪ʱ, d̪, d̪̊, t̪ʷ, ⁿt̪ʷ, d̪ʷ, ⁿd̪ʷ, t̪ʷʰ, t̪ʷ', d̪ʷʱ, d̪ʷ, d̪̊ʷ, t̪ʲ, ⁿt̪ʲ, d̪ʲ, ⁿd̪ʲ, t̪ʲʰ, t̪ʲ', d̪ʲʱ, d̪ʲ, d̪̊ʲ, t̪ˠ, ⁿt̪ˠ, d̪ˠ, ⁿd̪ˠ, t̪ˠʰ, t̪ˠ', d̪ˠʱ, d̪ˠ, d̪̊ˠ, t̪ˢ, ⁿt̪ˢ, d̪ˢ, ⁿd̪ˢ, t̪ˢʰ, t̪ˢ', d̪ˢʱ, d̪ˢ, d̪̊ˢ, ùp, èb, ùpʷ, èbʷ, ùk, èg, ùkʷ, ègʷ, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪', d̪ʱ, d̪, d̪̊, t̪ʷ, ⁿt̪ʷ, d̪ʷ, ⁿd̪ʷ, t̪ʷʰ, t̪ʷ', d̪ʷʱ, d̪ʷ, d̪̊ʷ, ʈ, ⁿʈ, ɖ, ⁿɖ, ʈʰ, ʈ', ɖʱ, ɖ, !, ʈʷ, ⁿʈʷ, ɖʷ, ⁿɖʷ, ʈʷʰ, ʈʷ', ɖʷʱ, ɖʷ, c͡p, ɟ͡b, c͡pʷ, ɟ͡bʷ, c, ᶮc, ɟ, ᶮɟ, cʰ, c', ɟʱ, ʃ, ʃ̬, k, ᵑk, g, ᵑg, kʰ, k', gʱ, g, ɠ, ɠ̬, kʘ, gʘ, kʘʰ, kʘ', kʘˀ, kl, gl, klʰ, kl', klˀ, k!, g!, k!ʰ, k!', k!ˀ, kǁ, gǁ, kǁʰ, kǁ', kǁˀ, kǂ, gǂ, kǂʰ, kǂ', kǂˀ, kʷ, ᵑkʷ, gʷ, ᵑgʷ, kʷʰ, kʷ', gʷʱ, gʷ, ɠʷ, ɠ̬ʷ, kʷˢ, ᵑkʷˢ, gʷˢ, ᵑgʷˢ, kʷˢ', gʷˢ, ɠʷˢ, ɠ̬ʷˢ, kʲ, ᵑkʲ, gʲ, ᵑgʲ, kʲʰ, kʲ', gʲʱ, gʲ, ɠʲ, ɠ̬ʲ, kˢ, ᵑkˢ, gˢ, ᵑgˢ, kˢ', gˢʱ, gˢ, ɠˢ, ɠ̬ˢ, k͡p, ᶮᵐk͡p, ᵑk͡p, g͡b, ᶮᵐg͡b, ᵑg͡b, k͡pʰ, k͡p', g͡bʱ, g͡b, k͡ʙ, k͡pʷ, g͡bʷ, q, ᶯq, ɢ, ᶯɢ, qʰ, q', ɢʱ, ɢ̬, ɠ, qʘ, ɢʘ, qʘʰ, qʘ', qʘˀ, ql, ɢl, qlʰ, ql', qlˀ, q!, ɢ!, q!ʰ, q!', q!ˀ, qǁ, ɢǁ, qǁʰ, qǁ', qǁˀ, qǂ, ɢǂ, qǂʰ, qǂ', qǂˀ, qʷ, ᶯqʷ, ɢʷ, ᶯɢʷ, qʷʰ, qʷ', ɢʷʱ, ɢ̬ʷ, ɠʷ, q͡p, q͡b, ʔ, ʔʷ, etc.

b. **Affricates**, e.g., pᶠ, ᵐpᶠ, bᵛ, ᵐbᵛ, pᶠʰ, pᶠ', bᵛʱ, b̪ᵛ, tᶿ, ⁿtᶿ, dᶞ, ⁿdᶞ, tᶿ, tᶿ', dᶞʱ, d̪ᶞ, tˢ, ⁿtˢ, dᶻ, ⁿdᶻ, tˢʰ, tˢ', dᶻʱ, d̪ᶻ, tɬ, ⁿtɬ, dɮ, ⁿdɮ, tɬʰ, tɬ', dɮʱ, d̪ɮ, tɕ, ⁿtɕ, dʑ, ⁿdʑ, tɕʰ, tɕ', dʑʱ, d̪ʑ, tɕʲ, ⁿtɕʲ, dʑʲ, ⁿdʑʲ, tɕʲʰ, tɕʲ', dʑʲʱ, d̪ʑʲ, tʃ, ⁿtʃ, dʒ, ⁿdʒ, tʃʰ, tʃ', dʒʱ, d̪ʒ, cᶜ, ᶮcᶜ, dʝ, ⁿdʝ, cᶜʰ, dʝʱ, d̪ʝ, cᶜ, ᶮcᶜ, ɟʲ, ⁿɟʲ, cᶜʰ, ɟʲʱ, ɟʲ, cᶍ, ᶮcᶍ, ɟˠ, ᶮɟˠ, cᶍʰ, cᶍ', ɟˠʱ, ɟˠ, kˣ, gˠ, kˣʰ, kˣ', kʘˣ, klˣ, k!ˣ, kǁˣ, kǂˣ, kᵡ, ᵑkᵡ, gᵡ, ᵑgᵡ, kᵡʰ, kᵡ', gᵡʱ, gᵡ, kᵡʷ, ᵑkᵡʷ, gᵡʷ, ᵑgᵡʷ, kᵡʷʰ, kᵡʷ', gᵡʷʱ, gᵡʷ, etc.

c. **Fricatives**, e.g., ɸ, β, β̞, βʒ, ɸɕ, βʝ, ʙ, ʙ̥, f, v, ṽ, fʰ, f', fʷ, vʷ, ṽʷ, fʷʰ, fʷ', fʲ, vʲ, ṽʲ, fʲʰ, fʲ', fˠ, vˠ, ṽˠ, fˠ', fs, fʃ, θ̪, ð̪, ð̪̊, θ, ð, ð̥, θʰ, θ', ðˢ, s̪, z̪, z̪̊, s̪ʰ, s̪', ɬ, ɮ, ɮ̬, ɬʰ, ɬ', ɬˢ, ɮˢ', ʂ̬, ɻ, ɕ, ʑ, ʑ̊, ɕʰ, ɕ', ʃ, ʒ, ʒ̊, ʃʰ, ʃ', ʃʷ, ʒʷ, ʒ̊ʷ, ʃʷʰ, ʃʷ', ʃʲ, ʒʲ, ʒ̊ʲ, ʃʲʰ, ʃʲ', ʃˢ, ʒˢ, ʒ̊ˢ, ʃˢ', ʂ, ʐ, ʐ̊, ʂʰ, ʂ', ç, ʝ, ɧ, ɻ̊, ɻ, x, ɣ, ɣ̊, xʰ, x', xʷ, ɣʷ, ɣ̊ʷ, xʷʰ, xʷ', xʲ, ɣʲ, ɣ̊ʲ, xʲʰ, xʲ', χ, ʁ, ʁ̥, χʰ, χ', χʷ, ʁʷ, ʁ̥ʷ, χʷʰ, χʷ', etc.

d. **Nasals**, e.g, m, m̥, m̰, mʷ, m̥ʷ, m̰ʷ, mˠ, mʲ, mˠ, mˢ, n̪, n̪̊, n̰, n̪, n̪̊, n̰, nʷ, n̥ʷ, n̰ʷ, nʲ, nˠ, nˢ, òm, òmʷ, ɳ, ɳ̊, ɳ̰, ɳʷ, ɳ̊ʷ, ɳ̰ʷ, ɳ, ɳ̊, ɳ̰, ɳʷ, ɳ̊ʷ, ɳ̰ʷ, ɲ, ɲ̊, ɲ̰, ŋ, ŋ̊, ŋ̰, ŋʘ, ŋ̊ʘ, ˀŋʘ, ŋ̊ʘʰ, ŋǀ, ŋ̊ǀ, ˀŋǀ, ŋ̊ǀʰ, ŋǃ, ŋ̊ǃ, ˀŋǃ, ŋ̊ǃʰ, ŋǁ, ŋ̊ǁ, ˀŋǁ, ŋ̊ǁʰ, ŋǂ, ŋ̊ǂ, ˀŋǂ, ŋ̊ǂʰ, ŋʷ, ŋ̊ʷ, ŋ̰ʷ, ŋʲ, ŋˠ, ŋ͡m, ŋ͡mʷ, ɴ, ɴ̥, ɴ̰, ɴʷ, ɴ̥ʷ, ɴ̰ʷ, etc.

e. **Liquids**, e.g, l̪, l̪̊, l̰, l̪̊, l̪ʷ, l̪̊ʷ, l̰ʷ, l̪ʷ, l̰ˠ, l, l̥, l̰, l̥, lʷ, l̥ʷ, l̰ʷ, l̥ʲ, l̰ʲ, l̥ʲ, lˠ, l̰ˠ, l̥ˠ, l̰ˠ, l̥ʷ, l̰ʷ, ɭ̥ʷ, ɭ̰ʷ, ɭ, ɭ̥, ɭ̰, ɭ̥, ɭʷ, ɭ̥ʷ, ɭ̰ʷ, ʎ, ʎ̥, ʎ̰, ʎ̥, ɬ, ɬ̥, ɮ̥, ɬ̥ʷ, ɮ̥ʷ, ɬ̥ʷ, ɮ̥ʷ, ʟ, ʟ̃, ʟ̥, ʟ̰, ʟʷ, ʟ̃ʷ, ʟ̥ʷ, ʟ̰ʷ, ɻ, ɻʷ, r, r̃, rʷ, rʲ, rˠ, rˢ, ɾ, ɾ̃, ɾʷ, ɾʲ, ɾˠ, ɾˢ, ɹ, ɹʷ, ɾ̥, ɾ̥ʷ, ɽ, ɽʷ, ʀ, ʀʷ, 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.

(9) [–consonantal]

a. **Vowels**, e.g., i, ĩ, i̯, ĩ̯, y, ỹ, y̯, ỹ̯, ɨ, ɨ̃, ɨ̯, ɨ̯̃, ʉ, ʉ̃, ʉ̯, ʉ̯̃, u, ũ, u̯, ũ̯, ɪ, ɪ̃, ɪ̯, ɪ̯̃, ʏ, ʏ̃, ʏ̯, ʏ̯̃, ʊ, ʊ̃, ʊ̯, ʊ̯̃, e, ẽ, e̯, ẽ̯, ø, ø̃, ø̯, ø̯̃, ɘ, ɘ̃, ɘ̯, ɘ̯̃, ɵ, ɵ̃, ɵ̯, ɵ̯̃, ɤ, ɤ̃, ɤ̯, ɤ̯̃, o, õ, o̯, õ̯, ə, ɛ, ɛ̃, ɛ̯, ɛ̯̃, œ, œ̃, œ̯, œ̯̃, ɜ, ɜ̃, ɜ̯, ɜ̯̃, ɞ, ɞ̃, ɞ̯, ɞ̯̃, ʌ, ʌ̃, ʌ̯, ʌ̯̃, ɔ, ɔ̃, ɔ̯, ɔ̯̃, æ, æ̃, æ̯, æ̯̃, ɐ, ɐ̃, ɐ̯, ɐ̯̃, a, ã, a̯, ã̯, ɶ, ɶ̃, ɶ̯, ɶ̯̃, ɑ, ɑ̃, ɑ̯, ɑ̯̃, ɒ, ɒ̃, ɒ̯, ɒ̯̃, etc.

b. **Semivowels**, e.g., ʊ, ʊ̃, ʊ̯, ʊ̯̃, ʊ̆, j, j̃, j̊, j̯, jʷ, j̃ʷ, j̊ʷ, j̯ʷ, jˤ, ɥ, ɥ̃, ɥ̊, ɥ̯, w, w̃, ʍ, ʍ̯, wˤ, w̆, ɯ, ɯ̃, ɯ̊, ɯ̯, ɯʷ, ɯ̃ʷ, ɯ̊ʷ, ɯ̯ʷ, etc.

c. **Glottals**, e.g., h, hʷ, hʲ, hˤ, ɦ, ɦʷ, ɦʲ, ɦˤ, 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[8]

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:

(10) *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’
	[tɥe][9]	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!

[8] 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 below.

[9] [ɥ] is the symbol used for [y] in non-nuclear position, in parallel with [w] for [u], and [j] for [i].

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 (11), from the Halland dialect of Swedish (Kaisse 1992, Hume & Odden 1996). Observe that the uvular consonant /ʁ/, which is either word-final[10] or prevocalic[11] in the first column, corresponds to [ɑ̯] elsewhere in the second column.[12] 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. 49ff— 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).

(11) *Halland Swedish*

a.	toʁ	'dry'	toɑ̯-t	'dry'
b.	toʁ-a	'dry (sg???)'	toɑ̯-k	'dry (pl.)'
c.	fœʁ-ø:da	'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.

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

Northern	*Southern*		*Northern*	*Southern*	
baɲu	bãju	'bath'	veʎa	veja	'old (f.)'
soɲu	sõju	'dream'	paʎa	paja	'straw'
viɲu	vĩju	'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 1990), as does Persian (Hayes 1986).[13] To illustrate the latter, compare the following word pairs:[14]

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

(13) 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[15] 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*, [bɑɾʊ] *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.

(14) *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”

---

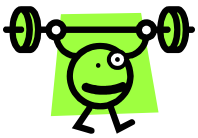
gaːv ‘bull’, *hiːvdæh* ‘seventeen’, nor after consonants, e.g. *særv* ‘cypress’, *dʒozv* ‘except’. As Hayes (1986) remarks, such data make clear that it is *v* which changes to *w*, not the other way around.

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

[15] 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 (15b). By contrast, the nasal does not agree in place of articulation with a following [–consonantal] vowel or glide (15c). However, a glide which undergoes fortition does trigger nasal place assimilation, as shown in (15d). This suggests that strengthened glides are [+consonantal].

(15) *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][16]	'a piece of ice'

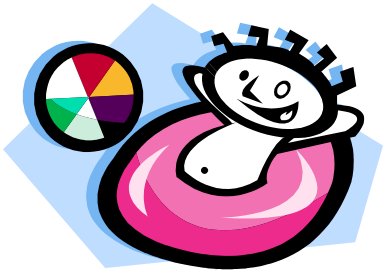
Exercise: Relying on our discussion so far, try to give a simple explanation for the different pronunciations of Malay words in the Standard dialect versus the Kelantan dialect (Trigo 1991, Halle 1995).

Standard	*Kelantan*	
ʔasap	ʔasaʔ	'smoke'
kilat	kilaʔ	'lightning'

[16] The fricative [ʒ] is also regularly strengthened to [dʒ] after nasal stops, i.e. the end result would be: [uɲ dʒelo].

masaʔ	masɒʔ	‘cook’
balas	balah	‘finish’
negatef	negatɨh	‘negative’
ʔalem	ʔalɨN	‘pious’
sabon	saboN	‘soap’
dukoŋ	dukoN	‘carry’
batal	bata:	‘cancel’
jujo:	jujo:	‘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.[17] 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 (16a). 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 (16b). 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[18]: *[lə ɔm], *[le ɔm], *[la ide], *[le ide], etc.[19] Now consider the behaviour of *h*-aspiré words, illustrated in (16c): 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.

(16)

	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’

[17] 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.”
[18] The technical term for adjacent vowels (e.g., English [keɑs] ‘chaos’) is *hiatus*.
[19] The asterisk here means “ungrammatical”.

	l ɛʁɔin	lez ɛʁɔin	‘heroine’
c.	lə ɛʁo	le ɛʁo	‘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 (17a), 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 (17b): 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 [ɛʁɔin] ‘heroine’ (*[ma ɛʁɔin]). 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 ɛʁɔin]. Turning now to (17c), observe how the “*h*-aspiré” forms do not trigger this gender shift, thus displaying the behaviour of consonant-initial words.

(17)	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 ɛʁɔin	‘my (MASC.) heroine (FEM.)’
	c.	vjø ɛʁo	‘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 (18). 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.

(18)	*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 (19). 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.

(19)	*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**ɨ**n-**e**k	s**ɨ**n-k-a	'son'
	sz**ɨ**nk		'pub'
f.	bar**e**k		'bar'
	bark		'shoulder'
g.		par**e**k	'couple'
		park	'park'
h.		sz**ɨ**n**e**k	'ham'
		sz**ɨ**nk	'pub'

To account for contrasts like those in (18-19), yers are often considered "empty" vowels that are variably vocalised. In particular, Bethin (1998) treats each yer as a "floating" [–conson-

antal] which is realised as the "default" vowel [e] under certain (syllable-defined) conditions,[20] but otherwise remains unfilled.

2.2.1.2. [±sonorant]

2.2.1.2.1. Introduction

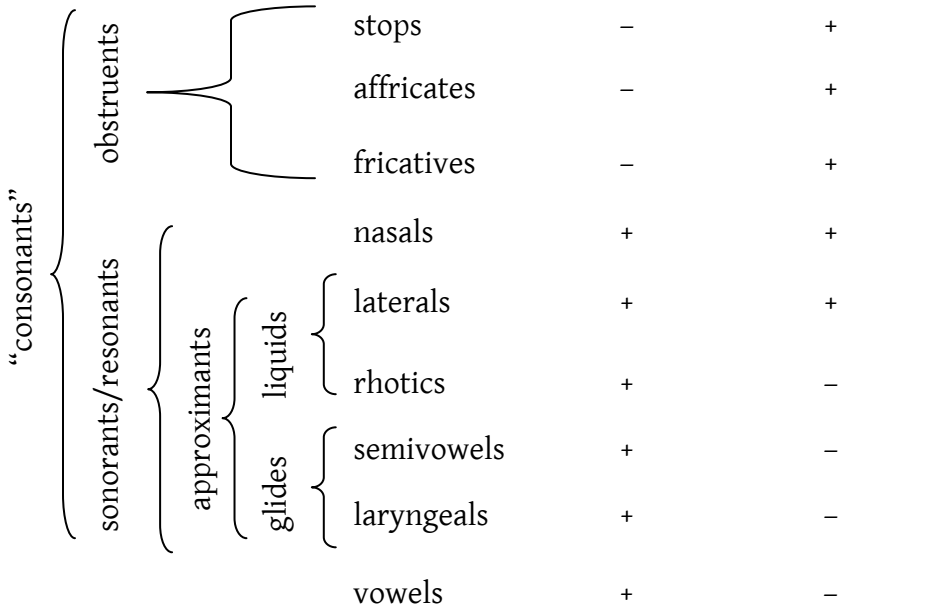
I'm aluminumin' 'um, Mum!
Which wrist watches are Swiss wrist watches?

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 (20).

(20) *Segments by major class features*



	[sonorant]	[consonantal]
stops	–	+
affricates	–	+
fricatives	–	+
nasals	+	+
laterals	+	+
rhotics	+	–
semivowels	+	–
laryngeals	+	–
vowels	+	–

[20] 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 studies of many languages, e.g. Nuxalk (Nater 1984:6), Dakota (Shaw 1980:26-7), Odawa (Piggott 1980), Yowlumne (Archangeli 1988), Athapaskan in general (Rice 1995[21]), 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').

(21) [–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:

(22)

		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:

(23) *Sonorant glottalisation in Oowekyala plural forms*

	singular	*plural*	
a.	mam	mim'am	'blanket, bedding, bedcover'
b.	nusa	nin'usa	'to tell stories, legends, myths'

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

c.	lanca	lil'anca	'to go underwater'
d.	wi:kʷ	wiw'i:kʷ	'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 (22) above).

(24) *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:

(25) *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).

By contrast, Durand (1990) argues that /h/ is [–sonorant] in Malay (see also Fallon 2002:192). The argument runs as follows. First, nasals assimilate in place to a following consonant. For example, the velar nasal of /məŋ-/, shown in (26a), becomes labial [m] before [b] (26b), alveolar [n] before [t] (26c), and alveolopalatal [ɲ] before [tʃ] (26d).

(26)

a.	/məŋ-adʒar/	[məŋadʒa]	'to teach (active)'
b.	/məŋ-baja/	[məmbaja]	'to pay (active)'
c.	/məŋ-daki/	[məndaki]	'to climb (active)'
d.	/məŋ-tʃatu/	[mə̃ɲtʃatu]	'to ration (active)'

Second, any voiceless obstruent other than /tʃ/ deletes following a nasal, as shown in (27).

(27)

a.	/məŋ-pukul/	[məmũkol]	'to beat (active)'
b.	/məŋ-tulis/	[mənũles]	'to write (active)'
c.	/məŋ-kawal/	[məŋãwal]	'to guard (active)'
d.	/məŋ-salin/	[məɲalen]	'to copy (active)'
e.	/məŋ-hakis/	[məŋakes]	'to erode (active)'

Crucially, /h/ appears to pattern with voiceless obstruents in this regard, i.e., it deletes after /ŋ/, as shown here:

(28) /məŋ-hakis/ [məŋakes] ‘to erode (active)’

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].

(29) *Hausa* (Hume & Odden 1995)

a.	/dʒibdʒi:/	dʒuwdʒi:	‘trash heap’	cf.	dʒiba:dʒe:	‘pl.’
b.	/tafʃi:/	tawʃi:	‘drum’	cf.	tafa:ʃe:	‘pl.’
c.	/talaktʃi/	talawtʃi	‘poverty’	cf.	talaka	‘a poor one’
d.	/hagni/	hawni	‘left side’	cf.	bahago	‘lefthanded one’
e.	/fatke/	farke	‘merchant’	cf.	fata:ke	‘pl.’
f.	/maz-maza/	marmaza	‘very fast’			
g.	/k’as-k’as-i:/	k’ark’asi:	‘underside’			

2.2.1.2.3. Russian labial fricatives

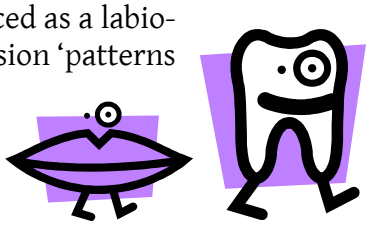
Modern Russian (Gussmann 2002) has a well-known restriction whereby obstruents ([–sonorant]) must be voiceless in syllable-final position (30a-d), unless they are followed by a voiced obstruent, in which case both obstruents are obligatorily voiced (30e-i). Note that the labial fricatives /v, vʲ/ behave like ordinary obstruents in this regard, as shown in (30c, g, h, i).

(30)

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 (31a-c). What is surprising is that /v, vʲ/ pattern with sonorants in this regard: they fail to induce voicing in preceding obstruents, as shown (31d-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.”



(31)

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] [vʲ]ina	‘the taste of wine’
f.	svi[st] [vʲ]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: [±lateral], [±strident] 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):

(32) *Words illustrating different coronal laterals in Kaititj*

laminal dental		*apical alveolar*		*apical post-alveolar*		*laminal post-alveolar*	
l̪inp	'armpit'	lubiɹ	'thigh'	l̻a̻iŋk	'hit'	l̪ukuŋk	'to light'
a̪l̪uŋ	'burrow'	aluŋk	'chase'	a̻l̻at	'sacred board'	a̪l̪ilk	'smooth'
alba̪l̪	'smoke'	irmal	'fire saw'	aldima̻l̻	'west'	kura̪l̪	'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.[22] For instance, languages have been reported in West Africa (e.g., Kotoko) and in Papua New Guinea (e.g., Melpa) in which 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:

(33) *Words illustrating laterals in Mid-Waghi*

Laminal dental	*Apical alveolar*	*(Dorsal) Velar*
a̪l̪a a̪l̪a	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 that the phoneme inventory of Chipewyan (Athapaskan), for instance, includes the lateral sonorant /l/ as well as the lateral obstruents /tˡ, tˡʰ, tˡʾ, ɬ/. Similarly, the phoneme inventory of Oowekyala (Wakashan) has the lateral sonorants /l, l'/ as well as the lateral obstruents /tˡ, dˡ, tˡʾ, ɬ/.[23] These laterals are illustrated in the following words:

(34) *Some words with laterals in Oowekyala (Howe 2000)*

Voiceless lateral affricate	tˡamu	'ocean perch, shiner'
Voiced lateral affricate	dˡa:	'to wedge, to split with a wedge'
Ejective lateral affricate	tˡʾa:	'black bear'
Voiceless lateral fricative	ɬaɢis	'a tent'
Voiced lateral sonorant	lasa	'to plant'
Glottalised lateral sonorant	l'apa	'to spread apart with the thumbs'

[22] 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).

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

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

(35) *Lateral velar obstruents in Archi*

Voiceless prevelar fricative	ɻ̊ob	'sheath'
Labialised voiceless prevelar fricative	ɻ̊ʷalli	'large ravine'
Voiced prevelar fricative	naɻdor	'home'
Voiceless prevelar affricate	kʲ̊an	'hole'
Labialised voiceless prevelar affricate	kʲ̊ʷijtʼu	'seventeen'
Prevelar ejective affricate	kʲ̊ʼal	'lamb'
Labialised prevelar ejective affricate	kʲ̊ʷʼas	'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:

(36)	*Standard Italian*	*Florentine Italian*	
a.	[dolʧe]	[doɾʧe]	'sweet, dessert'
b.	[sɔldi]	[sɔɾdi]	'money'
c.	[palkoʃɛniko]	[paɾkoʃɛniko]	'stage'

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

(37)	*Standard Castillian*	*Andalusian*	
a.	[e.lo.so]	[e.lo.so]	'the bear'
b.	[el.θo]	[eɾ.θo]	'the zoo'
c.	[al.baː.ka]	[aɾ.baː.ka]	'basil'
d.	[pul.po]	[puɾ.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?

(38)				
	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 /tˢ/ and /tˢ'/ are changed to /tˡ/ and /tˡ'/, respectively. For example, *ʔa:ʔaniʔaksajikqatˢsa* 'I believe that I will' is pronounced [ʔa:ʔaniʔakɬajikqatˡɬa], *qʷaja:tˢ'i:k* 'wolf' is pronounced [qʷaja:tˡ'i:k], *ʕatˢ'iɬa* 'persisting' is pronounced [ʕatˡ'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 /tˡ/ is found in some dialects of Totonac, such as that spoken in Xicotepec Juárez. But in Mizantla Totonac, /tˡ/ has changed to /t/. This can be seen by comparing cognates (MacKay 1994:376, n. 8):

(39) *Totonac*

Xicotepec Juárez	*Mizantla*	
pu:tˡ̰eqé	pú:taqɛ̌	's/he counts'
pa̰tˡ̰anan	pa̰tá̰n	's/he vomits'
tˡ̰a̰:wan	taná:nán	's/he walks'
qa̰tˡ̰a	qá̰t	'big'
tˡ̰a̰ma̰nk	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].[24] 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 above), these are carefully distinguished from [–strident] phonemes such as /θ, ð, tᶿ, dᶞ/.

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 (Ladefoged & Maddieson 1996:139).

[24] Chomsky and Halle (1968:329): "Strident sounds are marked acoustically by greater noisiness than their non-strident counterparts. ... Stridency is a feature restricted to obstruent continuants and affricates."

(40) *Ewe*

éɸá	'he polished'	éfá	'he was cold'
èβè	'the Ewe language'	èvè	'two'
éɸlè	'he bought'	éflɛ̃	'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, /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, tʃ, ʒ, dʒ/, 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.[25]

A strong argument for the autonomous status of the feature [+strident] is provided by the diminutive morpheme ("small, little") in Plains Cree (Algonquian; Hirose 1997). As illustrated in (41), the primary distinction of diminutives is that "plain" /t/'s become [+strident] affricates [tˢ]. In some cases, the diminutive is also signaled by a suffix, e.g. -(i)s in (41a,b) or -(i)sis in (41c,d). But as shown in (41e,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 be represented just by the feature [+strident], independently of any phoneme.

(41) *Diminutive formation in Plains Cree*

	Non-diminutives		*Diminutives*	
a.	atoske-w	's/he works'	atˢoske-s-iw	's/he works a little'
	work-3		work-DIM-3	
b.	astotin	'a/the hat'	astˢotˢin-is	'a little hat'
	hat		hat-DIM	
c.	atim	'dog'	atˢimo-sis	'a/the little dog'
	dog		dog-DIM	
d.	ni-tem	'my horse'	ni-tˢem-isis	'my little horse'
	1-horse		1-horse-DIM	
e.	jot-in	'it is windy'	jotˢ-in	'it is a little windy'
	windy-0		windy-DIM-0	
f.	wat	'a/the hole'	watˢ-a	'(the) little holes'
	hole		hole-DIM-PL	

[25] 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.

As another example of [+strident] being added to phonemes, consider the historical development in German of [+strident] affricates from [–strident] stops.[26] This can be demonstrated by a comparison with English (Picard 1999:71):

(42)	English	*pool*	*tongue*	*cow*
	German	*Pfuhl*	*Zunge*	*Kxū* (Swiss)
		[p^f]	[t^s]	[k^x]

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^x] involves a shift from velar to uvular.[27]

Exercises

A. Describe as simply as possible the unusual phonological pattern in the speech of a young girl, as studied by Caramata & Gandour (1984). [Note: this pattern is abnormal.]

(43) *Disordered speech*

a.	bi	'bee'	m.	bɑ	'ball'
b.	us	'shoes'	n.	ɪŋks	'sink'
c.	ʌts	'shirt'	o.	ajf	'five'
d.	di	'tea'	p.	ops	'soap'
e.	ips	'sheep'	q.	kus	'school'
f.	go	'goat'	r.	gæ	'kite'
g.	ajnf	'fine'	s.	neks	'snake'
h.	du	'two'	t.	af	'fall'
i.	ɪŋgəs	'finger'	u.	dains	'shines'
j.	bə	'bus'	v.	bu	'boat, book'
k.	aks	'forks'	w.	us	'shoe'
l.	as	'saw'	x.	bæ	'bath'

B. Labialised consonants are illustrated below in the West African language Kutep. (In these data, [ɕ] is a dorsal-coronal fricative, [ʑ] its voiced counterpart, and [$t^ɕ$], its affricate counterpart; accents on vowels are tones, which may be ignored.) What determines the phonetic form of the labialised element? (Roca & Johnson 1999)

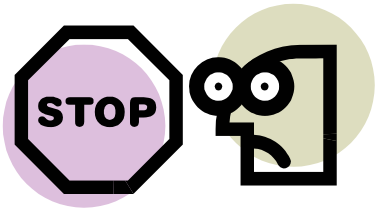
(44)	bap^{w}a	'they grind'	baʑ^{v}am	'they begged'
	bat^{w}ap	'the picked up'	aɕ^{f}ápaŋ	'groundnuts'

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

[27] [–strident] affricates (e.g., $p^ɸ$, $t^θ$) do not involve such readjustment. In these, "[a]ffricate releases may involve only a slight widening of the articulatory constriction of the stop, so that stop and fricative components have identical place of articulation." (Ladefoged & Maddieson 1996:90).

bat^{sf}áp	‘they chose’	bask^{w}áp	‘they are foolish’
bat$^{\theta f}$ák	‘they sleep’	bas^{f}a	‘they kneel’
nsáz^{v}akk^{w}à	‘the water is hot’	baŋ^{w}áŋ	‘they slip’
bab^{w}a	‘they deceived’	bam^{w}à	‘they measured’
bamb^{w}à	‘they tasted’	baŋg^{w}à	‘they drink’
band^{w}ap	‘they wove’		

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* [timstɻ] ~ [timpstɻ], *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):

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

a.	sa	‘let out’
	t^{s}a	‘take food with tongue’
b.	ʂa	‘sand’
	ʈ^{ʂ}a	‘to pierce’
c.	ɕa	‘blind’
	t^{ɕ}a	‘to add’

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

(46) *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
c.	kata	to use a long thing (e.g., log) or put it somewhere
	xata	to peek, to stretch the head out
d.	kʷisa	to spit
	xʷi̯sa	to whip, to make a whipping movement
e.	qusa	bent, crooked
	χusa	to sprinkle, to splash
f.	qʷl̩qʷa	to sprain, wrench
	χʷl̩qʷa	to sharpen with a file

The status of affricates, such as /tˢ, dᶻ, tˢ', tˡ, dˡ, tˡ'/ 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 dˡ, where a homorganic sonorant [l] appears to be made (rather than a homorganic voiced fricative [ɮ]).[28] 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.).

(47)	tˢ	[t͡sʰ]	vs.	ts	[tʰs]
	tˡ	[t͡ɬʰ]	vs.	tɬ	[tʰɬ]

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.

(48)	tˢ'	[t͡sʼ]	vs.	ts	[tʼs]
	tˡ'	[t͡ɬʼ]	vs.	tɬ	[tʼɬ]

In the case of voiced /dᶻ/, the 'fricative' component has no independent status in Oowekyala. That is, the sound [z] does not occur independently of [dᶻ] (cf. phoneme inventory in section 2.1 above). This provides a robust argument in favour of the affricate dᶻ being a single segment.

(49)	dᶻ	[d͡z]	vs.	d	*z

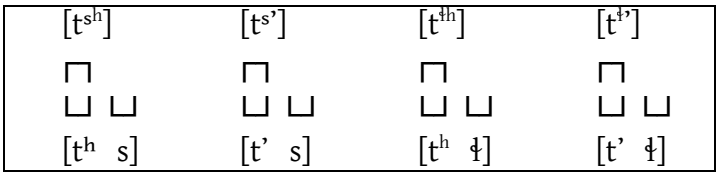
In the case of /dˡ/, the 'sonorant' component [l] immediately follows the stop release. By contrast, the corresponding d+l sequence is always separated by schwa; that is, d+l is always pronounced ...dəl... in Oowekyala.

(50)	dˡ	[d͡l]	vs.	dl	[dəl]

(51) Idealisation of segmental duration (no overlap)

[28] In North America, /dˡ/ is found only in North Wakashan. Sherzer (1976:67) reports /dˡ/ in several families (e.g., Tlingit, Athapaskan, Penutian), but in these linguistic groupings the sound is actually /tˡ/, the plain counterpart of phonologically aspirated /tˡʰ/ and glottalised /tˡ'/ (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.



The phonetic differences just described, combined with the relatively permissive phonotactics[29] of Oowekyala, allow lexical contrasts between affricates and matching stop-fricative sequences, as the following pairs illustrate:

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

a.	tsəla	to cut through water
	tsəla	pushing
b.	ts'a:	flow of water, creek flowing
	t'sa	to hit sth. with a rock, to bang rocks together, to chip pieces from rocks
c.	tstsila[30]	to do what somebody else does or did
	tstsa	push repeatedly

(53) *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 (54) and (55). 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.

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

/Red$_{PL}$-t s - a/	/Red$_{PL}$-ts a i n a/	/Red$_{PL}$-s p - a/
[t i t s a]	[ts i ts a i n a]	[s i s p a]
plural of: 'to push'	plural of: 'Chinese'	plural of: 'to flash'

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

a.	t͡sit͡saina	plural of: chinese
b.	tit͡sa	plural of: to push
c.	t͡s'it͡s'm:	plural of: index finger
d.	tit͡ɬa	plural of: to bait
e.	t'at'ɬa	plural of: to slice fish parallel to the backbone

[29] "Phonotactics" is the set of constraints on sequencing of phonemes in a language.
[30] A sequence like tstsh is doubly released ([ùshùsh]).

f. t͡ɬ’it͡ɬ’aː plural of: black bear
g. t̲’it̲’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.:

(56) *-axsala* ‘aimlessly’
a. χʷa̲ːtaxsala cut any way, carelessly
cf. χʷta to cut with a knife
b. ga̲ːlaxsala to crawl aimlessly
cf. gla to crawl, to go on all fours
c. ja̲ːχʷaxsala 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. (57a,b), whereas stop+fricative sequences such as /ts/ do get separated, e.g. (57).

(57) *-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 above). As mentioned above, Oowekyala has /dᶻ/ but not /z/. 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 [tʃ], 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.

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] /t^{s}, d^{z}, t^{s}', s/, and a series specified [+lateral] /t^{ɬ}, d^{l}, t^{ɬ}', ɬ, l, l'/. Crucially, affricates /t^{s}, 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 (58) 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.

(58)	*Pres. pple. neg.*	*Past pple.*	
a.	cɔ̀p	cof	'to overtake'
	kɛp	kɛ̀f	'to scoop (food) hastily'
b.	lo̯t̪	loθ	'to suck'
	jæ̯t̪	jæθ	'to wade'
c.	paːt	pàːr̥	'to sharpen'
	wɨt	wɨr̥	'to cut a point'
d.	jaːc	jaːç	'to hit'
	j̪j̪èːc	j̪j̪eːç	'to dismiss a person'
e.	j̪æk	j̪æh	'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 (59) reveals (Picard 1999:71). Here the feature involved is [±continuant].

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

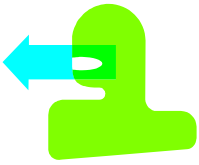
Exercises

A. English allows [tʃ] word-initially (e.g., *church*, *chat*), but not [ts]. (Tsawwassen is pronounced [s] or [t]; *tsetse* and *tsar* are exotic, frequently pronounced with [z].) Why?

B. How do you explain the following contrasts in Polish?

[ʧ]	Czech	'Czech'	[tʃ]	trzech	'three-gen. m.'
	czy	'whether'		trzy	'three'
	czysta	'clean-f.'		trzysta	'three hundred'
	oczyma	'eyes-instr.'		otrzyma	'will obtain-3sg.'
	paczy	'warps-3sg.'		patrzy	'looks at-3sg.'

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 (60) and discussed in the sections that follow.

(60) 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 (60) designate major articulations, i.e., the articulators that realise the articulator-free features such as [±cons], [±son], and [±cont] (see 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. These include:

- labial stops /p, ᵐp, b, ᵐb, pʰ, p', bʱ, b̪, ɓ, ɓ̥, pʷ, ᵐpʷ, bʷ, ᵐbʷ, pʷʰ, pʷ', bʷʱ, b̪ʷ, ɓʷ, ɓ̥ʷ, pʲ, ᵐpʲ, bʲ, ᵐbʲ, pʲʰ, pʲ', bʲʱ, b̪ʲ, ɓʲ, ɓ̥ʲ, pˠ, ᵐpˠ, bˠ, ᵐbˠ, pˠ', bˠʱ, b̪ˠ, ɓˠ, ɓ̥ˠ, ᵐpˤ, bˤ, ᵐbˤ, pˤ', bˤʱ, b̪ˤ, ɓˤ, ɓ̥ˤ,, etc./,
- labial affricates /pᶠ, ᵐpᶠ, bᵛ, ᵐbᵛ, pᶠʰ, pᶠ', bᵛʱ, b̪ᵛ, etc./,
- labial fricatives /ɸ, β, β̞, f, v, ṽ, fʰ, f', fʷ, vʷ, ṽʷ, fʷʰ, fʷ', fʲ, vʲ, ṽʲ, fʲʰ, fʲ', fˤ, vˤ, ṽˤ, fˤ', etc./,
- labial trills /ʙ, ʙ̥/,
- labial nasals /m, m̥, m̪, mʷ, m̥ʷ, m̪ʷ, mˠ, mʲ, mˠ, mˤ, etc./, and
- labial glides /ʊ, ʊ̃, ʊ̥, ʊ̪, ʊ̆, etc./.

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:

(61) *Oowekyala*

a.	bat$^{\text{ɬ}}$a	'to fathom, measure by using the extended arms or fingers'
b.	pat$^{\text{ɬ}}$a	'to flatten'
c.	p'at$^{\text{ɬ}}$'s	'sth. strung out on the ground'
d.	mat$^{\text{ɬ}}$a	'to shake hands, take by the hand'
e.	m'it$^{\text{ɬ}}$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].

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

That (62) is markedness-based is evident typologically. For instance, consider the marking implication in (63), 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).

(63) *A marking implicational* (Sherzer 1976:258, 1.3.1)

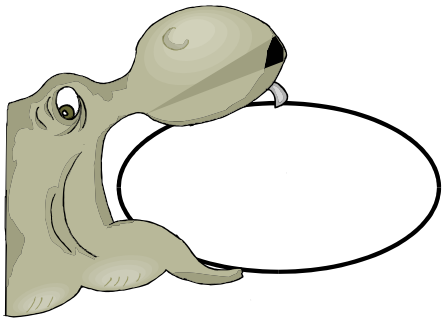
f, v, φ, β → p

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 (62) in Oowekyala grammar, consider the adaptation of English labial fricatives into Oowekyala, as illustrated by the words in (64).[31]

(64) *Loan adaptations of labial fricatives in Oowekyala*

	Oowekyala	*English*	
a.	pəlawas	flawə(ɹ)z	'flowers'
b.	kʷabi	kɑfi	'coffee'
c.	sdup	stov	'stove'
d.	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:

(65) *Some labiovelars and labiouvulars in Oowekyala*

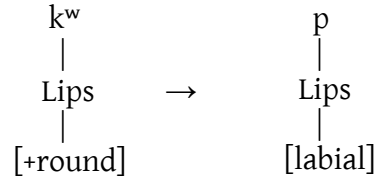
a.	qʷχʷ	powder
b.	χʷtkʷ	(sth.) cut with a knife
c.	kʷxʷa	hot
d.	kʷχʷbis	noiseless fart, cushion creeper
e.	kʷ'kʷ'χʷsj'akʷ	sth. chopped up, kindling
f.	qʷ'iqʷxʷsm̩	powdery blueberry (Vaccinum ovalifolium)
g.	kʷ'qʷ'χʷdˡa	incessantly urinating (said of a male)
h.	xʷm̩ɢʷatˢ'i	bee-hive

[31] 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.

i. ɢʷaχʷɢʷalaɲusiwa Raven-at-the-North-End-of-the-World
j. ɢʷiqʷχʷɢʷaχa plural of: to eat bread

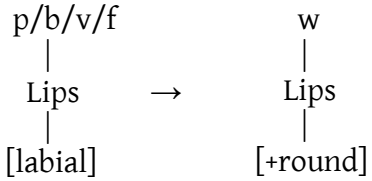
Such facts —that languages without labials (*p, *m, *f, etc.) may nonetheless admit labialised segments (e.g., kʷ),[32] and that languages without labial continuants (*f, *v, etc.) may otherwise allow labialised continuants (e.g., xʷ)— suggest that [labial] and [+round] are relatively independent features. As Halle, Vaux & Wolfe (2000) claim, "in most languages the labialized velar kʷ has the feature complement [dorsal, +consonantal, –sonorant, +round, –continuant ....], with no specification for the feature [labial] (see Halle 1995)." Still, it is not the case that [labial] and [+round] are totally independent. For instance, the evolution of Romance **kʷ* to [p] in Romanian (cf. Latin *aqua* 'water' and Romanian *apă)* can be expressed as the replacement of [+round] by the articulator feature [labial].[33] But this replacement is mysterious unless [+round] and [labial] are related through a common organising node —Lips— which remains constant during the change.

(66)



Similarly, Klingenheben's Law whereby labial consonants weaken to [w] syllable-finally in Hausa (see section 2.2.1.2.2 above) seems arbitrary unless labialised segments like [w] are related to labial consonants through the Lips node, which remains constant during the lenition process:[34]

(67)



Turning now to arguments for the autosegmental status of [+round], we first consider *stability*. Goldsmith (1976:140) defines this phenomenon as "the tendency of a feature value to persist despite the erasure of the major segment (generally, vowel) which appeared to have borne that feature." For example, Québec French avoids vowel hiatus (adjacent vowels) through vowel deletion: the first vowel deletes before the second one, which is lengthened, as shown in (68). However, Dumas (1977) observes that the [+round] feature of a deleted vowel is

[32] The reverse situation, in which labials are allowed but labialised segments are banned (*u, *kʷ), is rare. According to Bernhardt & Stemberger (1998), some child languages pattern this way, e.g. Morgan's Child English allowed [labial] but not [+round]: /fuːd/ [buːd] 'food', /bʊk/ [bʊk] 'book', /owpən/ [ʔɤpən] 'open' (p. 359).

[33] There is also simultaneous loss of the articulator feature [dorsal]; see section 2.3.3.1 below. The change from *kʷ to a labial stop is relatively common (e.g., Indo-European languages such as Greek, Lehman 1952; Muskogean languages, Booker 1993). Note that the asterisk before kʷ here means not "ungrammatical" but "historical".

[34] There is also simultaneous gain of the articulator feature [dorsal]; again see section 2.3.3.1 below.

transferred to a preceding consonant, as illustrated in (68e).[35] The fact that [+round] "survives" the vowel's deletion suggests that it is autonomous from this vowel, i.e., [+round] is autosegmental.

(68) *Vowel coalescence in Québec French*

a.	e a	[isõtala:truve]	ils sont allés (l)a trouver	'they went to see her'
b.	i e	[sto:se:kœ:rã]	c'est aussi écoeurant!	'it's just disgusting'
c.	e o	[jã:nepo:so:tã]	il en est passé autant	'so many went by'
d.	i ã	[sa:prã:syk]	ça a pris en sucre	'it turned into sugar'
e.	o a	[ẽkutʷa:mastˢɪk]	un couteau à mastic	'a putty knife'

Next consider the case of a "floating" [+round] feature in Chaha, a Gurage language of Ethiopia which has labialised dorsals (k^w, g^w, x^w, ...) as well as labialised labials (b^w, m^w, f^w, ...), but no labialised coronals (*t^w, *d^w, *s^w, ...). Interestingly, the third masculine object in Chaha is indicated simply by labialisation, i.e., [+round]. As shown in the data below (from McCarthy 1983:179), the floating [+round] appears to target the rightmost labialisable consonant of the stem: the stem-final consonant, if labialisable (69a), else the stem-medial consonant, if labialisable (69b), else the stem-initial consonant, if labialisable (69c). The third masculine object fails to surface if the stem has no labialisable consonant, as in (69d). The fact that [+round] represents a morpheme (3rd m. sg. object) onto itself is a strong argument for its autosegmental status.

(69) *Labialisation in Chaha*

	without object	*with 3rd m. sg. object*	
a.	dænæg	dænæg^w	'hit'
	nædæf	nædæf^w	'sting'
	nækæb	nækæb^w	'find'
b.	nækæs	næk^{w}æs	'bite'
	kæfæt	kæf^{w}æt	'open'
	bækær	bæk^{w}ær	'lack'
c.	qætær	q^{w}ætær	'kill'
	mæsær	m^{w}æsær	'seem'
	mæk^{j}ær	m^{w}æk^{j}ær	'burn'
d.	sædæd	sædæd	'chase'

2.3.2. Tongue Blade

Three features depend on the Tongue Blade: [coronal], [±anterior], and [±distributed].

[35] According to Prunet (1992:57, n. 7), "the stability of [+round] is optional" in this process.

2.3.2.1. [coronal]

Chomsky and Halle (1968:304): "Coronal sounds are produced with the blade of the tongue raised from its neutral position; noncoronal sounds are produced with the blade in the neutral position." Phonemes specified [coronal][36] are relatively numerous in most languages; they include:

- dentals, e.g., t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪', d̪ʱ, d̪̊, d̪̥, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪', d̪ʱ, d̪̊, d̪̥, t̪ʷ, ⁿt̪ʷ, d̪ʷ, ⁿd̪ʷ, t̪ʷʰ, t̪ʷ', d̪ʷʱ, d̪̊ʷ, d̪̥ʷ, t̪ʲ, ⁿt̪ʲ, d̪ʲ, ⁿd̪ʲ, t̪ʲʰ, t̪ʲ', d̪ʲʱ, d̪̊ʲ, d̪̥ʲ, t̪ˠ, ⁿt̪ˠ, d̪ˠ, ⁿd̪ˠ, t̪ˠʰ, t̪ˠ', d̪ˠʱ, d̪̊ˠ, d̪̥ˠ, tθ, ⁿtθ, dð, ⁿdð, tθ, tθ', dðʱ, d̪̊ð, θ̪, ð̪, ð̪̥, θ, ð, ðʱ, θʰ, θ', ðˤ, s̪, z̪, z̪̃, s̪ʰ, s̪', ɬ, ɮ, ɬʰ, ɬ', ɮʱ, ɬ̥, ɮ̥, ɬˠ, ⁿɬˠ, dɮˠ, ⁿdɮˠ, ɬˠʰ, ɬˠ', dɮˠʱ, d̪̊ɮˠ, d̪̥ɮˠ, tˤ, ⁿtˤ, dˤ, ⁿdˤ, tˤ', dˤʱ, d̪̊ˤ, d̪̥ˤ, tˢ, ⁿtˢ, dᶻ, ⁿdᶻ, tˢʰ, tˢ', dᶻʱ, d̪̊ᶻ, tɬ, ⁿtɬ, dɮ, ⁿdɮ, tɬʰ, tɬ', dɮʱ, d̪̊ɮ, s, ⁿs, z, ⁿz, z̃, sʰ, s', sʷ, zʷ, sʲ, zʲ, sˤ, zˤ, ɬ, ɮ, ɮ̥, ɬʰ, ɬ', ɬˤ, ɮˤ, ɬˤ', n, n̥, n̪, nʷ, n̥ʷ, n̪ʷ, nʲ, nˠ, nˤ, l, l̥, l̪, l̪̥, lʷ, ɬʷ, l̥ʷ, l̪ʷ, l̪̥ʷ, lʲ, ɬʲ, l̥ʲ, l̪ʲ, l̪̥ʲ, lˤ, ɬ, l̥, l̪, l̪̥, ɬʷ, ɬ̥ʷ, l̥ʷ, l̪̥ʷ, ɺ, ɺʷ, r, r̃, rʷ, rʲ, rˠ, rˤ, ɾ, ɾ̃, ɾʷ, ɾʲ, ɾˠ, ɾˤ, ɹ, ɹʷ, ɾ̥, ɾ̥ʷ, etc.
- retroflexes, e.g., ʈ, ⁿʈ, ɖ, ⁿɖ, ʈʰ, ʈ', ɖʱ, ɖ̥, !, ʈʷ, ⁿʈʷ, ɖʷ, ⁿɖʷ, ʈʷʰ, ʈʷ', ɖʷʱ, ɖ̥ʷ, ʂ, ʐ, ʐ̃, ʂʰ, ʂ', ɳ, ɳ̊, ɳ̥, ɳʷ, ɳ̊ʷ, ɳ̥ʷ, ɭ, ɭ̊, ɭ̥, ɭ̥̊, ɭʷ, ɭ̊ʷ, ɭ̥ʷ, ɭ̥̊ʷ, ɽ, ɽ̊, ɽ̥, ɽ̥̊, ɽʷ, ɽ̊ʷ, ɽ̥ʷ, ɽ̥̊ʷ, etc.
- palatoalveolars, e.g., tʃ, ⁿtʃ, dʒ, ⁿdʒ, tʃʰ, tʃ', dʒʱ, d̪̊ʒ, cᶜ, ᶮcᶜ, dʲ, ⁿdʲ, cᶜʰ, dʲʱ, d̪̊ʲ, ʃ, ʒ, ʒ̃, ʃʰ, ʃ', ʃʷ, ʒʷ, ʒ̃ʷ, ʃʷʰ, ʃʷ', ʃˠ, ʒʲ, ʒ̃ʲ, ʃˠʰ, ʃˠ', ʃˤ, ʒˤ, ʒ̃ˤ, ʃˤ', etc.
- palatals, e.g., ɕ, ʑ, ʑ̃, ɕʰ, ɕ', c, ᶮc, ɟ, ᶮɟ, cʰ, c', ɟʱ, ɟ̊, ɟ̥, cᶜ, ᶮcᶜ, ɟʲ, ⁿɟʲ, cᶜʰ, ɟʲʱ, ɟ̊ʲ, cˠ, ᶮcˠ, ɟˠ, ⁿɟˠ, cˠʰ, cˠ', ɟˠʱ, ɟ̊ˠ, tᶜ, ⁿtᶜ, dᶻ, ⁿdᶻ, tᶜʰ, tᶜ', dᶻʱ, d̪̊ᶻ, tᶜʲ, ⁿtᶜʲ, dᶻʲ, ⁿdᶻʲ, tᶜʲʰ, tᶜʲ', ç, ɟ̊, ʝ̃, çʰ, ç', ɲ, ɲ̊, ɲ̥, ʎ, ʎ̊, ʎ̥, ʎ̥̊, j, j̃, j̊, j̊̃, jʷ, j̃ʷ, j̊ʷ, j̊̃ʷ, jˠ, j̃ˠ, ɥ, ɥ̃, ɥ̊, ɥ̊̃, etc.

That such diverse phonemes uniquely share a phonological feature is suggested by their class behaviour in phonological patterns. For example, Canadian (and American) English allows a large number of consonants to occur before [ju], e.g., p[ju]ny (puny), b[ju]ty (beauty), f[ju]me, v[ju] (view), am[ju]se, c[ju]be. But an even larger class of consonants is not permitted to occur before [ju]: *θju..., *ðju..., *tju..., *dju..., *sju..., *zju..., *nju..., *lju..., *ʃju..., *ʒju..., tʃju..., dʒju..., *ɹju... Close examination reveals that those consonants which are not allowed before [ju] in Canadian English are precisely all consonants articulated with the tongue blade or tip. This generalisation is captured if they share an articulator feature: [+consonantal, coronal]+ [ju] is prohibited syllable-initially.[37]

[36] [coronal] used to be known as [–grave] in Jakobson's acoustic-features framework.

[37] Note that this prohibition does not hold in British English. Compare:

Canadian/American English	*British English*
d[u]pe	d[ju]pe
l[u]rid	l[ju]rid
n[u]ws (news)	n[ju]ws
pre[zu]me (presume)	pre[zju]me
st[u]pid	st[ju]pid
s[u]t (suit)	s[ju]t

Exercises

A. List all the English consonants which may appear after /aw/ in one-syllable words, with an example of each, e.g.: /t/ *shout*. (Halle & Clements 1983)

B. Traditional Arab grammarians divide the consonants of their language into two groups on the basis of their effect on the definite prefix ʔal-. The "sun" letters induce a complete assimilation of the lateral consonant in the prefix while the "moon" letters have no effect. Study the following examples to determine the basis for the distinction. (Kenstowicz 1994)

(70)

a.	ʔal-qamr	'the moon'	b.	ʔaʃ-ʃams	'the sun'
	ʔal-faras	'the mare'		ʔad-daːr	'the house'
	ʔal-kitaːb	'the book'		ʔaz-zajt	'the oil'
	ʔal-ħarb	'the war'		ʔan-nahr	'the river'
	ʔal-ʔab	'the father'		ʔaθ-θawb	'the garment'

Given your solution, predict the definite form of the following nouns.

(71)

raʒul	'man'	ðalq	'tip of tongue'
xaːtam	'ring'	walad	'boy'
baːb	'gate'	tiʒaːra	'commerce'
sana	'year'	laban	'milk'
mawt	'death'	ɣada	'lunch'
harab	'escape'		

Suggestive evidence that [coronal] has autosegmental status (and that [coronal] is an articulator feature on par with other articulator features) comes from speech errors, e.g., the articulator features [labial] and [coronal] are individually exchanged in the speech error *pedestrian* >^{e} *tebestrian* (Fromkin 1971). Further evidence that [coronal] is autosegmental comes from *mutation* patterns in Shona, a Southern Bantu language.

As LaCharité (1995) discusses, the causative suffix in Shona may be -is- or -es- when added to some stems, as illustrated in (72a,b,c). More typically, however, the causative morpheme is represented by two "floating" features, [+strident] and [coronal], which arguably survive from underlying -s-.[38] These two features target the stem-final consonant, resulting in various consonant "mutations": r > d^{z} (72c,d), t > t^{s} (72e), k > t^{s} (72f), ^{ŋ}g > ^{n}z (72g), b > ɗb$^{\widehat{zv}}$ (72h), and β > $\widehat{zv}$ (72i).

(72) *Shona* (LaCharité 1995)

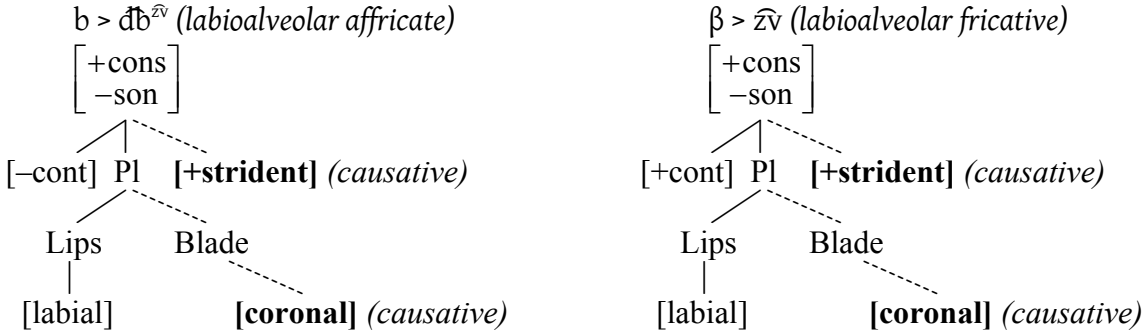
a.	-bik-a	'cook'	-bik-is-a	'make (someone) cook'
b.	-e^{n}d-a	'go'	-e^{n}d-es-a	'make (someone) go'
c.	-kwír-á	'go up, climb'	-kwír-ís-á	'make (someone) climb'

[38] See section 2.3.1.2 above regarding "stability effects."

			-kwíd^{z}-á	or ‘lift up’
d.	-rir-a	‘make a sound’	-rid^{z}-a	‘make (someone) make a sound’
e.	-net-	‘become tired’	-net^{s}-a	‘make tired’
f.	-sek-a	‘laugh’	-set^{s}-a	‘make (someone) laugh’
g.	-té^{ŋ}g-á	‘buy’	-té^{n}z-á	‘sell’
h.	-reɓ-a	‘be long’	-reɗb$^{\widehat{zv}}$-a	‘lengthen’
i.	-ɲóróβ-á	‘be moist, soft’	-ɲóróẑv-á	‘moisten, soften’

In the first two changes, r > d^{z} and t > t^{s}, only [+strident] is obviously added to the stem-final consonants (which are already coronal).[39] In the next two changes, k > t^{s} and ^{ŋ}g > ^{n}z, both “floating” features —[coronal] and [+strident]— are added to the stem-final velar consonants, resulting in the loss of the original velar articulation (see [dorsal] in section 2.3.3.1 below). Finally, in the last two changes, b > ɗb$^{\widehat{zv}}$ and β > ẑv, both ‘causative’ features —[coronal] and [+strident]— are added to the stem-final labial consonants, resulting in *complex* segments, as illustrated here:

(73) *Shona causativisation*



In sum, causative formation in Shona provides a strong argument for the autosegmental status of the articulator feature [coronal].

[39] See LaCharité (1995) for arguments that /r/ is [–continuant] in Shona, hence the change r > d^{z} rather than r > z.

2.3.2.2. [±anterior]

As we saw in the preceding section, a wide variety of phonemes are specified with the articulator feature [coronal]: dentals (tʱ/t̪, dʱ/d̪, θ, ð, ...), alveolars (t, d, s, z, n, l, r, ...), retroflexes (ʈ, ɖ, ʂ, ʐ, ɳ, ɻ, ...), and palatoalveolars (tʃ/c, dʒ/ɟ, ʃ, ʒ, ɲ, j, ...). In this section we will divide these phonemes into two subclasses according to the feature [±anterior]. Chomsky and Halle (1968:304) define this feature[40] as follows:

> *Anterior sounds are produced with an obstruction that is located in front of the palato-alveolar region of the mouth; nonanterior sounds are produced without such an obstruction.*

Specifically, then, dentals and alveolars are considered [+anterior] and, as such, they are distinguished in the phonology from both retroflexes and palatoalveolars, which are considered [–anterior]. For example, Hall (1997:38) reports that in Albanian, words may end in [kt], [ks], or [kθ], but not in [kʃ]. To explain this gap, Hall suggests that only [+anterior] phonemes (i.e., dentals and alveolars) are permitted word-finally after [k] in Albanian.

(74) *Albanian constraint*
*[k][–anterior]#[41]

As Chomsky and Halle (1968:406, 407) observe, [–anterior] is generally more highly *marked* than [+anterior] (see also Morelli 1999:128–9; Roca & Johnson 1999:585; Lombardi 2000). The markedness of [–anterior] is evident in phoneme inventories. Thus Oowekyala grammar allows numerous [+anterior] phonemes but it excludes [–anterior] consonants, e.g., it has /s, z, tˢ, dᶻ/ but not */ʃ, ʒ, tʃ, dʒ/. So for instance the English word *matches* was borrowed into Oowekyala as [madᶻis]. Similarly, French *magie* [maʒi] 'magic' was borrowed into the Bantu language Lingala as [mazi] because Lingala lacks /ʒ/. As Paradis and Lacharité (2001:259) explain, "there is a prohibition against the non-anterior coronal fricatives /ʃ ʒ/ in ... Lingala."

That [–anterior] phonemes are relatively complex is also apparent in language acquisition. Berhardt and Stemberger (1998:299–300) observe that it is common for children under nine to replace [–anterior] palatoalveolars by [+anterior] alveolars in their speech, e.g. *ship* as [sɪp], *chip* as [tˢɪp]. The opposite pattern, in which all [+anterior] alveolars are replaced by [–anterior] palatoalveolars, is rare and attested only in individuals with oral mechanism challenges such as cleft palates (ibid.).

Notwithstanding, many languages do contrast [+anterior] phonemes with [–anterior] ones. For example, the West African language Hausa contrasts [+anterior] /ɾ/ (or /r/) with [–anterior] /ɽ/, e.g., *bárá:* ~ *bárá:* 'servant' vs. *báɽà* 'begging' (Ladefoged & Maddieson 1996:237); the California language Karok contrasts [+anterior] /s̪/ with [–anterior] /ʂ/, e.g., *s̪ú:f* 'creek' vs. *ʂú:f* 'backbone'; similarly, in Luiseño: *s̪ukat* 'deer' vs. *s̪ukmal* 'fawn' (ibid., p. 146). Here are some

[40] Chomsky and Halle's feature [anterior] corresponds to Jakobson's earlier feature [diffuse] for consonants (Chomsky & Halle 1968:306).

[41] The number sign "#" is used to indicate a word boundary.

(near) minimal pairs involving [±anterior] from the South Wakashan language Nuuchahnulth (Sapir & Swadesh 1939):

(75) *Nuuchahnulth*

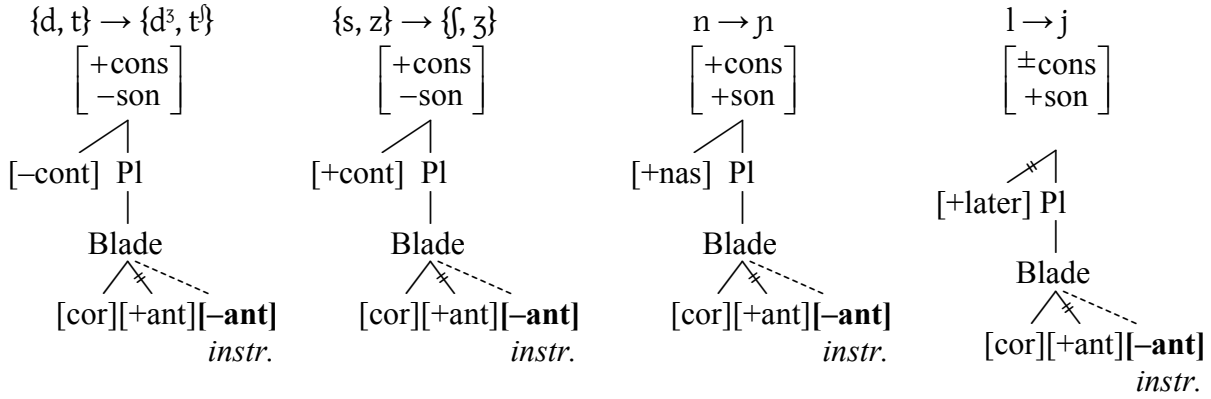
a.	su:p	'soap' or 'soup' < Eng	ʃu:wis	'shoes' < Eng
b.	tˢaka:	'to get spilled'	tʃaʔak	'island'
c.	tˢ'aʔak	'river'	tʃ'aʔak	'water'

The *autosegmental* status of the feature [±anterior] can be inferred from apparent cases of "floating" [–anterior]. For example, in the Ethiopian language Amharic the instrumental suffix appears to be just [–anterior], which targets stem-final coronals (Zoll 2001; Leslau 1995):

(76) *Instrumental in Amharic*

a.	hedæ	'?'	mæhedʒa	'means for going somewhere'
b.	kæf:ætæ	'open'	mækfætʃa	'key'
c.	wæg:æzæ	'excommunicate'	mæwæg:aʒa	'means to excommunicate'
d.	dær:æsæ	'arrive'	mædræʃa	'arrival, time or place of arrival'
e.	kæd:ænæ	'cover'	mækdæɲ:a	'lid'
f.	næq:ælæ	'pull out'	mænqæja	'instrument for pulling things out'

In these examples, the floating feature causes stem-final [+anterior] /d, t, z, s, n, l/ to become [–anterior] /dʒ, tʃ, ʒ, ʃ, ɲ, j/, respectively. These *palatalisations* can be represented as follows:



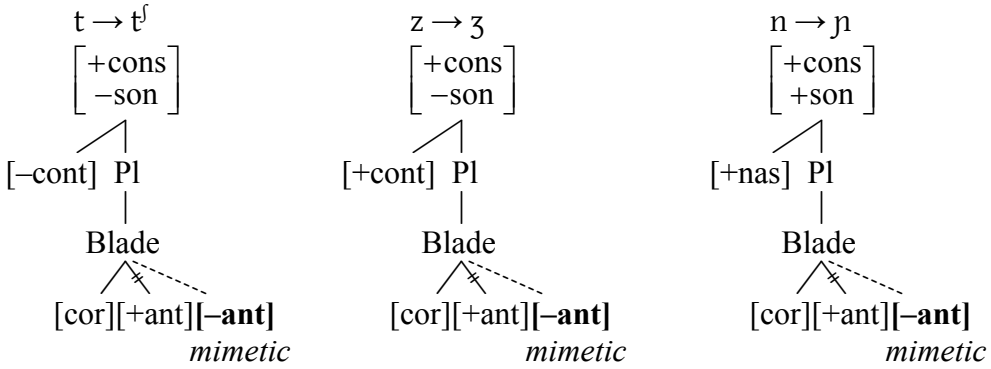
Another example of palatalisation comes from Japanese mimetics. *Mimetics* are words that sound like what they mean ("onomatopoeia," e.g., English: *bow-wow, cock-a-doodle-doo*) or that have peculiar sound patterns ("ideophone," e.g., English: *helter-skelter*, *teeter-totter*). Interestingly, Japanese mimetics are characterised by *palatalisation* of the rightmost coronal consonant (note that mimetics also involve *reduplication*):

(77) *Japanese mimetics* (Archangeli & Pulleyblank 1994:333)

a.	toko	tʃoko-tʃoko	'childish small steps'
	zabu	ʒabu-ʒabu	'dabble in liquid'
	noki	ɲoki-ɲoki	'sticking out one after another'
b.	meta	metʃa-metʃa	'destroyed'
	kasa	kaʃa-kaʃa	'rustling'
	huna	huɲa-huɲa	'limp'
c.	dosa	doʃa-doʃa	'in large amounts'
	noso	noʃo-noʃo	'slowly'
	neta	netʃa-netʃa	'sticky'

In autosegmental terms, mimetics may be said to carry a "floating" [–anterior] feature which targets a coronal, whether morpheme-initial, as in (77a), or morpheme-medial, as in (77b). When both consonants of the morpheme are coronal, the rightmost one is targeted, as shown in (77c). This autosegmental analysis is illustrated here:

(78) *Mimetic palatalisation*



2.3.2.3. [±distributed]

Chomsky and Halle (1968:312) define the feature [±distributed] as follows:

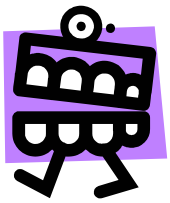
Distributed sounds are produced with a constriction that extends for a considerable distance along the direction of the air flow; nondistributed sounds are produced with a constriction that extends only for a short distance in this direction.

Chomsky and Halle propose this feature primarily to distinguish coronals produced with the blade of the tongue (*laminal*) from those produced with the tip of the tongue (*apical*). Specifically, among [–anterior] coronals, retroflex coronals are considered [–distributed] (because the tip of the tongue is curled upwards in their production) whereas palatoalveolars are considered [+distributed]. For example, the Indo-Aryan language Hindi has

just one series of [+anterior] coronal stops, but it has two series of [–anterior] coronal stops: [–distributed] retroflexes and [+distributed] palatoalveolars (Ladefoged & Maddieson 1996:58):

(79) *Hindi*

[+anterior]		[–anterior, –distributed]		[–anterior, +distributed]	
t̪al	'beat'	ʈal	'postpone'	tʃɐl	'walk'
t̪ʰal	'plate'	ʈʰal	'wood shop'	tʃʰɐl	'deceit'
d̪al	'lentil'	ɖal	'branch'	dʒɐl	'water'
d̪ʱar	'knife'	ɖʱal	'shield'	dʒʱɐl	'glimmer'



Among [+anterior] coronals, dentals are typically [+distributed] (except when they are produced with the tip of the tongue) while alveolars are typically [–distributed] (except when they are produced with the blade of the tongue). As Ladefoged and Maddieson (1996:20) report:

> *In the languages we have investigated, dental stops are usually laminal rather than apical, with contact on both the teeth and the front part of the alveolar ridge, whereas the alveolar stops are often apical, with contact usually on the center of the alveolar ridge.*

They thus report the following generalisation (p. 23): "languages that contrast dental and alveolar stops have laminal dentals and apical alveolars." In featural terms, [+anterior, –distributed] is usually interpreted as alveolar, whereas [+anterior, +distributed] is usually interpreted as dental. For example, the following words from Toda, a Dravidian language, illustrate [+anterior, +distributed] dental stops, [+anterior, –distributed] alveolar stops, and [–anterior] retroflex stops in syllable-final position (ib., p. 21):

(80) *Toda*

	Voiceless		*Voiced*	
dental	poṯ̪	'ten'	moḏ̪	'churning stick'
alveolar	paːt	'cockroach'	mod	'village with dairy'
retroflex	ṯ̪aʈ	'churning vessel'	maɖ	'head'

As another example, most Athapaskan languages have just one series of [–anterior] coronal obstruents (palatoalveolars), but they have at least two series of [+anterior] coronal stops: [+distributed] dentals and [–distributed] alveolars. This three-way contrast can be illustrated with Chipewyan affricates (ib., p. 91):

(81) *Chipewyan*

[+anterior, +distributed]		[–anterior, –distributed]		[–anterior]	
tᶿɛ̂θ	'hide'	tˢɛ̂ke	'rubbers'	tʃíɛ	'berries'
tᶿʰe	'pipe'	tˢʰapa	'money'	tʃʰɛθ	'duck'
tᶿ'áí	'dish'	tˢ'i	'canoe'	tʃ'oɣ	'quill'

Finally, note that the two Blade features [±anterior] and [±distributed] predict a four-way phonological contrast among coronals. Such a contrast is rare, but not unknown. In Nunggubuyu (Heath 1984), a non-Pama Nyungan language of Northern Australia, a contrast is made between stops which are dental ([+ant, +dist]) vs. alveolar ([+ant, –dist]) vs. alveolopalatal ([–ant, +dist]) vs. retroflex ([–ant, –dist]). The following data illustrate this kind of contrast in Arrernte, another Australian language (Ladefoged & Maddieson 1996:28):

(82) *Arrernte*

laminal dental		*apical alveolar*		*apical palatoalvelar*		*laminal palatoalveolar*	
aṯəmə	'grind'	atəmə	'burst'	kwəʈə	'smoke'	aṯəməjə	'mother's father'
aṉəɻə	'sitting'	anəmə	'sitting'	aɲə	'tree'	alənə	'tongue'

2.3.3. Tongue Body

Four features depend directly on the Tongue Root: [dorsal], [±high], [±low], and [±back]. Each is discussed in turn below.

2.3.3.1. [dorsal]

The feature [dorsal] characterises segments that are produced primarily with the Tongue Dorsum. It is perhaps the most important articulator feature. (The other articulator features discussed so far are [labial] and [coronal].) Among [–consonantal] segments, [dorsal] defines the major articulation of vowels and of back semivowels (oral glides).[42] That vowels involve a primary "dorsal articulation" has been recognised since Sievers (1901); see also Chomsky and Halle (1968:302).

(83) *[–consonantal, dorsal]*

a. Vowels, e.g., i, ĩ, i̯, ĩ̯, y, ỹ, y̯, ỹ̯, ɨ, ɨ̃, ɨ̯, ɨ̯̃, ʉ, ʉ̃, ʉ̯, ʉ̯̃, u, ũ, u̯, ũ̯, ɪ, ɪ̃, ɪ̯, ɪ̯̃, ʏ, ʏ̃, ʏ̯, ʏ̯̃, ʊ, ʊ̃, ʊ̯, ʊ̯̃, e, ẽ, e̯, ẽ̯, ø, ø̃, ø̯, ø̯̃, ɘ, ɘ̃, ɘ̯, ɘ̯̃, ɵ, ɵ̃, ɵ̯, ɵ̯̃, ɤ, ɤ̃, ɤ̯, ɤ̯̃, o, õ, o̯, õ̯, ə, ɛ, ɛ̃, ɛ̯, ɛ̯̃, œ, œ̃, œ̯, œ̯̃, ɜ, ɜ̃, ɜ̯, ɜ̯̃, ɞ, ɞ̃, ɞ̯, ɞ̯̃, ʌ, ʌ̃, ʌ̯, ʌ̯̃, ɔ, ɔ̃, ɔ̯, ɔ̯̃, æ, æ̃, æ̯, æ̯̃, ɐ, ɐ̃, ɐ̯, ɐ̯̃, a, ã, a̯, ã̯, ɶ, ɶ̃, ɶ̯, ɶ̯̃, ɑ, ɑ̃, ɑ̯, ɑ̯̃, ɒ, ɒ̃, ɒ̯, ɒ̯̃, etc.

b. Semivowels, e.g., w, w̃, ʍ, w̯, wˢ, w̆, ɥ, ɥ̃, ɥ̊, ɥ̯, ɥʷ, ɥ̃ʷ, ɥ̊ʷ, ɥ̯ʷ, etc.

Among [+consonantal] segments, [dorsal] defines the major articulation of velars and uvulars.

[42] Front semivowels (j,j̃,j̊,j̯,jʷ,j̃ʷ,j̊ʷ,j̯ʷ,jˢ, ɥ, ɥ̃, ɥ̊, ɥ̯) are specified [coronal, –anterior]. See, e.g., Amharic above. Also Halle, Vaux & Wolfe (2000:433).

(84) *[+consonantal, dorsal]*

a. **Velars**, e.g., k, ᵑk, g, ᵑg, kʰ, k’, gʱ, g̰, g̠, g̠̰, kʷ, ᵑkʷ, gʷ, ᵑgʷ, kʷʰ, kʷ’, gʷʱ, g̰ʷ, g̠ʷ, g̠̰ʷ, kʷˀ, ᵑkʷˀ, gʷˀ, ᵑgʷˀ, kʷˀ’, gʷˀ, g̠ʷˀ, kʲ, ᵑkʲ, gʲ, ᵑgʲ, kʲʰ, kʲ’, gʲʱ, g̰ʲ, g̠̰ʲ, kˀ, ᵑkˀ, gˀ, ᵑgˀ, kˀ’, gˀʱ, gˀ, g̠̰ˀ, g̠̰̰ˀ, kˣ, gˠ, kˣʰ, kˣ’, kʘˣ, kǂ, ᵑkǂ, gǂ, ᵑgǂ, kǂʰ, kǂ’, gǂʱ, gǂ, kǂʷ, ᵑkǂʷ, gǂʷ, ᵑgǂʷ, kǂʷʰ, kǂʷ’, gǂʷʱ, gǂʷ, l̪̊, l̪, x, ɣ, g̠̰̃, xʰ, x’, xʷ, ɣʷ, g̠̰̃ʷ, xʷʰ, xʷ’, xʲ, ɣʲ, g̠̰̃ʲ, xʲʰ, xʲ’, ŋ, ŋ̊, ŋ̠, ŋ̠ʷ, ŋ̊ʷ, ŋ̠ʷ, ŋʲ, ŋˀ, ʟ, ʟ̃, ʟ̥, ʟ̠, ʟʷ, ʟ̃ʷ, ʟ̥ʷ, ʟ̠ʷ, etc.

b. **Uvulars**, e.g., q, ᴺq, ɢ, ᴺɢ, qʰ, q’, ɢʱ, ɢ̰, ɢ̠, qʷ, ᴺqʷ, ɢʷ, ᴺɢʷ, qʷʰ, qʷ’, ɢʷʱ, ɢ̰ʷ, ɢ̠ʷ, χ, ʁ̠, χ̃, χʰ, χ’, χʷ, ʁ̠ʷ, χ̃ʷ, χʷʰ, χʷ’, ɴ, ɴ̥, ɴ̠, ɴʷ, ɴ̥ʷ, ɴ̠ʷ, ʀ, ʀʷ, ʁ, ʁʷ, etc.

[dorsal] also characterizes clicks and many complex segments, that is, segments specified not only [dorsal] but also [labial] or [coronal]. Clicks are velaric ingressive sounds, in which the [dorsal] closure is released to form an ingressive sound with the other closure, i.e. [coronal] or [labial]. For instance, the click /kʘ/ is both [dorsal] and [labial] (like the complex segment /k͡p/).

(85) *[+consonantal, dorsal, labial/coronal]*

a. **Clicks**, e.g., kʘ, gʘ, kʘʰ, kʘ’, kʘˀ, kǀ, gǀ, kǀʰ, kǀ’, kǀˀ, k!, g!, k!ʰ, k!’, k!ˀ, kǁ, gǁ, kǁʰ, kǁ’, kǁˀ, kǂ, gǂ, kǂʰ, kǂ’, kǂˀ, kǀˣ, k!ˣ, kǁˣ, kǂˣ, qʘ, ɢʘ, qʘʰ, qʘ’, qʘˀ, qǀ, ɢǀ, qǀʰ, qǀ’, qǀˀ, q!, ɢ!, q!ʰ, q!’, q!ˀ, qǁ, ɢǁ, qǁʰ, qǁ’, qǁˀ, qǂ, ɢǂ, qǂʰ, qǂ’, qǂˀ, ŋʘ, ŋ̊ʘ, ˀŋʘ, ŋ̊ʘʰ, ŋǀ, ŋ̊ǀ, ˀŋǀ, ŋ̊ǀʰ, ŋ!, ŋ̊!, ˀŋ!, ŋ̊!ʰ, ŋǁ, ŋ̊ǁ, ˀŋǁ, ŋ̊ǁʰ, ŋǂ, ŋ̊ǂ, ˀŋǂ, ŋ̊ǂʰ, etc.

b. **Complex segments**, e.g., t͡k[43], k͡p, ᵑ͡ᵐk͡p, ᵑk͡p, g͡b, ᵑ͡ᵐg͡b, ᵑg͡b, k͡pʰ, k͡p’, g͡bʱ, g͡b̰, k͡p̪, k͡pʷ, g͡bʷ, q͡p, q͡b, etc.

As an example of a process in which [dorsal] is specifically targeted, consider the Gurage language Muher, where the velar ejective /k’/ weakens to [ʔ] in postvocalic position (Rose, in press). This can be seen by comparing the following verbs. (Verbs are in the 3rd sg. masc., except the imperative which is in the 2nd sg. masc.)

(86)	*Perfect*	*Imperfect*	*Jussive*	*Imperative*	
a.	k’əffəməm	jɨʔəffu	jəʔfɨf	k’ɨfɨf	‘cut, nick’
b.	k’ɨnəbbam	jɨʔnabbu	jəʔəmba	k’əmba	‘chatter, talk nonsense’
c.	ləkk’əməm	jɨləʔmu	jəlk’ɨm	lɨʔɨm	‘pick’
d.	nəkk’ələm	jɨnəʔlu	jənɨʔɨl	nɨʔɨl	‘uproot, pull out’

Crucially, this process can be understood as the loss (“delinking”) of [dorsal].

Note that labialisation ([+round]) does not interfere with this lenition process, such that a labialised [kʷ’] is realised as [ʔʷ] postvocalically. In (87a,b) labialisation is an underlying property of the verbal root, whereas in (87c,d) labialisation is added to non-labialised roots to indicate the impersonal mood. As Rose (in press, p. 3) explains, “a glottal stop reduced from a /k’/ is still labialized. For example, the 3ms object of the imperative *nɨʔɨl* ‘uproot’ is *nɨʔʷɨl*.”

[43] According to Maddieson (1990; see also Chitoran 1998) there are no complex stops of the sort [ùk, èg, p̪͡k, b̪͡g]. What happens, then, when a stop is phonologically specified both [coronal] and [dorsal], or both [labial] and [dorsal]? The answer is a click (Ladefoged & Maddieson 1996).

(87)	*Root*	*Perfect*	*Imperfect*	*Jussive*	
a.	/kʷ'm/	kʷ'əməm	jɨʔʷəmu	jəʔʷɨm	'stand'
b.	/k'wr/	kʷ'əkkʷ'ərəm	jɨʔʷəkkʷ'ɨru	jəʔʷəʔʷɨr	'squeeze, wring'
c.	/lak'/	laʔʷim	jɨləʔʷit	jəlaʔʷi	'surpass'
d.	/nk'-nk'/	nɨʔənnəʔʷim	jɨnk'ənnɨʔʷit	jənəʔnəʔʷi	'shake'

Exercise:

Kinyarwanda seems to allow consonant clusters of considerable complexity, e.g., *mŋa:nhoreje* 'you (pl.) worked for me', *tkwaŋga* 'we hate', *kari:dgwi* 'seven'. This fact clashes with the evidence from nativisation of (German) loan words, which suggest that consonant clusters are not permitted. Resolve this contradiction.

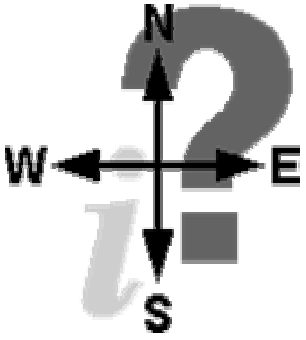
(88) *German loans in Kinyarwanda*

a.	Burgermeister	→	burugumesitiri
b.	Republik	→	repuburika
c.	Präsident	→	pa:tirisija
d.	Präfek	→	perefe

2.3.3.2. Other Tongue Body features

The other Tongue Body features are [±high], [±low], and [±back]. Chomsky and Halle (1968:304–305) define these features as follows:

> *The three features "high," "low," "back" characterize the placement of the body of the tongue. ... High sounds are produced by raising the body of the tongue above the level that it occupies in the neutral position; nonhigh sounds are produced without such a raising of the tongue body. ... Low sounds are produced by lowering the body of the tongue below the level that it occupies in the neutral position; nonlow sounds are produced without such a lowering of the body of the tongue. ... Back sounds are produced by retracting the body of the tongue from the neutral position; nonback sounds are produced without such a retraction from the neutral position.*



A basic function of these three Tongue Body features is to distinguish between vowels. These features, along with their values for common vowels, are listed in (89).

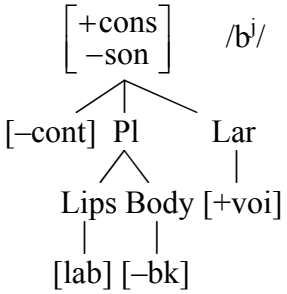
(89) Basic vowel features

	i, y, ɪ, ʏ	ɨ, ɯ, ʉ, u, ʊ	e, ɛ, œ, ɶ	ɤ, ʌ, o, ɔ	æ	a, ɑ, ɒ
[high]	+	+	–	–	–	–
[low]	–	–	–	–	+	+
[back]	–	+	–	+	–	+

The feature [±low] plays no role among consonants (the reason for this should be obvious to you; think about the definition of [+consonantal]), but the features [±high] and [±back] are important in distinguishing between velars and uvulars (see (84) above): the first are [+high, –back], while the second are [–high, +back]. This distinction is illustrated in the following Oowekyala minimal pairs:

(90) *Oowekyala velars vs. uvulars*

a.	kapəla	'lifting a lid, blanket, etc.'
	qapəla	'rising and coming towards one (said of steam, haze, smell), steam, smell, air'
b.	kiχa	'to use a saw'
	qiχa	'to fade (colour)'
c.	gənala	'getting more (money), adding to what one already has'
	ɢənala	'carrying on the arm; a game, like tug-of-war played on the fourth night of the Dʲəwʾəχa Dances'
d.	kʾɬa	'to move (brush, sweep, shake) particles from a surface'
	qʾɬa	'to lift, pick up, hold, carry a person (esp. a baby)'



The feature [–back] is also used in consonants to characterise palatalisation. For example, Japanese has a series of palatalised consonants, that is, sounds produced by raising the tongue body toward the hard palate when certain consonants are pronounced. The superscript [ʲ] is used to represent palatalised consonants. Examples in Japanese include *sanbyaku* [sambʲaku] 'three hundred', *ryokan* [rʲokan] 'inn', *myaku* [mʲaku] 'pulse', and *kyaku* [kʲaku] 'guest' (Tsujimura 1996:16). Because these sounds are produced with tongue body raising, they are traditionally treated as having a [–back] feature, in addition to their primary articulator feature ([labial], [coronal], or [dorsal]).

The palatalisation feature, which is assumed to be [–back], can also act as a "floating" feature. For instance, in Zoque (Akinlabi 1996), [–back] represents the third person possessive. It targets word-initial consonants, whether labial (91a), alveolar (91b), velar (91c), or glottal (91d). Of course, no phonetic effect is observed when the word-initial consonant is already palatalised (91e).

(91) *Zoque* (Wonderly 1965)

a.	pata	'mat'	pʲata	'his mat'
	buɾu	'burro'	bʲuɾu	'his burro'
	faha	'belt'	fʲaha	'his belt'
	mula	'mule'	mʲula	'his mule'
	wakas	'cow'	wʲakas	'his cow'
b.	tatah	'father'	catah	'his father'
	sʌk	'beans'	ʃʌk	'his beans'
	nanah	'mother'	ɲanah	'his mother'
c.	kama	'cornfield'	kʲama	'his cornfield'
	gaju	'rooster'	gʲaju	'his rooster'
d.	hajah	'husband'	hʲajah	'his husband'

	ʔatˢi	‘older brother’	ʔʲatˢi	‘his older brother’
e.	pʲesa	‘room’	pʲesa	‘his room’
	ʃapun	‘soap’	ʃapun	‘his soap’
	tʲᶴoʔngoyah	‘rabbit’	tʲᶴoʔngoyah	‘his rabbit’

Notice that when [–back] is added to [coronal] consonants, the result is actually [coronal, –anterior]. This reflects an articulatory equivalency between [–anterior] and [–back] (think about this equivalency in terms of articulation).

Russian, too, has suffixes which appear to carry a [–back] feature which docks onto stem-final consonants, e.g.: (from Blumenfeld 2002:6)

(92)
-ʲonok	DIM, /ut-/ ‘duck’ vs. /utʲ-onok/ ‘duck-DIM’
-ʲonok	DIM, /orʲol-/ ‘eagle’ vs. /orlʲ-onok/ ‘eagle-DIM’
-ʲuga	PEJOR, /vor-/ ‘thief’ vs. /vorʲ-uga/ ‘thief-PEJOR’
-ʲsk	ADJ, /general-/ ‘general’ vs. /generalʲ-skij/ ‘of a general’ (ADJ)
-ʲsk	ADJ, /volg-/ ‘Volga’ vs. /volʒ-skij/ ‘Volga’ (ADJ)
-ʲba	?, /sud-/ ‘judge’ vs. /sudʲ-ba/ ‘fate’
-ʲba	?, /drug-/ ‘friend’ vs. /druʒ-ba/ ‘friendship’

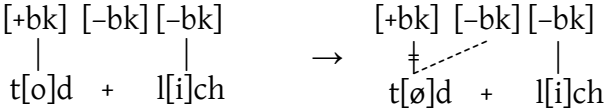
More examples of floating [–back] features come from German (Wiese 1996, Roca & Johnson 1999). The adjectival suffix -lich and the adverbial suffix -ig, both translatable as ‘-ly’ in English, each carry a floating [–back]. To see this, first consider the changes in (93): when -lich or -ig are added to a root, its back vowels (e.g., /o, u, ɔ/) become fronted (/ø, y, œ/, respectively).

(93)
T[o]d	‘death’	t[ø]d+lich	‘deadly’
Br[u]der	‘brother’	br[y]der+lich	‘brotherly’
v[ɔ]ll	‘full’	v[œ]ll+ig	‘fully’

Other suffixes, even those which appear to be very similar on the surface, do not trigger such fronting:

(94)
M[o]de	‘fashion’	m[o]d+isch	‘fashionable’
R[u]he	‘silence’	r[u]h+ig	‘quiet’
d[ɔ]rt	‘there’	d[ɔ]rt+ig	‘of that place’

Roca and Johnson (1999:161–3) suggest that what is special about the suffixes -lich and -ig in (93) is that they carry a floating [–back] feature which replaces the [+back] specification of the root vowels, as represented here for *tödlich* ‘deadly’:

(95)


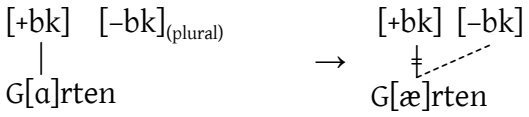
Vowel fronting is also used to indicate the plural form of many nouns in German, e.g. (96). The umlaut diacritic (¨) indicates fronting ([–back]) in a vowel in German orthography.

(96)

Singular	*Plural*	
Garten	Gärten	‘garden(s)’
Vogel	Vögel	‘bird(s)’
Voter	Väter	‘father(s)’
Mutter	Mütter	‘mother(s)’
Bruder	Brüder	‘brother(s)’
Tochter	Töchter	‘daughter(s)’
Kloster	Klöster	‘cloister(s)’

Here, too, it is suggested that a floating [–back] feature, which represents the plural, replaces the [+back] specification of noun vowels (Wiese 1996, Roca & Johnson 1999).

(97)



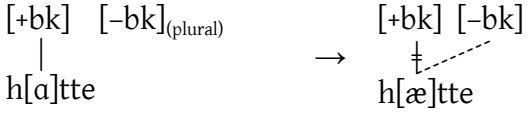
Finally, vowel fronting is also used to indicate the subjunctive form of many verbs, e.g.:

(98)

Past Indic.	*Past Subj.*	
h[ɑ]tte	h[æ]tte	‘have’
br[ɑ]chte	br[æ]chte	‘bring’
w[u]βte	w[y]βte	‘know’

Again, it is believed that a floating [–back] feature, now representing the subjunctive, replaces the [+back] specification of verb vowels:

(99)



Roca and Johnson (1999:164–5) go so far as to analyse English irregular plural forms such as *geese* and *teeth* in the same way: a floating [–back] plural marker replaces the [+back] specification of the vowels in *goose* and *tooth*, respectively. (Note that the [+round] specification of these vowels is assumed to be lost simultaneously, since English disallows the combination [–back, +round] in vowels, i.e. *[y].)

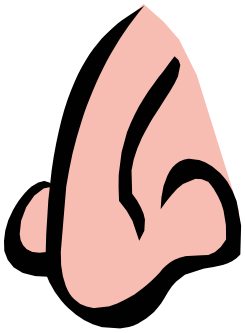
Turning now to [±high], it, too, can occur autonomously from segments. For instance, in Latvian the accusative singular marker appears to be just the feature [+high]. Latvian has two two [–high] vowels /e, a/ and two [+high] vowels /i, u/. At the end of singular accusative forms, a nonhigh vowel is raised to its high counterpart, that is, nonhigh front *e* is raised to high front *i*, and nonhigh back *a* is raised high back *u*, e.g. (100a). Naturally, when the stem-final vowel is already high *i* or *u*, no raising is observed in the singular accusative, e.g. (100b).

(100) *Latvian* (Archangeli 1984)

	sg. loc.	*sg. dat.*	*sg. acc.*	
a.	maːteː	maːtej	maːti	‘mother’ (fem.)

	maːsaː	maːsaj	maːsu	‘sister’ (fem.)
	zirgaː	zirgam	zirgu	‘horse’ (masc.)
b.	zivi:	zivij	zivi	‘fish’ (fem.)
	gulbi:	gulbim	gulbi	‘swan’ (masc.)
	tirguː	tirgum	tirgu	‘market’ (masc.)

2.4. Soft Palate



A single feature is realised by the Soft Palate: [±nasal].[44] Chomsky and Halle (1968:316) define this feature as follows: “Nasal sounds are produced with a lowered velum which allows the air to escape through the nose; nonnasal sounds are produced with a raised velum so that the air from the lungs can escape only through the mouth.” That such a distinction is psychologically real is apparent in speech errors, e.g., the articulator features [+nasal] and [–nasal] are exchanged in the speech error *Cedars of Lebanon* >[e] *Cedars of Lemadon* (Fromkin 1971).

The unmarked value for [nasal] is orality, i.e., [–nasal] (Chomsky & Halle 1968:405). Indeed there are languages in which the feature [+nasal] is banned entirely, such as South Wakashan Ditidaht and Makah (Klokeid 1975).[45] So for example, the root *naq-* ‘to drink’ in North Wakashan Oowekyala has the cognate *daq-* in these other languages. The substitution of [–nasal] phonemes for [+nasal] phonemes is also common in child language, e.g. Sally (Berhardt & Stemberger 1998:320):

(101) Substitution of oral phonemes for nasals in Child English

a.	mask	[pæks]
b.	mouthy	[bʌʊθiː]
c.	music	[tusɪk]
d.	noise	[towəs]
e.	plum	[bap^{h}]

(Berhardt & Stemberger attribute the variation between voiceless and voiced stops in the substitution process to the fact that Sally “did not yet have a voicing contrast” (ibid.).)

More typically, however, languages have at least one nasal, and a language with any nasal has a [+anterior] consonant, e.g., /n/ (Maddieson 1984:69). The labial nasal consonant /m/ is also relatively common, while the velar nasal /ŋ/ appears to be relatively marked. As Maddieson (1984:69) reports, the presence of /ŋ/ in a language implies the presence of both /m/ and /n/, but not vice versa. Oowekyala is an example of a language with /m, n/ (also /m̰, n̰, mː, nː/) but no /ŋ/. For instance, English ‘king’ is adapted as *kin* in Oowekyala (Hilda Smith, p.c.).

While the feature [+nasal] favours [+consonantal] phonemes (/m, n̪, n, ɳ, ɲ, ŋ, ɴ, etc./), it can also combine with [–consonantal]. First, the feature [+nasal] is used for a placeless glide which is found in Indic languages and which is usually written with capital N. Sanskrit grammarians described this glide as an unmodified nasal following a vowel and accordingly referred

[44] Halle, Vaux and Wolfe (2000) introduce [rhinal] as the articulator feature of nasal glides (Trigo 1988) but it is unclear that this feature is motivated independently of [+nasal]. (This feature is not mentioned in the original 1998 manuscript that was eventually revised and published as Halle et al. 2000.)

[45] This is an areal feature, also shared by Twana and Lushootseed.

to it as *anusvara*, literally "after sound" (anu+svara). It involves no particular articulator except the soft palate, which is lowered. The so-called "mora nasal" of Japanese, e.g. *hoN* 'book', is also arguably a nasal glide (Catford 1977, Vance 1986).

Nasal glides are common in some varieties of Spanish, where they occur before nonstops or word-finally (D'Introno & Sosa 1984:2–3). The following words are from a variety of Spanish spoken in northern Dominican Republic (Piñeros 2002).[46] The nasal glide here sounds like "a very weak and reduced" velar nasal (ŋ) (Jimenez Sabater 1975:117).

(102) *Nasal glides in Northern Rustic Dominican Spanish*

a.	oj̯teNsja	'proper name'
	eNfejmo	'sick'
	saNha	'ditch'
	oNraḏo	'honest'
	eNlase	'link'
b.	raṯoN	'mouse'
	seɣuN	'according to'
	bweN	'good'

Second, even [–consonantal] /h/ may be specified [+nasal]. For example, Kwangali, a Kovango (Bantu) language spoken in Namibia, has nasalised h's which are written <nh>, e.g. *nhonho* [ɦoɦo] 'devil's horn'.

(103) Kwangali (Ladefoged & Maddieson 1996:132)

ɦoɦo	'devil's thorn'	hompa	'chief'
ɦuɦwa	'fowl'	huma	'bite'
muɦo	'kind of spear'	muhona	'master'
koɦi	'beneath, under'	ruhunga	'feather'

Third, many languages contrast oral and nasal vowels, e.g. Morley Stoney (Convery 1997):

(104)

hi	'blade of knife'	hĩ	'fur'
ha	'skin'	hã	'yes'
hu	'intercourse'	hũ	'how about it'

Another well-known example of such a language is French, e.g., [nɛ̃] 'dwarf' vs. [ne] 'nose'. That [+nasal] is relatively autonomous of the vowel in such cases is suggested by *stability* effects. Recall that Québec French has a process of vowel coalescence: two vowels V1 and V2 merge to form a long vowel. As the data in (105a-f) make clear, the first vowel deletes before the second one, which is lengthened. Crucially, data such as (105g-h) reveal that while the first vowel deletes in coalescence, its feature [+nasal] survives on the remaining vowel. As Dumas (1977:114) states: "the feature of nasality ... is absolutely immune to any reduction and is systematically transferred to the vowel that remains" (my translation).

(105) *Vowel coalescence in Québec French* (Prunet 1992)

a.	e a	[isõtala:truve]	ils sont allés (l)a trouver	'they went to see her'
b.	i e	[sto:se:kœ:rã]	c'est aussi écoeurant!	'it's just disgusting'
c.	e o	[jã:nepo:so:tã]	il en est passé autant	'so many went by'

[46] Piñeros points out that in this variety, N is sometimes realised as [ŋ] or else simply deleted, in which case the [+nasal] feature survives on the preceding vowel.

d.	i ã	[sa:prã:syk]	ça a pris en sucre	'it turned into sugar'
e.	e ã	[ʒe:tãpɛʃe]	j'ai été empêché	'I was prevented'
f.	ẽ e	[sa:bẽtˢi:re]	ça a ben étiré	'it stretched well'
g.	ẽ a	[ləmulã:lave]	le moulin à laver	'the washing-machine'

Similarly, in Yoruba when a nasal vowel is deleted, the nasality is usually transferred to an adjacent vowel. Here is Pulleyblank (1998:90):

> *[I]n the phrase* [kpḯ olú] *'divide mushrooms', vowel deletion optionally applies to delete the nasalised vowel of the first word (the verb). When this deletion takes place, the nasality of the deleted vowel is not lost; on the contrary, it survives on the initial vowel of the following noun:* [kpõlú].

The autosegmental treatment of nasality seems important for languages like Southern Barasano, in which words are composed either of completely oral segments or completely nasal segments, as illustrated in the two columns below (Pulleyblank 1998:107–8):

(106) *Southern Barasano*

mãnõ	*none*	juka	*vulture*
mĩnĩ	*bird*	wati	*going?*
mãɦãŋĩ	*comer*	wesika	*above*
ŋãmõr̃õnĩ	*ear*	hikoro	*tail*
ẽõnõ	*mirror*		

As Pulleyblank (1998) argues, this generalisation —that words are entirely oral or entirely nasal— is best understood under two assumptions: first, it is assumed that nasal words are lexically marked by the inclusion of a [+nasal] autosegment, while oral words lack such a specification (or else carry a [–nasal] specification). Second, it is assumed that this [+nasal] feature links and spreads throughout the word. This analysis is illustrated here:

(107)

Underlying representations	b a d o [+nas]	w a t i
Link & spread nasality	b a d o [+nas]	n/a
Surface Representations	[mãnõ] 'none'	[wati] 'going?'

Finally, a different language, Terena, offers an even stronger argument for a "floating" [+nasal] feature. In this language, [+nasal] is a morpheme; it indicates the first person singular, e.g.: aride 'sickness' vs. ãr̃ĩnẽ 'my sickness' (Bendor-Samuel 1966).

(108)

Underlying representations	a r i d e	a r i n e
Link & spread nasality	n/a	[+nas] a r i n e [+nas]
Surface representations	[aride] 'sickness'	[ãr̃ĩnẽ] 'my sickness'

2.5. Guttural features

Two articulators are located in the guttural region of the oral tract, below the uvula: the Tongue Root and the Larynx. These articulators and their dependent features are treated in the sections that follow.

2.5.1. Tongue Root

Two features depend on the Tongue Root: [radical] and [±ATR].

2.5.1.1. [radical]

[radical] is an articulator feature which characterises phonemes produced primarily with the root of the tongue, such as the pharyngeal glides /ʕ, ħ/. The latter are famously found in Arabic, but also occur in many other languages. They are illustrated in the following words from Morley Stoney (Covenry 1997:47):

(109)

[bóʕã]	'blow'	[ħoʕã́]	'fish'
[ʕi]	'brown'	[gaħníʕa]	'choose'
[ãʕán]	'on top'	[ħno]	'growling'
[naʕé]	'stomach'	[ĩjáħe]	'mountain'

We treat pharyngeals as glides, i.e. [–consonantal, +sonorant], following, e.g., Laufer (1996), Halle, Vaux & Wolfe (2000). But it should be noted that many treat pharyngeals as fricatives, i.e. [+consonantal, –sonorant], e.g., Ladefoged & Maddieson (1996).

2.5.1.2. [±ATR]

The feature [±ATR] distinguishes between sounds in which the tongue root is advanced (+) or retracted (–). Because the Tongue Root is connected to the Tongue Body, there is some interaction between [±ATR] and the Tongue Body features [±high], [±low], and [±back]. In particular, high vowels tend to be also [+ATR], because the Tongue Root is pulled forward as the Tongue

Body is raised. On the other hand, low vowels tend to be [–ATR] because the Tongue Root tends to retract rather than advance when the Tongue Body is lowered.

Some vowels, such as [a] and [ʌ], are ambiguous in terms of their [±ATR] specification. Each is treated as [+ATR] in some languages, and [–ATR] in other languages. Otherwise, the feature [±ATR] is useful in distinguishing between so-called "tense" versus "lax" vowels in (Canadian) English as in many other languages:

(110)

[+ATR]	i, e, æ, u, o	also:	y, ø, etc.
	beat, bait, bat, boot, boat		
[–ATR]	ɪ, ɛ, ɑ, ʊ, ɔ[47]	also:	ʏ, œ, etc.
	bit, bet, bought, foot, boy/bore		

Note that in English, [+ATR] [i, e, u, o] are typically longer than their [–ATR] counterparts [ɪ, ɛ, ʊ, ɔ]. For instance, the [+ATR] vowels highlighted in the left column of (111) are noticeably long (cf. short vowels in right column). By contrast, [–ATR] [ɪ, ɛ, ʊ, ɔ] are never long in English.

(111)

[eː]	Can**a**dian	cf.	Can**a**da
	Ar**a**bia		Ar**a**b
	Jord**a**nian		Jord**a**n
	reg**a**lia		reg**a**l
	cour**a**geous		cour**a**ge
[oː]	Mong**o**lia		Mong**o**l
	Babyl**o**nian		Babyl**o**n
	fel**o**nious		fel**o**n
	col**o**nial		col**o**ny
	Greg**o**rian		Greg**o**ry
[iː]	coll**e**giate		coll**e**ge
	com**e**dian		com**e**dy

Exercises

A. Consider the distribution of [uː] and [ʊ] in the data below, which comes from a single speaker of American English (Davenport & Hannahs 1998).

(112)

a.	ɹuːm	'room'	k.	ɹʊt	'root'
b.	luːt	'loot'	l.	wʊd	'wood'
c.	huːf	'hoof'	m.	ɹʊk	'rook'
d.	zuːm	'zoom'	n.	sʊt	'soot'
e.	puːl	'pool'	o.	kʊd	'could'
f.	ɹuːt	'root'	p.	ɹʊf	'roof'

[47] In Canadian English [ɔ] is not a contrastive vowel: it occurs before [j] and [ɹ]; [o] occurs elsewhere.

g.	kuːd	‘cooed’	q.	hʊf	‘hoof’
h.	wuːd	‘wooed’	r.	rʊm	‘room’
i.	suːt	‘soot’	s.	pʊl	‘pull’
j.	ɹuːf	‘roof’	t.	gʊd	‘good’

i) Look for evidence of contrastive distribution, complementary distribution and/or free variation. Which do you find?
ii) In what ways is the evidence concerning the number of phonemes involved apparently contradictory?
iii) How should this contradiction be resolved? (i.e. how many phonemes are represented by the phones [uː] and [ʊ], and why)?

B. *Canadian French* (ibid.)

Examine the high vowels in the following data. Is the alternation between tense —[i, y, u]— and lax —[ɪ, ʏ, ʊ]— vowels predictable? If so, what is the prediction? If not, demonstrate why it is not predictable. Note: stress is always on the final syllable.

(113)

a.	plozɪb	‘plausible’	i.	tʊt	‘all’ (fem.)
b.	by	‘goal’	j.	vi	‘life’
c.	kri	‘cry’	k.	rʊt	‘route’
d.	tu	‘all’ (masc.)	l.	vɪt	‘quickly’
e.	sʊp	‘soup’	m.	lu	‘wolf’
f.	marɪn	‘marine’	n.	lʏn	‘moon’
g.	trʏf	‘truffle’	o.	ry	‘street’
h.	rʏd	‘rude’	p.	ply	‘rained’

Now examine the following data. Does the previous observation hold? (Assume that all high vowels pattern the same way.) If not, what modification must be made?

(114)

a.	vitɛs	‘speed’	e.	sifle	‘whistle’
b.	sinema	‘cinema’	f.	afrɪk	‘Africa’
c.	afrikɛ̃	‘African’	g.	sivɪl	‘civil’
d.	sivilite	‘civility’	h.	supe	‘dine’

Evidence of a floating [ATR] feature comes from Akan. In this Kwa language, the [ATR] specification of vowels in prefixes and suffixes usually agrees with the [ATR] specification of neighbouring vowels in stems (this is *vowel harmony*; we return to this topic later in the course). For example, the prefix is [+ATR] *o-* in (115a), as it is next to a [+ATR] vowel in the stem *bi̱sa*. But the same prefix is [–ATR] *ɔ-* in (115b), as it is next to a [–ATR] vowel in the stem, *ka̱ri*. Conversely, the suffix is [–ATR] *-ɪ* in (115a), as it is next to a [–ATR] vowel in the stem *bisa̱*, while it is [+ATR] *-i* in (115b), as it is next to a [+ATR] vowel in the stem, *kari̱*.

(115) *Akan: affixation to "regular" roots*

a.	ɔ-bisɑ-ɪ	'he asked'	b i s ɑ | | [+atr][–atr]	'to ask'
b.	ɔ-kɑri-i	'he weighed'	k ɑ r i | | [–atr][+atr]	'to weigh'

But Akan has some exceptional roots, such as *dʒʷanɪ* 'to flee' and *sʲanɪ* 'to come down', which begin with [–ATR] vowels yet which paradoxically behave as if they begin with [+ATR]: as shown in (116c,d), these roots systematically induce [+ATR] prefixes.

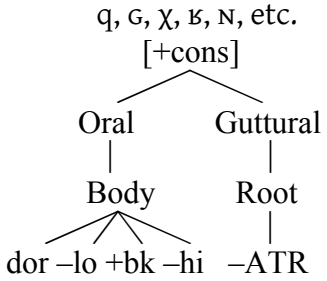
(116) *Akan*

a.	ɔ-bisɑ-ɪ	'he asked'	c.	ɔ-dʒʷɑnɪ-ɪ	'he fled'
b.	ɔ-kɑri-i	'he weighed'	d.	ɔ-sʲɑnɪ-ɪ	'he came down'

Kenstowicz (1994) explains that these roots derive historically from [dʒ**u**ɑnɪ] and [s**i**ɑnɪ]. When the etymological vowels [u] and [i] (in bold) were dropped, some of their features survived ("stability"): [+round] of historical [u] survived as labialisation on the preceding consonant ([dʒʷ]) in the first root, while [–back] of historical [i] survived as palatalisation on the preceding consonant ([sʲ]) in the second root. Interestingly, the feature [+ATR] of deleted [u, i] also survived —not as a secondary feature on a preceding consonant but as a "floating" feature. Its presence is thus manifest only in preceding prefixes.

Turning now to consonants, it is sometimes claimed that uvulars are specified with the Tongue Root feature [–ATR], in addition to being specified with the Tongue Body features [+back] and [–high] (Chomsky and Halle 1968:305, 307; Halle, Vaux & Wolfe 2000:409). The Tongue Root-specification of uvulars follows Cole (1987), Elorrieta (1991), Pulleyblank (1995:12), etc.[48]

(117) *Possible representation of uvulars*



[48] The treatment of uvulars as involving the Tongue Root is similar to McCarthy's (1994) treatment of these segments as Dorsal-Pharyngeal, except that he defines Pharyngeal as an 'orosensory region', not an articulator. McCarthy's definition of Pharyngeal is primarily motivated by his belief that guttural laryngeals in Arabic are articulated without involvement of the tongue root. Shahin (1997) argues against this view, claiming that Arabic laryngeals are actively involved in tongue root retraction harmony. The Tongue Root feature [–ATR], not the orosensory feature Pharyngeal, is assumed here in keeping with an articulator-based model of features.

In this connection it is interesting to note that in South Wakashan languages plain uvular stops /q, qʷ/ have remained intact (compare, e.g., North Wakashan Oowekyala *naq-* 'drink' and South Wakashan Nootka-Nuuchahnulth *naq-* 'ibid.'), but ejective uvulars /q', qʷ'/ have changed to a glottalised pharyngeal approximant /ʕ'/ in both Ditidaht and Nootka-Nuuchahnulth, and uvular fricatives /χ, χʷ/ have changed to a voiceless pharyngeal fricative /ħ/ in Nootka-Nuuchahnulth but not in Ditidaht (Jacobsen 1969).

(118) Uvular-to-pharyngeal changes in South Wakashan

	Proto-South Wakashan	*Nootka-Nuuchahnulth*	*Ditidaht*	*Makah*	
a.	q'apaːk	ʕ'apaːk	ʕ'apaːk	q'paːk	'willing'
b.	qʷ'itˢaːk	ʕ'itˢaːk	ʕ'itˢaːk	qʷ'itˢaːk	'rotten'
c.	miq'aːt	miʕ'aːt	biʕ'aːt	biq'aːt	'sockeye salmon'
d.	q'iχak	ʕ'iħak	ʕ'aχak	q'iχak	'to cry, howl'
e.	χamup	ħamup	χabup	χabup	'knowing'
f.	χupt-	ħupta:	χuːbit'ad	χuːbit'ad	'snoring'
g.	tˢ'iχʷat-	tˢ'iħata	tˢ'iχʷatʃtˡ	tˢ'iχʷatʃitˡ	'to be scared'

These historical changes suggest that the interpretation of uvulars as Tongue Root-specified is independently-motivated at least in Wakashan. Unless uvulars are specified with the Tongue Root feature [–ATR], it is difficult to explain the shift of uvulars to Tongue Root-articulated ([radical]) pharyngeals in South Wakashan, e.g., North Wakashan Oowekyala ciχʷa 'sour' vs. South Wakashan Nuuchahnulth ciħuk 'ibid.'; North Wakashan Oowekyala huχʷa 'to whistle' vs. Nuuchahnulth huħa: 'ibid.'.

The feature [–ATR] has been used to characterize not only uvulars consonants but also *pharyngealisation* on nonback consonants, i.e., "emphatics" (/tˤ, sˤ, etc./) which are found in some Salishan, Athapaskan and Semitic languages, e.g., Qatari Arabic *sad* 'to prevail' vs. *sˤad* (name of the letter) (Ladefoged & Maddieson 1996:365; see van Eijk 1997, Bessell 1998; also McCarthy 1994 on [pharyngeal]). The option of specifying nonback consonants as [–ATR] turns out to be important also in Wakashan. As Lincoln & Rath (1980:25) report:

> It is a peculiarity of Ha[isla, a North Wakashan language,] that [some instances of] /t/ and /t'/ ... cause a following vocalic resonant to sound like after a plain uvular, for example: tiɬa [tɛɪɬa] 'to fish with baited hook and sinker'; tlqʷi [tʌlqʷi] 'the one there is soft (cloth, etc.)'; t'uxʷa [t'ɔʊxʷa] 'a wave'; t'msdu [t'ɑmsdu] 'stye'.

Lincoln & Rath (1986:46) also suggest some possible cases of emphatic /p, p'/. The fact that these consonants have the same lowering effect on an adjacent vowel as uvulars[49] suggests a common feature, arguably [–ATR].

[49] This lowering effect is described in greater detail in the following section.

2.5.2. Larynx

At least four features depend on the Larynx: [glottal], [±voice], [±spread glottis], [±constricted glottis]. (Tone is also considered Larynx-dependent by some phonologists, e.g., Avery & Idsardi 2001; Tone is introduced in the next major section.)

2.5.2.1. [glottal]

This feature characterises the class of segments that have the larynx as primary articulator, notably the laryngeal glides /h/ and /ʔ/. Like segments executed by other articulators ([labial], [coronal], [dorsal]), laryngeals may be labialised (hʷ, ʔʷ), palatalised (hʲ, ʔʲ), or pharyngealised (hˤ, ʔˤ) ([+round], [–back], and [–ATR], respectively).

Considering first labialised laryngeals, you might recall that in the Gurage language Muher, a labialised [kʷ'] is realised as [ʷ] postvocalically, as illustrated in the following data (repeated from (87) above):

(119)	*Root*	*Perfect*	*Imperfect*	*Jussive*	
a.	/kʷ'm/	kʷ'əməm	jɨʔʷəmu	jəʔʷɨm	'stand'
b.	/k'wr/	kʷ'əkkʷ'ərəm	jɨʔʷəkkʷ'ɨru	jəʔʷəʔʷɨr	'squeeze, wring'
c.	/lak'/	laʔʷim	jɨləʔʷit	jəlaʔʷi	'surpass'
d.	/nk'-nk'/	nɨʔənnəʔʷim	jɨnk'ənnɨʔʷit	jənəʔnəʔʷi	'shake'

In this case, the [dorsal] feature of /kʷ'/ is *delinked* after vowels, and is replaced by [glottal], resulting in labialised [ʔʷ].

An example of palatalised laryngeals is found in the following exercise, from Kenstowicz (1994).

Exercise: Irish

As part of the well-known lenition alternation in Irish, the voiceless plain coronals [t] and [s] and their palatalised counterparts [tʲ] and [sʲ] reduce to [h] and [hʲ], respectively. How can this process be formulated? Discuss its bearing on feature geometry with respect to place and stricture features and the representation of secondary articulation.

(120)				
	talə	'land'	mə halə	'my land'
	soləs	'light'	mə holəs	'my light'
	tʲoːxt	'temperature'	mə hʲoːxt	'my temperature'
	sʲoːl	'sail'	mə hʲoːl	'my sail'

An example of pharyngealised laryngeals comes from Oowekyala: it has laryngeals /hˤ, ʔˤ/ which pattern as a natural 'guttural' class with uvulars /q, ɢ, q', χ/, in the following way: both cause a following vowel to become lowered. The following data illustrate the lowering of /i, u/ to [ɛ, ɔ] after gutturals.[50]

(121) *Vowel-lowering in Oowekyala*

a.	dˡiqila	[dliqˣɛla]	'to give a name to s.o.'
b.	ka:qu	[kʲæqˣɔ]	'to collide'
c.	ɬaɢis	[ɬaɢɛs]	'a tent'
d.	tan'iɢu	[tʰan'iɢɔ]	'close to each other (as two people passing)'
e.	tq'ila	[tʰq'ɛla]	'to advise'
f.	w'aq'ut	[w'aq'ɔtʰ]	'to feed a visitor, give a feast of welcome'
i.	hiɬ	[hɛɬ]	'to set right, to heal'
j.	huma	[hɔma]	'to obtain information (by watching, listening, questioning)'
k.	ʔixp'a	[ʔɛxʲp'a]	'good or sweet taste, to have a good or sweet taste'
l.	ʔukʷ	[ʔokˣʷ]	'to pity, to have mercy'

The parallel lowering effect of uvulars and laryngeals is reported for Oowekyala by Hilton & Rath (1982:15-6, 19-20); it is also reported for Heiltsuk by Lincoln & Rath (1980:15-6) and by Rath (1981:9-11), for Haisla by Lincoln & Rath (1986:17, 20-1), and for Kwakwala by Lincoln & Rath (1980:20). By contrast, this effect is completely absent from South Wakashan languages (e.g., Sapir & Swadesh 1939, Fraser & Howe 1996). The feature responsible for this natural class behaviour of laryngeals and uvulars is [–ATR]. (See above; also recall "emphatics" in Haisla.)

Turning now to the relation between [glottal] and [radical], their dependence on a shared Guttural node is apparent in language acquisition. Shahin (1995) reports that laryngeals [h, ʔ] (variably) replace pharyngeals [ħ, ʕ] in Child (Palestinian) Arabic, e.g.:

(122) *Substitution of [glottal] for [radical] in Child (Palestinian) Arabic*

a.	/ħæ:mi/	[hæmi]	'difficult'	2;2
b.	/rˤu:ħ/	[lʊh]	'to go'	2;4
c.	/ʕʊsˤsˤ/	[ʔɑs]	'to press, squeeze'	1;11

In their discussion of this pattern, Bernhardt and Stemberger (1998:303) remark: "we might assume ... (for languages such as Arabic) that pharyngeals and glottals are subsumed under a node of their own [Guttural]. ... When one type of guttural is not possible, the other might replace it."

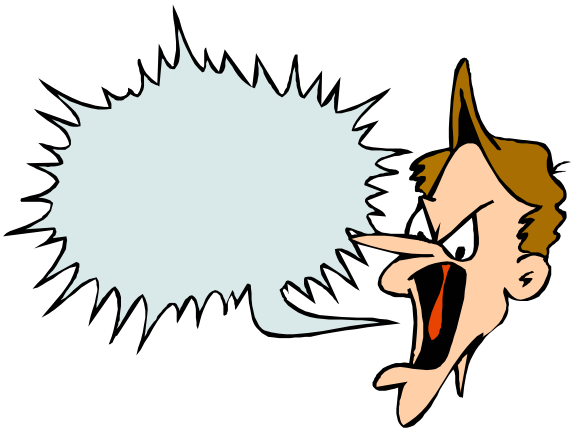
That [glottal] and [radical] pattern differently from other articulator features is also apparent from their natural class behaviour. For example, in Sudanese Arabic (Kenstowicz 1994) the coronal nasal [n] *assimilates* the point of articulation of the following consonant, becoming [m] before [labial] consonants, [ɲ] before [coronal, –anterior], and [ŋ] before [dorsal] consonants. Crucially, the coronal nasal [n] remains unchanged before [radical] [ħ, ʕ] or [laryngeal] [h, ʔ], as illustrated in (j-l):

[50] The lowering effect is strictly local, e.g. qput 'to overturn, tilt' is pronounced [qput], not [qpot].

(123)

	perfect	*imperfect*			*perfect*	*imperfect*	
a.	nabaħ	ja-mbaħ	'bark'	g.	nakar	ja-ŋkur	'deny'
b.	nafad	ja-mfid	'save'	h.	naxar	ja-ŋxar	'puncture'
c.	nazal	ja-nzil	'descend'	i.	nagal	ja-ŋgul	'transfer'
d.	nasaf	ja-nsif	'demolish'	j.	naħar	ja-nħar	'slaughter'
e.	naʃar	ja-ɲʃur	'spread'	k.	niʕis	ja-nʕas	'fall asleep'
f.	naʤaħ	ja-ɲʤaħ	'succeed'	l.	nahab	ja-nhab	'rob'

2.5.2.2. [±voice]



This feature distinguishes primarily between [+voice] segments which are produced with accompanying vocal fold vibration and [–voice] segments which do not involve any vibration of the vocal folds.[51]

In order for the vocal folds to vibrate, air needs to flow through them. In order for this to happen, the air pressure above the glottis (*supralaryngeal* or *supraglottal*) must be less than the air pressure below the glottis (*sublaryngeal* or *subglottal*). It follows that the natural (*unmarked*) laryngeal state for obstruents ([–sonorant]) is [–voice], since by definition obstruents involve high supralaryngeal pressure. (See [±sonorant] section above.) We can express this relationship between voicing and sonorancy as a markedness constraint:

(124) *Voicing markedness*

$$*\begin{bmatrix} -\text{sonorant} \\ +\text{voice} \end{bmatrix}$$

"Obstruents must be voiceless."

Indeed, obstruents are exclusively voiceless in many languages, e.g., Hawaiian, Korean, Nuuchahnulth, etc. Still, many languages do allow voiced obstruents in addition to voiceless obstruents, against (124).[52]

(125) *Voicing contrasts in obstruents*

	p	p^f	t	t^s	$t^ɬ$	$t^ʃ$	ʈ	c	k	q
[+voice]	b	b^v	d	d^z	d^l	$d^ʒ$	ɖ	ɟ	g	ɢ
	ɸ	f	θ	s	ɬ	ʃ	ʂ	ç	x	χ
[+voice]	β	v	ð	z	ɮ	ʒ	ʐ	ʝ	ɣ	ʁ

[51] Phonologists sometimes use the feature [±slack vocal folds] in place of [±voice], under the understanding that vocal folds vibrate (voicing) when they are "loose" [+slack] and vocal folds do not vibrate (voiceless) when they are "taut" or "stiff" ([–slack]) (Halle & Stevens 1971). The feature [±slack] was proposed based on vocal cord modeling but has not been supported by experimental evidence in actual observation of speakers (Keating 1988b).

[52] Some languages, such as Nukuoro (Polynesian), reportedly have voiced stops but no voiceless ones. De Lacy (2002:287, n. 165) denies the existence of such languages, describing Nukuoro stops as voiceless unaspirated, perhaps much like [p, t, k] in English *s*[p]*an*, *S*[t]*an*, *s*[k]*an*, respectively.

The following word pairs illustrate [±voice] contrasts among stops and fricatives in French:

(126) *French*

a.	pu	'lice'	d.	fu	'crazy'
	bu	'end'		vu	'you'
b.	tu	'all'	e.	su	'penny'
	du	'soft'		zu	'zoo'
c.	ku	'neck'	f.	ʃu	'cabbage'
	gu	'taste'		ʒu	'cheek'

The difficulty of implementing [+voice] in obstruents can be vividly illustrated by Southern Barasano. Recall from section 2.4 above that in this language words are generally composed either of completely oral segments or completely nasal segments, as shown in the first two columns of (127), repeated from (106) from section 2.4. A complication is now revealed in the third column of (127): voiced stops are prenasalised.

(127) *Southern Barasano*

mãnõ	'none'	juka	'vulture'	^{n}diro	'fly'
mĩnĩ	'bird'	wati	'going?'	wa^{m}ba	'come!'
mãɦãŋĩ	'comer'	wesika	'above'	^{m}ba^{ŋ}go	'eater'
ŋãmõr̃õnĩ	'ear'	hikoro	'tail'	ho^{ŋ}goro	'butterfly'
ẽõnõ	'mirror'			ta^{m}boti	'grass'

As Pulleyblank (2000:97) remarks, the prenasalised voiced stops of Southern Barasano, as exemplified in the third column of (127), raise several questions:

(i) If prenasalisation involves specification for the feature [+nasal], why don't prenasalised stops initiate nasal harmony?
(ii) Why do prenasalised stops appear in otherwise fully oral words?
(iii) If prenasalisation involves the assignment of [+nasal] to a segment, then why don't the targeted segments become fully nasal(ised)?

Pulleyblank proposes to answer these difficult questions by relying on the notion of "nasal leakage" in voiced stops:

> "Under the assumption that the input to the phonetic component is exactly as [*diro*, *waba*, *bago*, *hogoro*, etc.], there is a problem for the oral voiced stops. Phonetically, in order to maintain voicing there must be airflow from the lungs and through the larynx. With an oral stop, it is difficult to maintain such airflow because the supraglottal cavity is closed: as air flows up from the lungs, the supraglottal cavity will tend to increase in air pressure, counteracting the very airflow that is needed for voicing. To facilitate the realisation of voicing during a stop, therefore, a mechanism must be found to facilitate maintenance of a pressure differential across the glottis. One way to maintain the airflow is to allow air to escape through the nasal cavity. Effectively, by allowing air to "leak" out through the nose, a speaker prevents air pressure from building up in the supraglottal cavity, and it becomes possible to maintain voicing during an oral closure.

According to the proposal of nasal leakage, the prenasalised stops are not phonologically nasal at all. Phonologically, they are fully "oral". This accounts for the fact that they do not trigger nasal spreading. It similarly accounts for why they occur in "oral" words and why they are not fully nasal."

Prenasalisation in Southern Barasano highlights the phonetic difficulty of implementing voicing in obstruents. Given this difficulty, it is perhaps not surprising that in many languages, [±voice] is distinctive only for obstruents in certain positions. For example, German admits voiced obstruents, but not word-finally, as the following alternations illustrate:

(128) *Final devoicing in German*

a.	Lo[p] ~ Lo[b]es 'praise' ~ pl.	cf.	Perisko[p] ~ Perisko[p]e 'periscope' ~ pl.
b.	Ra[t] ~ Ra[d]es 'wheel' ~ pl.	cf.	Ra[t] ~ ra[t]en 'advice' ~ v.
c.	Sar[k] ~ Sär[g]e 'coffin' ~ pl.	cf.	Vol[k] ~ Vol[k]e 'people' ~ pl.
d.	akti[f] ~ akti[v]e 'active' ~ pl.	cf.	Ho[f] ~ Hö[f]e 'courtyard' ~ pl.
e.	Gra[s] ~ Grä[z]er 'grace'~ ?	cf.	Ro[s] ~ Ro[s]e 'horse' ~ pl.
f.	oran[ʃ]e ~ Oran[ʒ]e 'orange' ~ ?	cf.	la[ʃ] ~ la[ʃ]e 'lax' ~ ?

More specifically, German grammar permits voiced obstruents in syllable-initial position, but not in syllable-final position, as the following alternations illustrate. (A period [.] indicates a syllable boundary; the following data are from Wiese 1996)

(129) *Syllable-final devoicing in German*

a. e[d]el ~ e.[d]les / e[t].les
b. han[d]eln ~ Han.[d]lung / Han[t].lung
c. schmu[g]eln ~ Schmu.[g]ler / Schmu[k].ler
d. nör[g]eln ~ Nör.[g]ler / Nör[k].ler
e. Ei[g]entum ~ Ei.[g]ner / Ei[k].ner / Ei[ç].ner
f. Re[g]en ~ re.[g]nen / re[k].nen / re[ç].nen

We might say that German has a *positional markedness constraint* against voiced obstruents in syllable-final position:

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(130) *Syllable-final voicing markedness*

$$*\begin{bmatrix} -\text{sonorant} \\ +\text{voice} \end{bmatrix}.$$

"Voiced obstruents are not permitted syllable-finally."

This constraint results in *positional neutralisation*: lexical distinctions in [±voice] are neutralised syllable-finally; underlying [+voice] /b v d z ʒ g/ and underlying [–voice] /p f t s ʃ k/ become identical as [p f t s ʃ k] in syllable-final position.

Exercises:

A. *Turkish* (Halle & Clements 1983)

In the set of data below, the vowel of the possessed form suffix assimilates to the quality of the preceding stem vowel, according to a process of vowel harmony to be discussed later in the course. Ignore this process of assimilation for now, and focus on the alternation involving the final consonant of the noun stem in some of the forms:

(131)		*noun stem*	*possessed form*	*UR (stem)*
a.	'rope'	ip	ipi	
b.	'louse'	bit	biti	
c.	'reason'	sebep	sebebi	
d.	'wing'	kanat	kanadɨ	
e.	'honour'	ʃeref	ʃerefi	
f.	'rump'	kɨtʃ	kɨtʃɨ	
g.	'pilot'	pilot	pilotu	
h.	'bunch'	demet	demeti	
i.	'wine'	ʃarap	ʃarabɨ	
j.	'Ahmed'	ahmet	ahmedi	
k.	'slipper'	pabutʃ	pabudʒu	
l.	'power'	gytʃ	gydʒy	
m.	'basket'	sepet	sepeti	
n.	'art'	sanat	sanatɨ	
o.	'cap'	kep	kepi	
p.	'worm'	kurt	kurdu	
q.	'hair'	satʃ	satʃɨ	
r.	'colour'	renk	rengi	

Give the underlying representation (UR) of the noun stems in the space provided. Describe the phonological process that accounts for the consonant alternations. Justify your explanation by suggesting an alternative and showing that it is inferior to your solution.

B. *Friulian* (Kenstowicz 1994)

In the Friulian dialect of Italian, there is an alternation between voiced and voiceless obstruents. Suggest an explanation to account for the following voicing alternations. (Ignore accents.)

(132)				
	wárp	'blind'	kwárp	'body'
	warb-ít	'sty'	kwarp-út	dimin.
	piérd-i	'to lose'	dínt	'tooth'
	piért	3sg.	dint-isín	dimin.

In spite of their alleged phonetic difficulty, voiced obstruents are favoured in certain positions in many languages. This state of affairs can be illustrated with an exercise on Plains Cree (Algonquian), from Davenport & Hannahs (1998:112–3):

C. In the following data from Plains Cree (Algonquian), examine the sounds [p], [b], [t], [d], [k] and [g], and determine whether they are in complementary or contrastive distribution. How many phonemes do we need to posit to account for the distribution of these sounds? What are they? Explain your solution.

(133)

a.	pahki	'partly'	l.	tahki	'all the time'
b.	niːsosaːp	'twelve'	m.	mihtʃeːt	'many'
c.	taːnispiː	'when'	n.	nisto	'three'
d.	paskuaːu	'prairie'	o.	tagosin	'he arrives'
e.	asabaːp	'thread'	p.	miːbit	'tooth'
f.	siːsiːp	'duck'	q.	nisida	'my feet'
g.	waːbameːu	'he sees him'	r.	meːdaueːu	'he plays'
h.	naːbeːu	'man'	s.	kodak	'another'
i.	aːbihtaːu	'half'	t.	nisit	'my foot'
j.	nibimohtaːn	'I walk'	u.	nisiːsiːbim	'my duck'
k.	siːsiːbak	'ducks'	v.	iskodeːu	'fire'

Turning now to the possibility of a floating [+voice] feature, consider first the case of *rendaku* in the native vocabulary of Japanese (Yamato). This process assigns [+voice] to the initial consonant of the second member of a compound. For example:

(134) *Rendaku in Japanese*

a.	ju	+	toːɸu	→	judoːɸu
	'hot water'		'tofu'		'boiled tofu'
b.	jo	+	sakura	→	jozakura
	'night'		'cherry'		'blossoms at night'
c.	ko	+	tanuki	→	kodanuki
	'child'		'raccoon'		'baby raccoon'
d.	mizu	+	seme	→	mizuzeme
	'water'		'torture'		'water torture'
e.	ori	+	kami	→	origami
	'fold'		'paper'		'origami'
f.	jama	+	tera	→	jamadera
	'mountain'		'temple'		'mountain temple'
g.	iro	+	kami	→	irogami
	'colour'		'paper'		'colored paper'
h.	take	+	saru	→	takezaru
	'bamboo'		'net'		'bamboo net'

The feature [+voice] which is assigned in this fashion is assumed to be "floating" a priori, i.e., it is underlyingly independent of any segment (Itô & Mester 1995, Avery & Idsardi 2001).

Another example of floating [+voice] comes from Aka, a Bantu C language spoken in the Central African Republic (Kosseke & Sitamon 1993, Roberts 1994, Akinlabi 1996). In this language, the so-called "noun class 5" is marked by voicing the first consonant of the root, as shown in (135a). As Akinlabi (1996:286) explains, "the featural prefix is simply [voice]".

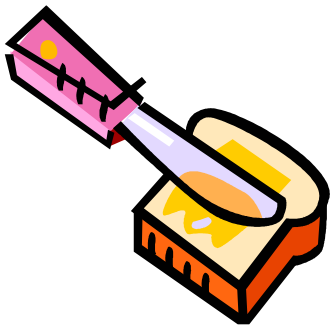
(135)

	Singular (class 5)	*Plural (class 6)*	
a.	dèngé	mà-tèngé	'piercing tool'
	dɔ̀tɔ̀	mà-tɔ̀tɔ̀	'catridge'
	gásá	mà-kásá	'palm branch'
	gìnì	mà-kìnì	'fly'
	bòkí	mà-pòkí	'arch of the eyebrows'
	bàpùlàkà	mà-pàpùlàkà	'lung'
	βɔ̀ndú	mà-ɸɔ̀ndú	'goiter'
	βókó	mà-ɸókó	'hole'
b.	dʒú	mà-su	'cheek'
	dʒèlé	mà-sèlé	'lizard' (sp.)
c.	gɔ̀àlà	mà-gɔ̀àlà	'game of imitation'
	bèlèlè	mà-bèlèlè	'sound of a waterfall'
	dʒámbà	mà-dʒámbà	'mud'

The examples in (135b) illustrate what happens with stems that begin with /s/. As Akinlabi (1996:286) explains, Aka does not have [z], though it does have [dʒ], so when [+voice] is added to /s/, the result is not [z], which Aka happens to lack, but [dʒ], its closest consonant. (In other words, [+voice] as well as [–continuant] are added to /s/.) The examples in (135c) are provided to show that nothing happens in Class 5 when the stem-initial consonant is already [+voice].

Note, finally, that the independence of [±voice] can also be motivated on the basis of evidence from speech errors, e.g., the articulator features [+voice] and [–voice] are exchanged in the speech errors *big and fat* >^{e} *pig and vat*, *I'll wring his neck* >^{e} *I'll* [ɹɪŋk] *his* [nɛg] (Fromkin 1971). The feature [+voice] is also changed to [–voice] in the error *reveal* >^{e} [ɹifiːɬ] (ibid.).

2.5.2.3. [±spread glottis]



Segments produced with the vocal folds held wide apart, such as [h] and aspirated consonants, are [+spread glottis]; other segments are [–spread glottis] (Halle & Stevens 1971).

The following word pairs from Standard Chinese illustrate lexical distinctions based on [±spread glottis]. (Aspirated obstruents are transcribed with the superscript [ʰ].)

(136) *Some [±spread glottis] contrasts in Standard Chinese* (all vowels are high level tone)

a.	pʰa	'flower'
	pa	'eight'

b.	tʰa	‘it, he/she’
	ta	‘to put up, build’
c.	tˢʰa	‘to wipe’
	tˢa	‘take food with tongue’
d.	ʈʂʰa	‘to stick in’
	ʈʂa	‘to pierce’
e.	tᶜʰa	‘to dig fingernail into’
	tᶜa	‘to add’
f.	kʰa	‘to scrape with knife’
	kai	‘ought to, must’

Standard Chinese has a full series of fricatives /f, s, ʂ, ɕ, x/ but these do not contrast in [±spread glottis]. Standard Chinese is typical in this regard —in having distinctive [±spread glottis] among its stops but not among its fricatives. Contrastive aspiration in fricatives is extremely rare. A possible case comes from Burmese: many —but not all—speakers of this language make a three-way contrast in their fricatives, presumably [+voice, –spread glottis] vs. [–voice, –spread glottis] vs. [–voice, +spread glottis], e.g., zà ‘lace’ vs. sà ‘hungry’ vs. sʰà ‘letter’ (Ladefoged & Maddieson 1996:179).

Burmese is also well-known for distinguishing voiced nasals from voiceless ones, as shown here:

(137) *Burmese* (Ladefoged & Maddieson 1996:111)

	Bilabial	*Alveolar*	*Palatal*	*Velar*	*Labialised-alveolar*
Voiced	mă	nă	ɲă	ŋâ	nʷă
	‘hard’	‘pain’	‘right’	‘fish’	‘cow’
Voiceless	m̥ă	n̥ă	ɲ̥ă	ŋ̊â	n̥ʷă
	‘notice’	‘nose’	‘considerate’	‘borrow’	‘peel’

The basis for this distinction is assumed to be [±spread glottis]. As Ladefoged and Maddieson (1996:111) remark: “These voiceless nasals usually have an open glottis for most of the articulation.”

The feature [±spread glottis] also presumably distinguishes between [ʍ] (also written [w̥] or [wʰ]) and [w], which are two contrastive phones in many dialects of English, e.g. Scottish (Davenport & Hannahs 1998:110):

(138) *Aspirated [ʍ] vs. unaspirated [w] in Scottish English*

ʍełz	‘whales’	wełz	‘Wales’
ʍɪtʃ	‘which’	wɪtʃ	‘witch’
ʍɛðʌɾ	‘whether’	wɛðʌɾ	‘weather’
ʍʌɪt	‘white’	wʌɪp	‘wipe’
əwʌɪɬ	‘awhile’	əwɔʃ	‘awash’
ʍaːe	‘why’	weː	‘way’
ʍɪp	‘whip’	wɔnt	‘want’

It is worth noting here that [±spread glottis] plays an important, albeit non-contrastive, role in English phonology: roughly, in absolute word-initial position, voiceless stops and im-

mediately following consonants (if any) are [+spread glottis]; consonants after /s/ are [–spread glottis].

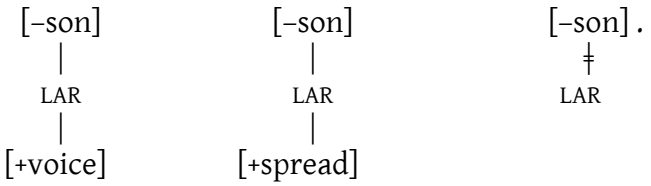
(139) *Aspirated vs. unaspirated allophones in English*

a.	[pʰ]an	vs.	s[p]an
b.	[tʰ]op	vs.	s[t]op
c.	[kʰ]an	vs.	s[k]an
d.	p[l̥]ant	vs.	s[l]ant
e.	p[ɹ̥]oud	vs.	sh[ɹ]oud
f.	p[j̊]ure	vs.	sp[j]ew
g.	qu[w̥]een	vs.	squ[w]eeze

Consider now the notion that [+spread glottis] and [+voice] constitute a natural class under Laryngeal. Evidence of their class behaviour comes from a common form of reduction whereby laryngeal distinctions are suppressed in syllable-final position. For example, many languages oppose plain, aspirated, and voiced stops [p,b,pʰ] in syllable-initial position but limit the syllable-final position to just [p]. One such language is Thai.

(140) *Laryngeal contrasts in Thai*

panja ‘brains’	baː ‘crazy’	pʰaː ‘cloth’	riːp ‘hurry’
pen ‘alive’	bil ‘Bill’	pʰjaː ‘title’	sip ‘ten’
plaː ‘fish’	bruː ‘fast’	pʰrɛː ‘silk’	rap ‘take’



As Kenstowicz (1994:160) reasons: “Given the feature tree, this sound change can be described as the delinking of the Laryngeal articulator and replacement with a default [–spread gl, –voiced] specification. Evidence that such neutralizations are to be described as delinking rather than as simply a plus-to-minus change in the laryngeal features is the fact that the delinked material can sometimes show up at another position in the string.” As we have seen earlier, this is a general trait of autosegmental features, known as *stability*.

A possible example is offered by Vaux (1998), who claims that /s/ in Proto-Indo-European was [+spread glottis], and that when /s/ deleted in Pali, its [+spread glottis] feature survived on an adjacent segment.

(141)

Sanskrit	*Pali*	
skandʰá-	kʰandʰa-	‘shoulder’
stána-	tʰana-	‘breast’
sparʃa	pʰasːa-	‘touch’
hásta-	hatːʰa-	‘hand’
jaʂʈí-	jaʈːʰi-	‘pole’

Here is Vaux (1998:504): "What is relevant for our purposes is the fact that the laryngeal features of the delinked segments survive. In *stána-* 'breast', for example, the initial *s* delinks, but the floating [+spread] specification of the *s* then attaches to the following segment, producing a voiceless aspirate."

Exercises

A. In fact, Vaux (1998:497) claims more generally that "the unmarked specification for fricatives is [+spread]." Use Vaux's claim to explain the following data from Northern Rustic Dominican Spanish, from Piñeros (2002:7).

(142) *Northern Rustic Dominican Spanish*[53]

a.	/peskad̤o/	→	pehkaðo	'fish'
	/abispa/	→	aβihpa	'whasp'
	/aros/	→	aroh	'rice'
	/moska/	→	mohka	'fly'
b.	/d̤ifṯeria/	→	d̤ihṯerja	'diphtheria'
	/afganiṣṯán/	→	ahganihṯáN	'Afghanistan'
c.	/relox/	→	reloh	'watch'

B. Try to explain the following data from Korean (Schane & Bendixen 1978).

(143) *Korean*

a.	nak	'fall'	+	hwa	'flower'	→	nak^{h}wa	'fall flower'
b.	kup	'bend'	+	hita	(causative suffix)	→	kup^{h}ita	'to bend'
c.	t^{ʃ}oh	'good'	+	ko	'and'	→	t^{ʃ}ok^{h}o	'good and'
d.	noh	'to lay'	+	ta	(verb ending)	→	not^{h}a	'to lay (eggs)'

Note, finally, that the two laryngeal features [+spread glottis] and [+voice] can combine in a single segment, a voiced aspirate. It is widely believed that Proto-Indo-European had voiced aspirates, which changed to simple voiced consonants in Proto-Germanic. This can be seen by comparing cognates in Sanskrit and English.[54]

(144)	*Sanskrit*	*English*
a.	b^{h}rá:tar	brother
	b^{h}ára-	bear
b.	d^{h}a:-	do, did, deed

[53] Piñeros (2002) points out that [h] optionally deletes in this variety.

[54] The change PIE **b^{ɦ}, *d^{ɦ}, *g^{ɦ}* > Germanic *b, d, g* was accompanied by another change: PIE **b, *d, *g* > Gc *p, t, k*, which is evident by comparing French and English cognates. (Both changes are part of "Grimm's Law".)

French	*English*
genou	knee
grain	corn
dent	tooth < tanθ
deux	two

c. ħamsa < *gʰ goose

Voiced aspirates survive in many Indic languages. For example, Sindhi stops contrast between [–voice, –spread glottis], [+voice, –spread glottis], [+voice, +spread glottis] and [–voice, +spread glottis], e.g. təru 'bottom' vs. dəru 'door' vs. dʰəru (district name) vs. tʰəru 'trunk of body' (Ladefoged & Maddieson 1996:83).

2.5.2.4. [±constricted glottis]

The feature [+constricted glottis] is widely assumed to be the phonological feature shared by ejectives, implosives, glottalised or laryngealised ("creaky") sonorants, and glottal stop.[55] Thus [+constricted glottis] has a variety of phonetic implementations across languages and even within languages. For instance, in the Chadic language Hausa, [+constricted glottis] is implemented as *creaky implosion* in bilabial and alveolar stops (145a), as *ejection* (postglottalisation) in alveolar fricatives and velar stops (145b), and as *preglottalisation* in glides (145c):

(145) *Hausa* (Ladefoged & Maddieson 1996:86)

	Glottalised		*Plain*	
a.	ɓa:tà	'spoil'	ba:tà:	'line'
	ɗa:mè:	'tighten (belt)'	da:mè:	'mix thoroughly'
b.	s'a:rà:	'arrange'	sa:rà:	'cut'
	k'a:rà:	'increase'	ka:rà:	'put near'
	kʷ'a:rà:	'shea nut'	kʷa:rà:	'pour'
c.	ʔja:	'daughter'	ja:	'he' [comp.]

Like the other laryngeal features, [+constricted glottis] can be very restricted in distribution in some languages. In the Wakashan language Nuu-chah-nulth (Howe & Pulleyblank 2001), for instance, ejectives occur only prevocalically, in syllable-initial position. This is exemplified in the following table where examples are given of word-initial ejectives, intervocalic ejectives and postconsonantal but prevocalic ejectives. There are no examples of either word-final or preconsonantal ejectives in Nuu-chah-nulth.

[55] These are segment types which go by a wide variety of names in the literature. For example, ejectives alone have been referred to variously as glottalised, glottalic, abruptive, checked, popped, with supraglottal expiration, with glottal occlusion, evulsive, with glottalic pressure, glottalic egressive, glottal stop sound, glottocclusive, glottal occlusive, recursive, etc! (Fallon 2002:6).

(146) *Surface distribution of ejectives*

a.	*Word-initial*	pʼuːʔi	*halibut*	tˢʼaʔak	*water*
		tʼuɬtˢʼiti	*head*	kʼaʃkʷaˀjap	*put things away*
		tˢʼaʔak	*river*	kʷʼisaː	*snowing*
		tˡʼupaː	*sunny*		
b.	*Intervocalic*	tupʼaɬ	*sea, ocean*	kʷʼatˡaq	*sea otter belt*
		ʔatʼa	*thick*	wikʼatˡ	*not*
		qʷajatˢʼiːk	*wolf*	tʼakʷʼas	*gills*
		ʔitˢʼaʔap	*to lift*		
c.	*Postconsonantal*	ɬapɬspʼatʼu	*bird wing*	hitaːqʼas	*woods, forest*
		tˢʼimtʼuː	*squirrel*	tˡʼaskʼasʔiʃ	*the surface is smooth*
		tˡuɬtˢʼuːʔiʃ	*it is clean*	ʔinkʷʼaɬs	*lamp, ceiling light*
		ʔimtˢʼaːp	*to play*		

Ejectives contrast with sequences of a consonant followed by a glottal stop:

(147) *Contrasts between glottalised obstruents and clusters with [ʔ]*

VCʼV	tʼaˀjatˢʼu	*fish line (straight down fishing)*
VCʔV	ʕaptˢʔin	*abalone*

Other possible combinations of ejectives with a glottal stop are not possible because ejectives cannot occur preconsonantally (explaining the absence of *VCʼʔV*) and glottal stops cannot occur except syllable-initially/prevocalically (explaining the absence of *VʔCV* and *VʔCʼV*).

The distribution of ejectives is faithfully repeated by the glottalised sonorants in Nuu-chah-nulth. As with ejectives, glottalised sonorants occur only in prevocalic/syllable-initial position. Examples are given in (148) of word-initial, intervocalic and postconsonantal but prevocalic glottalised sonorants. As with ejectives, there are no examples of either word-final or preconsonantal glottalised sonorants in Nuu-chah-nulth.

(148) *Surface distribution of glottalised sonorants*

a.	*Word-initial*	ˀmitˡaː	*raining*
		ˀnuˀwiːqsuʔi	*the father*
		ˀjaʔisi	*butter clams*
		ˀwasaqʃiʔ	*cough*
b.	*Intervocalic*	ˀjaˀma	*salal berry*
		kiˀnutˢak	*blue*
		kʷʼiˀjas	*snow on the ground*
		ɬiˀwaɬmis	*cloud*
c.	*Postconsonantal*	ɬuːtˀˀmuːp	*sister*
		mamaɬˀni	*European, white person*
		wikˀjuʔatˡs	*I have not*
		tˡatˀwaː	*paddle a canoe*

Again like the ejectives, a contrast is observed between glottalised sonorants and clusters with a glottal stop:

(149) *Contrasts between glottalised sonorants and clusters with [ʔ]*

VRʼV	qinɬhaːˀma	*egg*
VRʔV	ʔumʔiːqsu	*mother*

Finally, it is important to focus on glottal stops themselves. It has been noted that glottal stops occur only syllable-initially/prevocalically in Nuu-chah-nulth. Some examples have been seen already, but here we add to those to show the full range of contexts for a glottal stop.

(150) *Surface distribution of glottal stop*

a.	*Word-initial*	ʔaɬkuː	*here*
		ʔiːɬ	*big*
		ʔutʃqak	*foggy*
		ʔuːʃtup	*something*
b.	*Intervocalic*	ʕaʔuk	*lake*
		naʔaː	*hear*
		huːʔiːʔatɬ	*Ohiaht tribe*
		hiʔiːs	*there on ground*
c.	*Postconsonantal*	tɬʼaːtʃʔaːɬ	*thimbleberry*
		tʃimʔiɬ	*bed*
		ʔustʔiɬ	*floor, downstairs*
		muʃʔasum	*door*

As with both ejectives and glottalised sonorants, a glottal stop may not occur either word-finally or before a consonant. To account for the parallel behaviour of ejection in obstruents, creak in sonorants (glottalisation is realised as creakiness in the initial portion of glottalised sonorants) and a plain glottal stop, a single unified feature of [+constricted glottis] is needed. The crucial factor in determining the distribution of [+constricted glottis] in Nuu-chah-nulth is syllabic position. We may say that Nuu-chah-nulth has a *positional markedness constraint* against glottalisation in syllable-final position:

(151) *Syllable-final glottalisation markedness*

*[+constricted glottis] . "Glottalisation is not permitted syllable-finally."

So far, no mention has been made of glottalised fricatives. When it accompanies a fricative, the feature [+constricted glottis] is normally realised as ejection. Glottalised fricatives are extremely rare crosslinguistically but are commonly found in Tlingit (Ladefoged & Maddieson 1996:179):

(152) *Tlingit*

	Alveolar	*Velar*	*Labialised Velar*	*Uvular*	*Labialised Uvular*
Plain	saː	xaːt	xʷaːs	χeːt	χʷaːl
	'be narrow'	'protrude'	'hang'	'multiply'	'shake, tremble'
Ejective	sʼaː	xʼaːt	xʷʼaːsʼk	χʼeːtʼ	χʷʼaːsʼ
	'claim'	'file'	'be numb'	'gnaw, chew'	'become bald'

Turning now to the possibility of a floating [+constricted glottis], in his grammar of Klamath (a Penutian language of Oregon), Barker (1964: 263) posits a "morphophoneme ||'||, which is represented on the phonemic level by the glottalisation of some neighboring consonant", and which Blevins (1993:266) interprets as "a floating [constricted glottis] feature". This feature, which accompanies the diminutive /-ʔaːk'/ for example, affects stops (153a) and affricates (153b) as well as sonorants (153c,d). Note, too, that with vowel-final stems (153e) glottalisation is realised as [ʔ]. With a single feature, [+constricted glottis], a pattern such as this is straightforwardly accounted for.

(153) *Klamath diminutive*

a.	/Red + n'epʰ + ʔaːk'/	→	n'enp'aːk	'distributive little hands'
b.	/Red + pʰetʃʰ + ʔaːk'/	→	pept'aːk	'distributive little feet'
c.	/Red + qtʃʰuːl + ʔaːk'/	→	qtʃʰuqtʃʰuːl'aːk	'distributive little star'
d.	/Red + ʔankʰu+ ʔaːk'/	→	ʔaʔankw'aːk	'distributive little buffalos'
e.	/Red + kʰow'e + ʔaːk'/	→	kʰokw'eʔaːk	'distributive little frogs'

Similarly, Buckley (1990:9) reports that in Kashaya (a Pomoan language of California) "the Assertive morpheme is a floating [+constricted glottis] feature which links to an immediately preceding consonant, thereby glottalizing it". Stops and sonorants are both affected by the same glottalising feature.

(154) *Kashaya*

a.	jahmot + ʔ	→	jahmot'	'it's a cougar'
b.	tˢ'iʃkan + ʔ	→	tˢ'iʃkan'	'it's pretty'

To conclude this section we note that all three laryngeal features can be used contrastively in a single language. For example, Yuchi, a language isolate now spoken by just five people in Oklahoma, has the following inventory of stops (Crawford 1973:174):

(155) *Laryngeal specifications and examples of Yuchi stops and affricates*

	unmarked	[+voice]	[+spread gl.]	[+constr. gl.]
labials	p (pa 'sack')	b (ba 'burn')	pʰ (pʰa 'cut')	p' (gop'a 'look')
alveolars	t (geta 'hold on')	d (goda 'wash')	tʰ (gotʰa 'pick'	t' (jõʃt'a 'Shawnee')
alveolar affricates	tˢ (ditˢa 'I sleep')	dᶻ (ʔadidᶻa 'I say')	tˢʰ (tˢʰja 'dry')	tˢ' (tˢ'a 'I cry')
alveolopalatal affricates	tʃ (tʃu 'boat')	dʒ (gokʰadʒu 'armpit')	tʃʰ (tʃʰu 'bed')	tʃ' (set'a 'she drowns')
velars	k (j'aka 'white')	g (sjoga 'she rests')	kʰ (dᶻokʰa 'flour')	k' (dok'a 'I sift')

Note that the features [+spread glottis] and [+constricted glottis] are logically opposite, and so they never occur in the same segment. It is possible, however, for [+constricted glottis]

to combine phonologically with either [–voice] or [+voice]. Uduk is a Nilo-Saharan language that contrasts [+constricted glottis] in both [–voice] and [+voice] consonants, e.g.:

(156) *Uduk* (Ladefoged & Maddieson 1996:82)

	Bilabial		*Alveolar*	
voiceless	pàl	'to try'	tèr	'to collect'
voiced	baʔ	'to be something'	dèɗ	'to shiver'
aspirated	pʰàlal	'centipede'	tʰèr	'to pour off'
ejective	pʼàcʰàɗ	'fermented'	tʼèɗ	'to lick'
implosive	ɓàʔ	'back of neck'	ɗek'	'to lift'

2.6. Intrasegmental phonology: conclusion

> *'Bong-sewer,' said Hagrid, beaming at her, and holding out a hand to help her down the golden steps. Madame Maxine closed the door behind her ... she said playfully, 'Wair is it you are taking me, 'Agrid?'*
>
> 'Harry Potter and the Goblet of Fire,' J. K. Rowling, Vancouver, BC: Raincoast Books, p. 285.

Our discussion of segments began with the notion of 'inventory': all languages use fixed but varied sets of segments in building their lexical entries. This set in English includes /h/, which French lacks, hence Madame Maxine's h-less pronunciation of Hagrid. On the other hand, the set of segments in French includes /ɔ̃/, which English does not allow freely, hence Hagrid's rendition of *bonsoir* as *bong-sewer*. Such differences between languages can be treated as mere socio-historical accidents, but if we consider them in light of *phonological features*, they turn out to be instructive of aspects of human cognition: they reveal the grammatical knowledge in speakers' heads. For instance, the feature [+spread glottis] is licit in English grammar, but illicit in French grammar (as in most other Romance languages), so that English [h], as well as any other aspirated sound such as [pʰ, tʰ, ʍ, ...], will be realised without aspiration by French speakers. The feature [+nasal] is licit in the grammars of both French and English,[56] but whereas [+nasal] can combine with [–consonantal] in French (ĩ, ɛ̃, ɔ̃, œ̃, ɑ̃, .../), such combination is not freely allowed in English grammar (nor in most languages of the world).

To be sure, segment inventories are overwhelmingly diverse across languages, not only in number but also in kind. But this diversity seems reasonable, even expected, once a relatively small set of universal phonological features is recognised. For instance, Pericliev and Valdés-Pérez (2002) have recently reported that in the vast majority of languages with multiple idiosyncratic phonemes (approximately 92%), in terms of features the idiosyncracy is *shared*. To illustrate: Akan has the unusual segments /çʷ, cᶜʷ , ɟʲʷ, ɲʷ/; the idiosyncracy shared by these segments is the cooccurrence of [–anterior] and [+round]. All we really need to say, then, is that Akan grammar allows this combination, which is otherwise avoided cross-linguistically.

[56] ...but not in the grammars of Ditidaht, Lushootseed, Twana, etc.

At this point it is worth mentioning a popular recent theory in phonology, Optimality Theory (OT; Prince & Smolensky 1993). OT assumes that all languages share a universal set of *markedness* constraints on features and/or their combinations, such as *[+spread glottis], *[+nasal, –consonantal], and *[+round, –anterior]. Each such constraint ranks high in many grammars, so that potential words with aspirated segments, or nasalised vowels, or labialised palatals, never actually surface in these languages. In other languages, however, *faithfulness* to lexical specifications may outrank individual markedness constraints, so that potential words with [h], or [õ], or [ɲʷ], are indeed attested. For more information on this approach to segment inventories, see Kager (1999), McCarthy (2002).

[The remainder of this section is for advanced students only:]

In classical generative phonology (Chomsky and Halle 1968), certain intrasegmental combinations of features were banned by 'linking' rules. For example, the combination of features for a labial fricative could be banned by (157).

(157) A 'linking' rule à la Chomsky & Halle (1968)

$$[-\text{sonorant}] \rightarrow [-\text{continuant}] / \begin{bmatrix} \overline{\quad\quad} \\ -\text{coronal} \\ +\text{anterior} \end{bmatrix}$$

As Chomsky and Halle recognised, linking rules such as the one just given cannot be wholly language-specific since they normally reflect universal tendencies, i.e. *markedness* (see Trubetskoy 1939, Jakobson 1939, 1941 on Markedness Theory). For example, compare the rule in (157) with Sherzer's (1976:258) implicational statement (63) on p. 39. Since only languages without (157) can have labial fricatives, it is apparent that this rule contributes to making the segment inventory of languages without labial fricatives relatively less marked cross-linguistically, at least from the perspective of the marking implication in (63).

Chomsky and Halle cautioned that while the theory of markedness is absolute (i.e., shared by all languages), its application is relative (i.e. depends on particular languages). To continue with our current example: the markedness of labial fricatives remains constant, whether it is apparent in a grammar (e.g., Oowekyala or Blackfoot), or not (e.g., English or Ewe). In Chomsky & Halle (1968), therefore, markedness is not used to ban marked feature combinations directly. Rather, it is used to assess the 'naturalness' of language-specific rules affecting feature combinations from a system-external point of view. The rule in (157) is thus a good candidate for grammaticalisation because it results in a relatively less marked phonological system (Sherzer 1976:258). In contrast, an equally logical rule such as (158) is less likely to become grammaticalised because it would result in an increase of relative markedness (a system with labial fricatives but no labial stops).

(158) A logically possible but implausible SPE-style rule

$$[-\text{sonorant}] \rightarrow [+\text{continuant}] / \begin{bmatrix} \overline{\quad\quad} \\ -\text{coronal} \\ +\text{anterior} \end{bmatrix}$$

Suppose, then, that the grammar of a language includes a markedness-motivated language-particular rule like (157) above. This rule contributes to a relatively less marked inventory of segments ("no labial fricatives") in this language, but ironically it also adds to the grammar's complexity. This illustrates a basic contradiction in Chomsky & Halle's (1968) approach to segment inventories: the complexity (markedness) of a segment decreases only if the complexity (number of language-particular rules) of the grammar increases, and vice versa. This contradiction persists even in modern theories where rules like (157) are reinterpreted as 'persistent' feature-changing rules (Mohanan 1991, Myers 1991, Halle, Vaux & Wolfe 2000:409): such rules render phonological segments less complex (less marked) but their host grammar becomes more complex (it has more rules).

A partial solution to this problem was offered by the markedness-based Radical Underspecification theories of the 1980's (esp. Kiparsky 1982, 1985, Pulleyblank 1986).[57] On the starting assumption that "underlying representations must reduce to some minimum the phonological information used to distinguish lexical items" (Steriade 1995:114), underspecification theories postulate redundancy rules such as (159) (cf. (157)) that simplify the segment inventory by allowing unmarked values (such as [–continuant] in labial obstruents) to be absent from underlying segments. Crucially, those redundancy rules which prove to be cross-linguistically valid (because they are based on markedness) are assumed to be part of Universal Grammar. Consequently, redundancy rules simplify segment inventories without necessarily adding to the complexity of the language-specific portion of grammars.

(159) An underspecification-theoretic redundancy rule

$$[\quad] \rightarrow [-\text{continuant}] / \left[\begin{array}{l} \_\_\_\_\_ \\ -\text{sonorant} \\ -\text{coronal} \\ +\text{anterior} \end{array}\right]$$

As Mohanan (1991) remarks, however, the redundancy rules of underspecification theories introduce some formal redundancy into phonological theory, because they exist alongside 'linking' rules that work against marked combinations of features (see Roca 1994:82 for more discussion). Indeed, redundancy rules like (159) do not simply replace rules like (157). To see this, consider again the alleged adaptation of English labial fricatives into Oowekyala, e.g. (64). The redundancy rule (159) fills in underspecified features, but it does not require labial fricatives to change to stops. In order to account for the initial adaptation of e.g. Vancouver > bank^{w}uba in Oowekyala, one needs to posit the independent existence in Oowekyala grammar of some structure changing rule like (157) (see Mohanan 1991, Myers 1991).

To recapitulate, a basic contradiction of derivational phonology is that rules render phonological segments less complex (less marked) but their host grammar is more complex (it has more rules). This problem stems from the fact that markedness is not incorporated directly into the grammatical analysis. Optimality Theory (Prince and Smolensky 1993, Kager 1999, McCarthy 2002) avoids this problem by recognising the grammatical status of markedness constraints. So for instance, prohibitions on labial fricatives are understood as the effect of a markedness constraint on the feature combination [labial, +continuant] that is

[57] Because they assumed the segment as phonological primitive, contrastive underspecification theories contributed little to our understanding of feature cooccurrence restrictions within segments (see Archangeli 1988 for some critical discussion).

of a markedness constraint on the feature combination [labial, +continuant] that is literally present in every grammar (see section 2.3.1.1).

The optimality theoretic approach to segmental inventories differs from derivational approaches (e.g. Kiparsky 1985, Archangeli & Pulleyblank 1994) in at least two other ways. First, within derivational Lexical Phonology (e.g. Kiparsky 1985) a language's segment inventory fixes the melodic content of underlying representations but must also be stipulated as a general condition on the output of (lexical) rules —this is 'structure preservation' (Kiparsky 1985:92). Archangeli and Pulleyblank (1994) avoid this stipulation by making the claim that the conditions making up the inventory hold to the maximal extent possible, i.e. in both underived and derived lexical representations, as well as in (lexical) rules. In contrast, Optimality Theory imposes no restrictions on underlying representations and instead makes the strong claim that output constraints are not only necessary but sufficient in explaining phonological patterns, including the segmental inventory of a language.

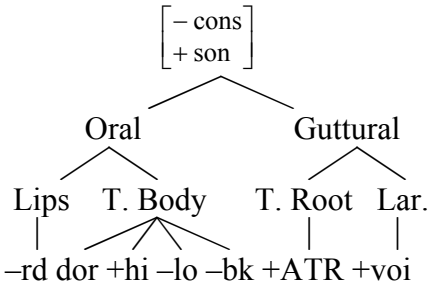
Second, to the extent that segmental inventories are discussed in derivational theory (esp. Kiparsky 1985, Archangeli & Pulleyblank 1994), they are treated as arbitrary (i.e. extragrammatical) selections of phonological features and arbitrary selections of featural cooccurrence conditions. By contrast, in Optimality Theory a language's segmental inventory is strictly determined by its constraint grammar. Specifically, each segment inventory derives from a particular interaction between 'markedness' constraints that militate against featural complexity, and 'faithfulness' constraints that aim to preserve lexical featural specifications.

2.7. Practice

Determine the distinctive feature(s) differentiating the phones in each pair:

a.	ɪ ʊ	b.	a ã	c.	a ʌ
d.	ɑ ɒ	e.	u y	f.	ø e
g.	ɛ ɔ	h.	i ɯ	i.	u ʊ
j.	e i	k.	æ ɑ	l.	e e̞
m.	j w	n.	ɛ œ	o.	o ɤ
p.	b d	q.	t k	r.	d ð
s.	s z	t.	l r	u.	n ɲ
v.	p β	w.	ʃ tʃ	x.	l ʎ
y.	s θ	z.	g ɣ	aa.	f ɸ
bb.	k q	cc.	ʃ x	dd.	ɟ j
ee.	h ʔ	ff.	t tˢ	gg.	d dʒ
hh.	l ɬ	ii.	b ɓ	jj.	p pʼ
kk.	l ɬ	ll.	z ɮ	mm.	n n̥
nn.	t ʈ	oo.	g ŋ	pp.	h ɦ
qq.	β w	rr.	p pʰ	ss.	k kʷ

In the next few pages, write the appropriate symbol for each tree: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Lar.
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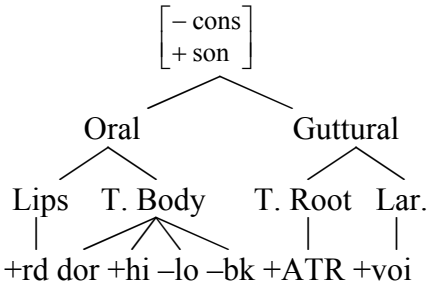
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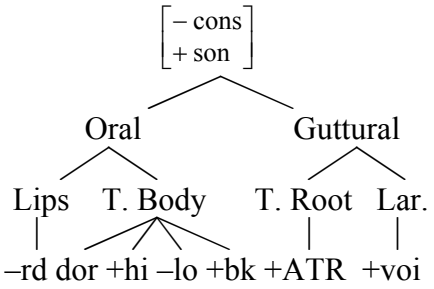
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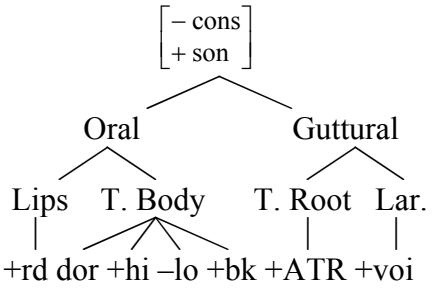
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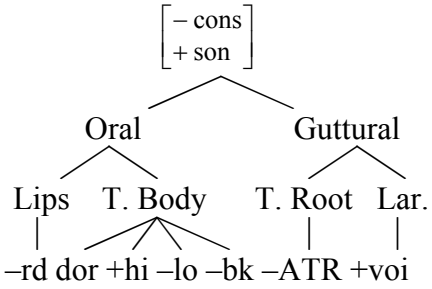
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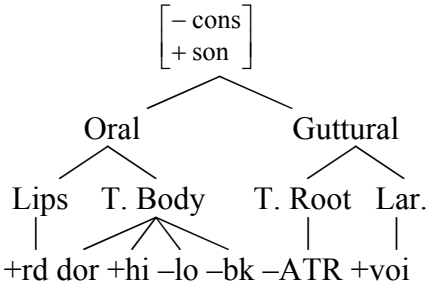
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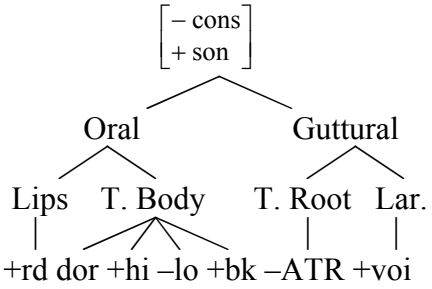
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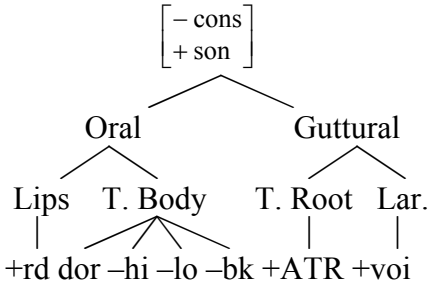
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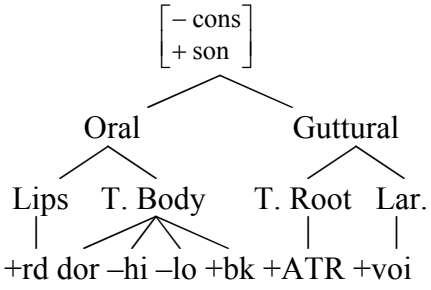
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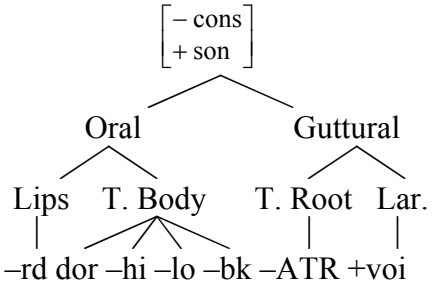
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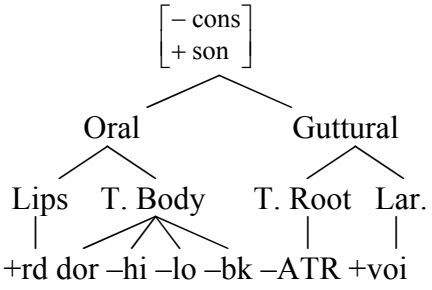
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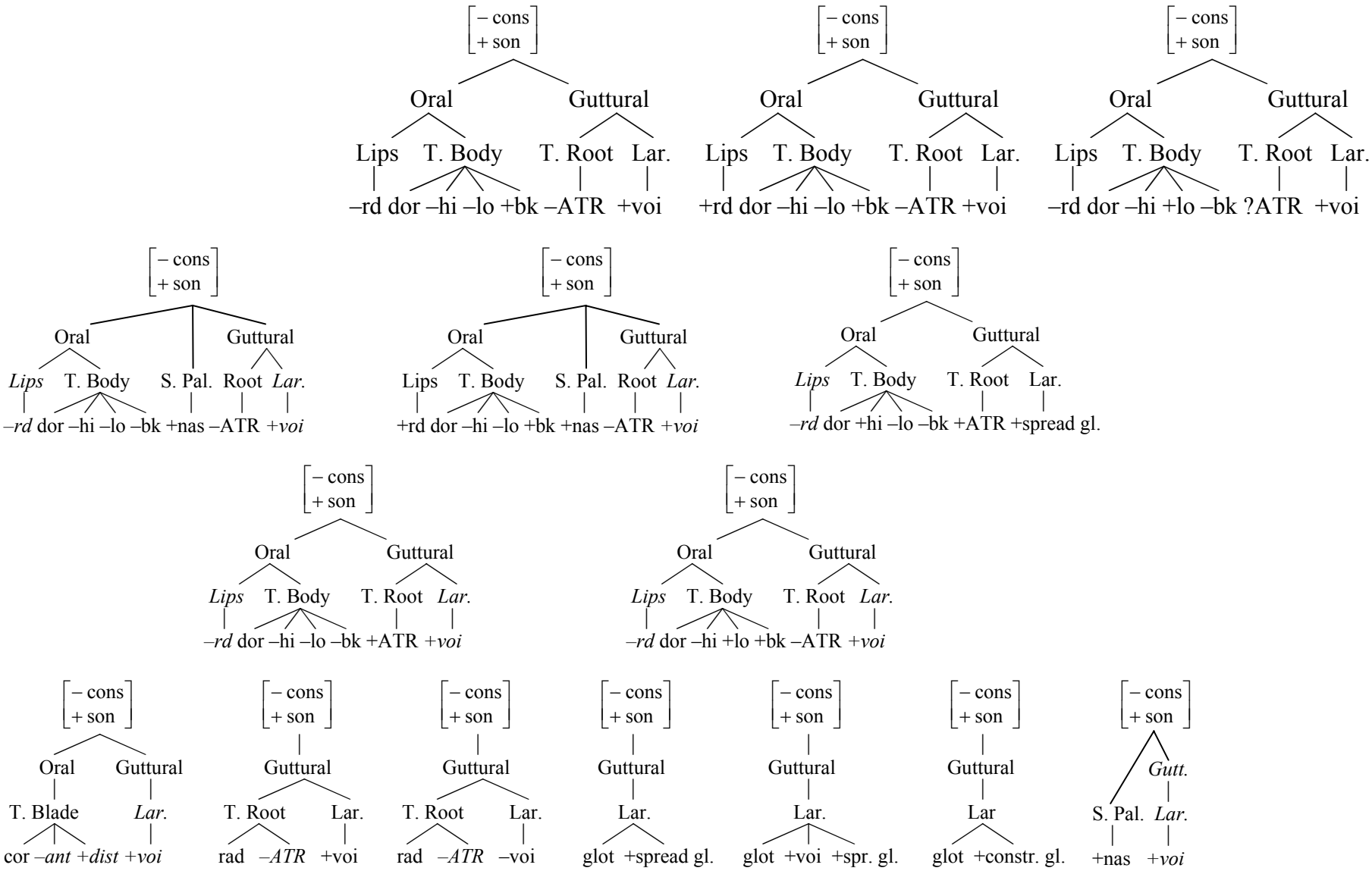
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Guttural
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T. Root
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Oral
Guttural
Lips
T. Body
T. Root
Lar.
+rd dor –hi –lo +bk –ATR +voi
[– cons, + son]
Oral
Guttural
Lips
T. Body
T. Root
Lar.
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[– cons, + son]
Oral
Guttural
Lips
T. Body
S. Pal.
Root
Lar.
–rd dor –hi –lo –bk +nas –ATR +voi
[– cons, + son]
Oral
Guttural
Lips
T. Body
S. Pal.
Root
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Guttural
Lips
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Lar.
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Guttural
Lips
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Guttural
Lips
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Lar.
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Lar.
rad –ATR +voi
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Guttural
T. Root
Lar.
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Lar.
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[– cons, + son]
Guttural
Lar.
glot +voi +spr. gl.
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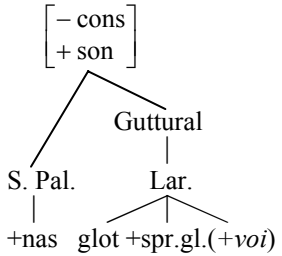
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Guttural
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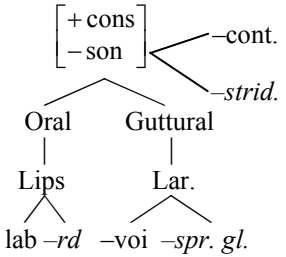
Lar.
+nas
glot +spr.gl.(+voi)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lab –rd
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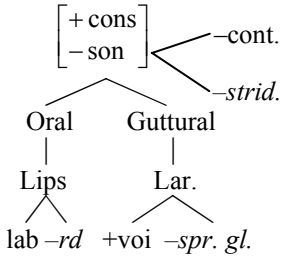
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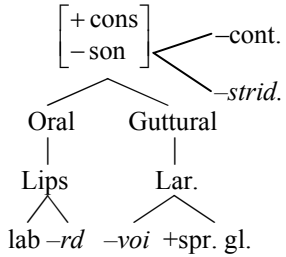
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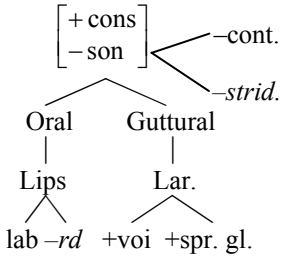
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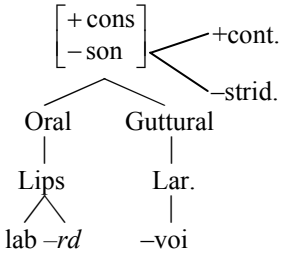
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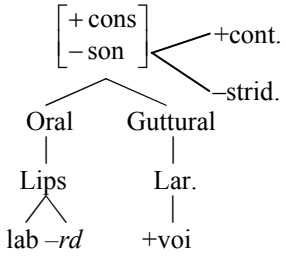
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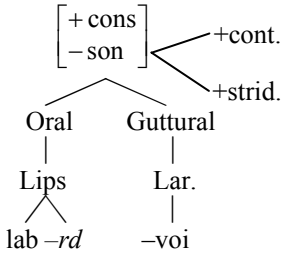
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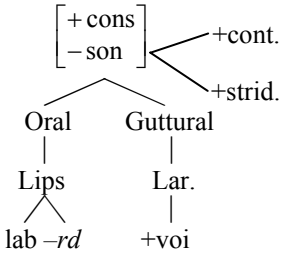
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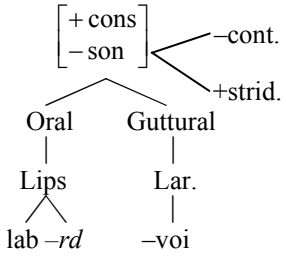
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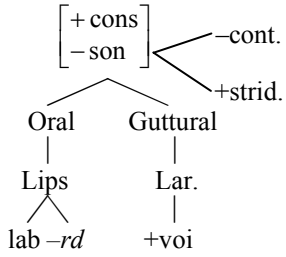
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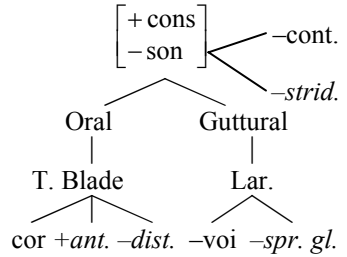
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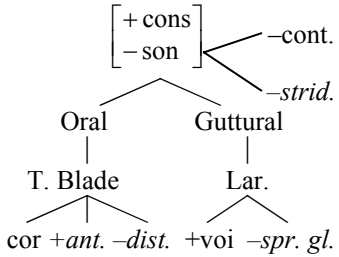
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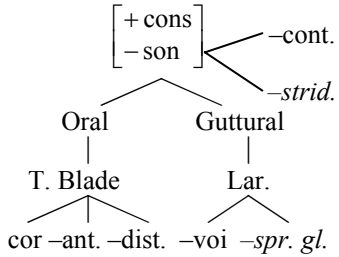
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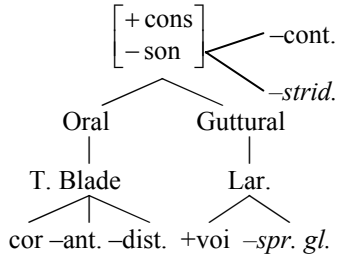
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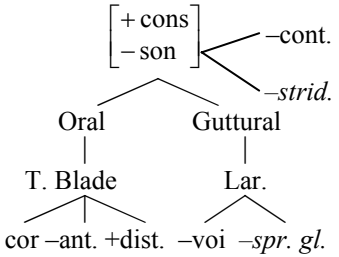
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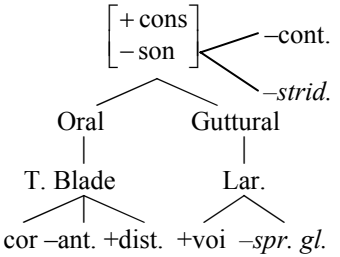
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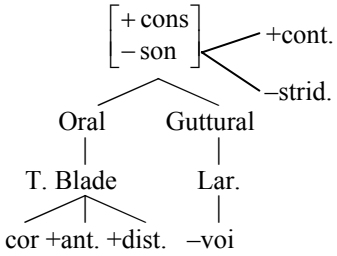
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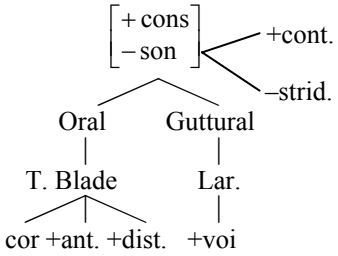
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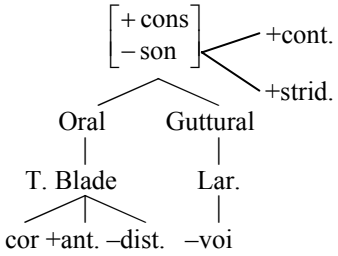
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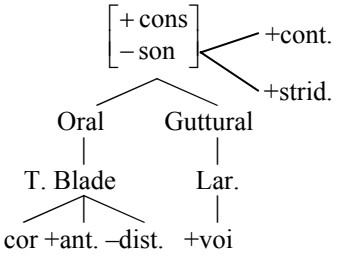
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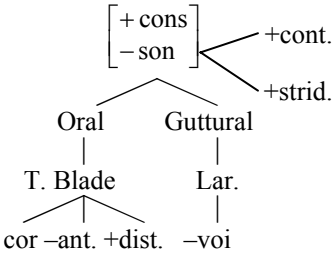
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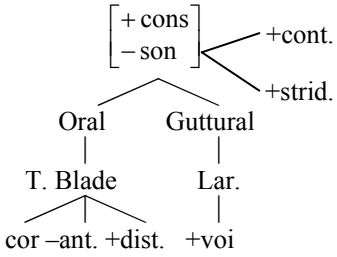
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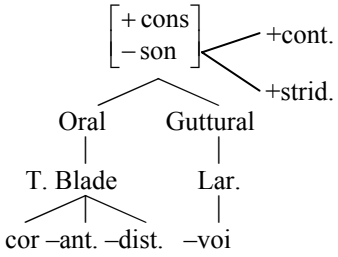
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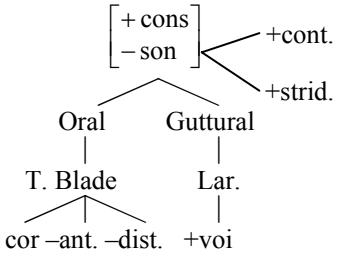
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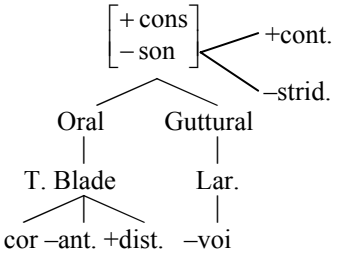
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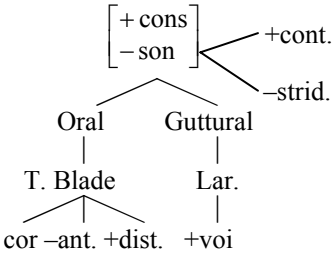
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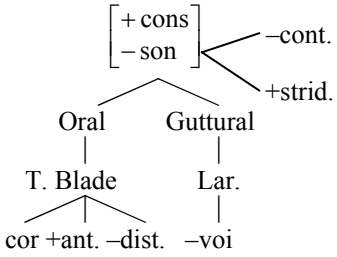
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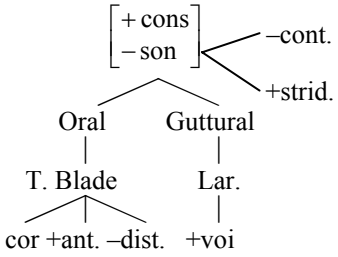
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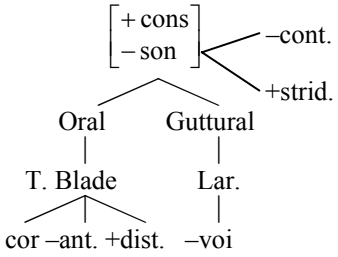
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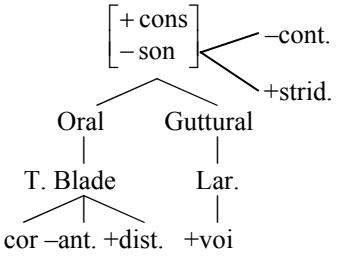
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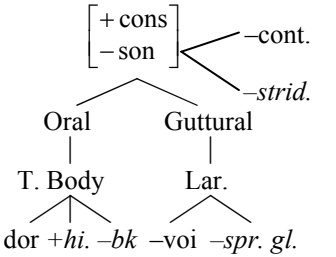
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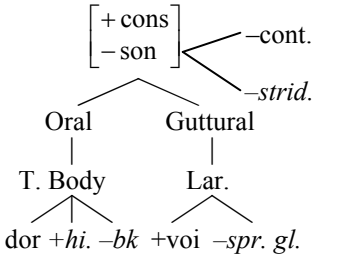
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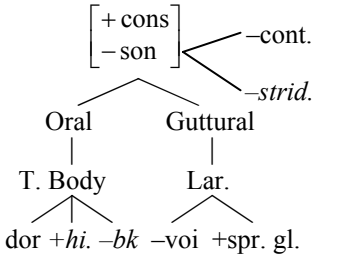
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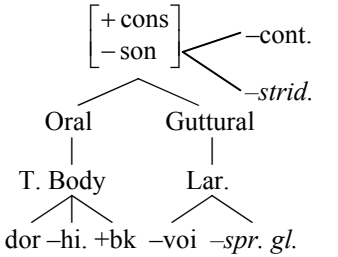
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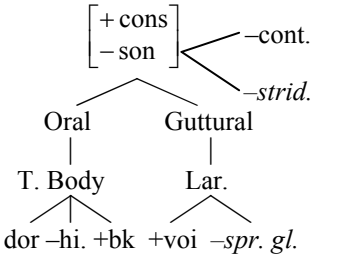
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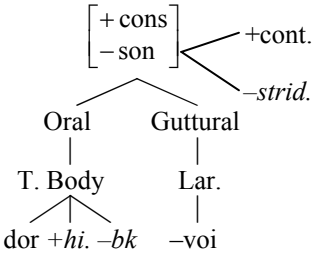
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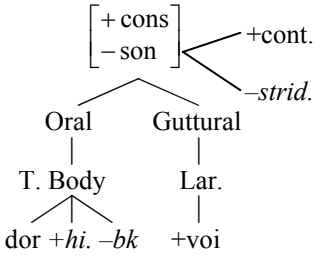
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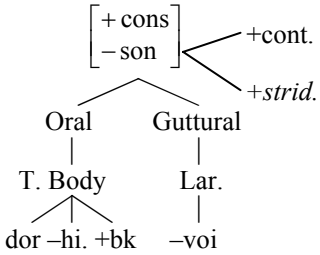
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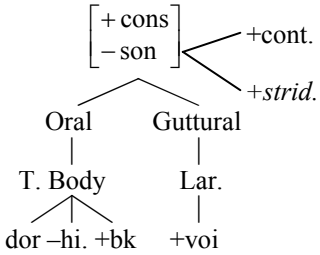
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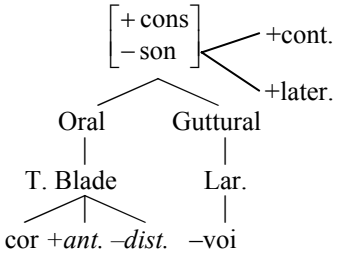
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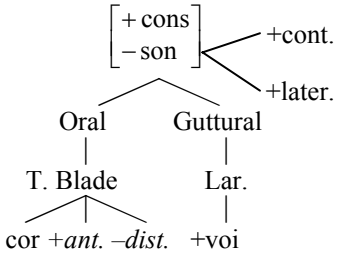
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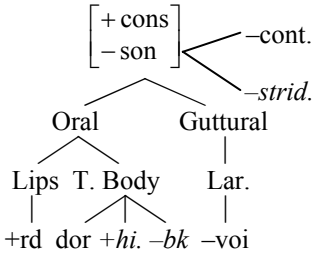
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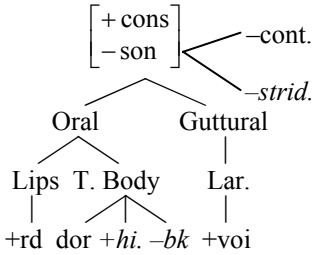
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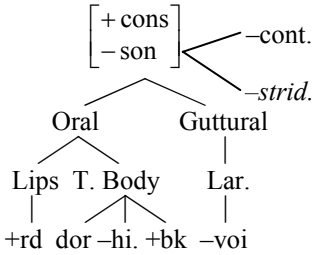
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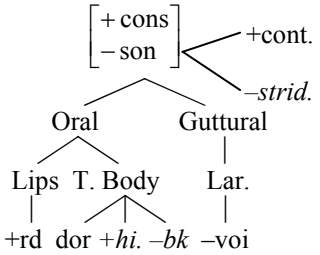
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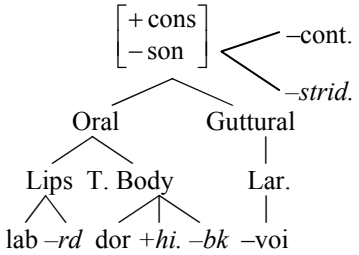
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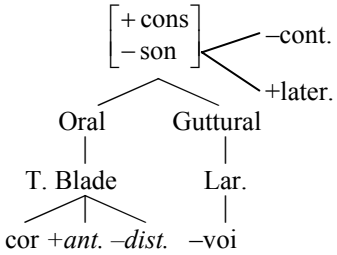
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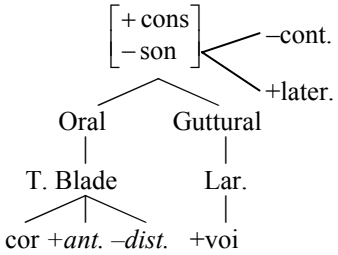
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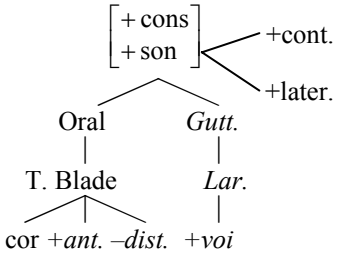
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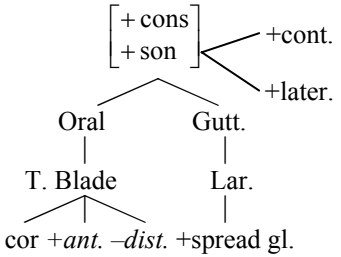
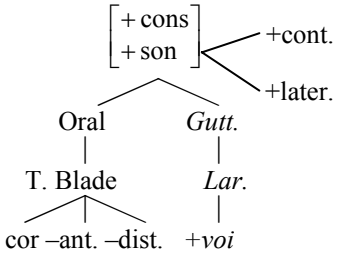
T. Blade
Lar.
cor +ant. –dist.
+voi


+cons
+son
+cont.
+later.
Oral
Gutt.
T. Blade
Lar.
cor +ant. –dist.
+spread gl.


+cons
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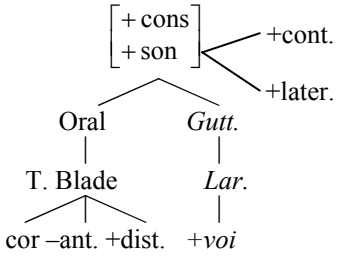
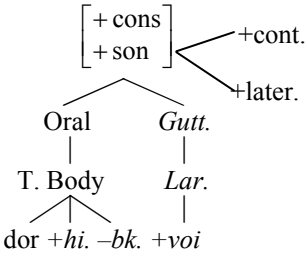
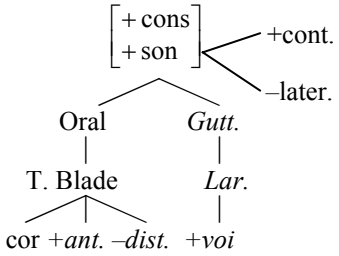
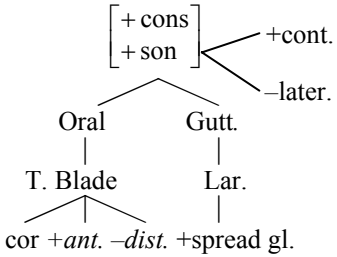
Lar.
cor –ant. –dist.
+voi


+cons
+son
+cont.
+later.
Oral
Gutt.
T. Blade
Lar.
cor –ant. +dist.
+voi


+cons
+son
+cont.
+later.
Oral
Gutt.
T. Body
Lar.
dor +hi. –bk.
+voi


+cons
+son
+cont.
–later.
Oral
Gutt.
T. Blade
Lar.
cor +ant. –dist.
+voi


+cons
+son
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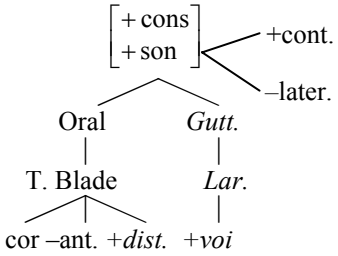
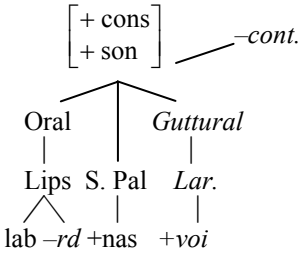
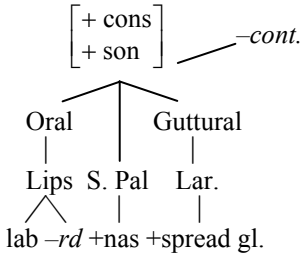
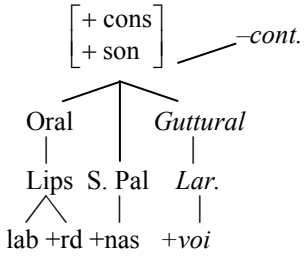
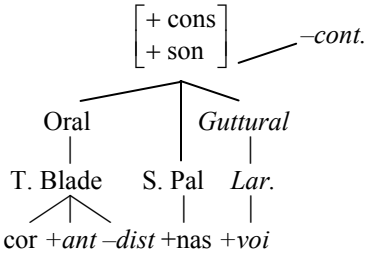
–later.
Oral
Gutt.
T. Blade
Lar.
cor +ant. –dist. +spread gl.

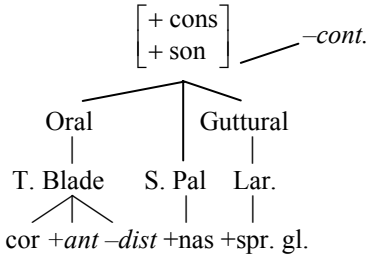

+cons
+son
+cont.
–later.
Oral
Gutt.
T. Blade
Lar.
cor –ant. +dist. +voi

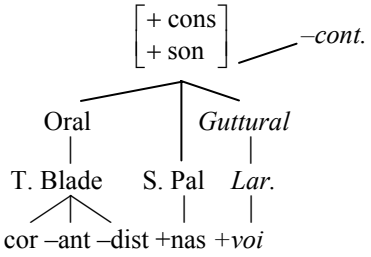

+cons
+son
–cont.
Oral
Guttural
Lips
S. Pal
Lar.
lab –rd +nas +voi

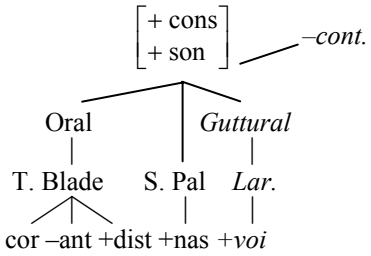

+cons
+son
–cont.
Oral
Guttural
Lips
S. Pal
Lar.
lab –rd +nas +spread gl.

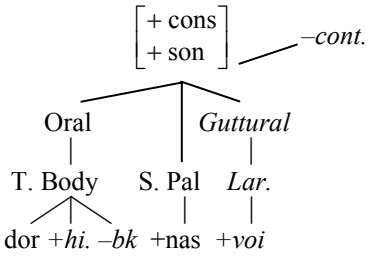

+cons
+son
–cont.
Oral
Guttural
Lips
S. Pal
Lar.
lab +rd +nas +voi

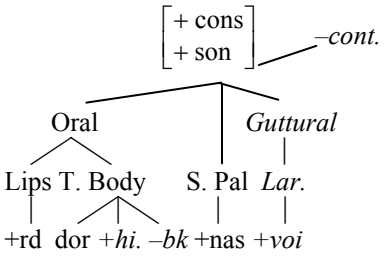

+cons
+son
–cont.
Oral
Guttural
T. Blade
S. Pal
Lar.
cor +ant –dist +nas +voi

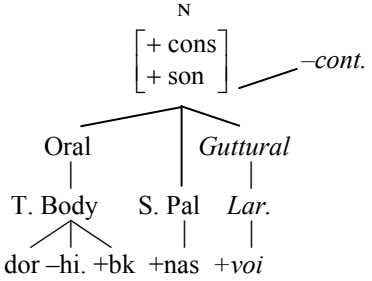

+cons
+son
–cont.
Oral
Guttural
T. Blade
S. Pal
Lar.
cor +ant –dist +nas +spr. gl.

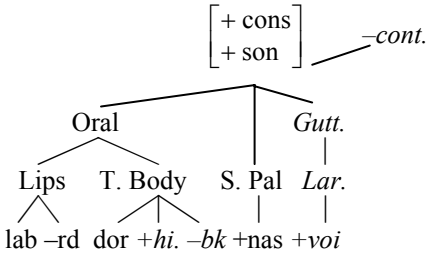

+cons
+son
–cont.
Oral
Guttural
T. Blade
S. Pal
Lar.
cor –ant –dist +nas +voi

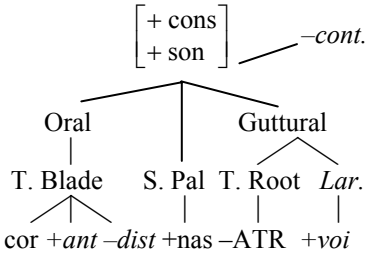

+cons
+son
–cont.
Oral
Guttural
T. Blade
S. Pal
Lar.
cor –ant +dist +nas +voi


+cons
+son
–cont.
Oral
Guttural
T. Body
S. Pal
Lar.
dor +hi. –bk +nas +voi


+cons
+son
–cont.
Oral
Guttural
Lips
T. Body
S. Pal
Lar.
+rd dor +hi. –bk +nas +voi


N
+cons
+son
–cont.
Oral
Guttural
T. Body
S. Pal
Lar.
dor –hi. +bk +nas +voi


+cons
+son
–cont.
Oral
Gutt.
Lips
T. Body
S. Pal
Lar.
lab –rd dor +hi. –bk +nas +voi


+cons
+son
–cont.
Oral
Guttural
T. Blade
S. Pal
T. Root
Lar.
cor +ant –dist +nas –ATR +voi

3. Intersegmental phonology

In this major section we turn to *syntagmatic* (as opposed to *paradigmatic*) segmental phonology: how segments exercise influence on each other. More specifically, we now consider the interactions of features *between* segments (as opposed to *within* segments).

3.1. Syntagmatic processes

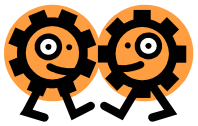
Opposites repel, likes attract.
-Isaak Newton

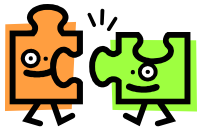
If the charges have opposite signs the force is attractive.
If the charges have the same sign the force is repulsive.
-Charles Coulomb

I am Homer of Borg. Prepare to be assim... OOH! DONUTS!
-Homer Simpson

Broadly, there are two ways in which neighbouring segments can affect each other directly.

On the one hand, a segment may influence another so that the sounds become more alike, or identical. This is *assimilation*, a process by which one segment systematically takes on a feature (or set of features) of a neighbouring segment. In nonlinear phonology, assimilation is viewed as the *spreading* of a feature (or set of features) from one segment to another. Specifically, assimilation occurs when an *association* is established between some feature of a segment and another segment. This association is represented in diagrams by a dotted line connecting the relevant feature of the *source* segment and the *target* (a.k.a. *focus*) segment. The target may either follow or precede the source, giving *progressive* or *regressive* assimilation, respectively.





(1) *Assimilation as spreading*

a. *progressive*

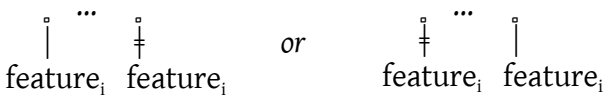
source target
|
feature

b. *regressive*

target source
|
feature

On the other hand, a segment may influence another so that the two become less alike, or different. This is *dissimilation*, a process by which one segment systematically avoids taking on a feature (or a set of features) of a neighbouring segment (Alderete 2002). In nonlinear phonology, dissimilation is viewed as the *delinking* of a feature (or set of features) from a segment in the neighbourhood of another segment specified with an identical feature (or set of features). The target of dissimilation, the segment whose feature is delinked, may either precede or follow the identically-specified segment.

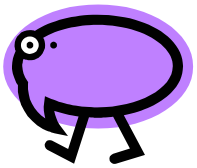
(2) *Dissimilation as delinking*



Below we consider how segments assimilate and dissimilate with respect to each of the features discussed in section 2. But we will also consider ways in which segments can affect each other indirectly, without feature spreading/assimilation or feature delinking/dissimilation (e.g., "acoustic assimilation").

3.2. Articulator-free features

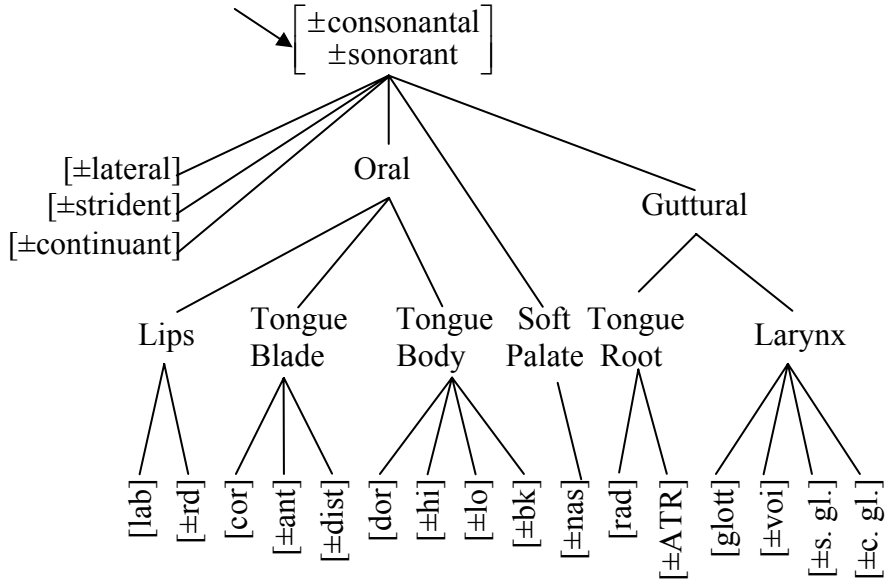
In this section we consider the syntagmatic behaviours of the articulator-free features: [±consonantal], [±sonorant], [±lateral], [±strident], and [±continuant]. We begin with the major class features.



3.2.1. Major Class Features

The major class features [±consonantal] and [±sonorant] are represented differently from other features in current feature geometry (e.g., Kenstowicz 1994, Halle 1995, Halle, Vaux & Wolfe 2000): they *constitute* the segmental root node, onto which the other features link [=(7)]:

(3) *Major class nodes inside <u>root</u> node*



The rationale for having the major class features represented *inside* the root was first provided by McCarthy (1988:97):

> *The two major class features [sonorant] and [consonantal] differ from all other features in one important respect: ... the major class features do not assimilate, reduce, or dissimilate except in conjunction with processes that affect the entire segment. Therefore the*

major class features should not be represented on separate tiers as dependents of the Root node – otherwise they would be expected to spread, delink, and so on just as the other features do. Instead, the major class features should literally form the Root node, so that the Root ceases to be a class node and instead becomes a feature bundle itself.

McCarthy's proposal has been widely accepted by phonologists, on the basis of his empirical claim that major class features never participate (individually) in assimilation or dissimilation. But this claim may not be valid. Kaisse (1992) documents several cases in which [±consonantal] appears to spread, contra McCarthy (1988). For instance, in Bergüner Romansh (a Räto-Romansh dialect of Switzerland), the glides /j, w/ strengthen to the voiced velar stop [g] before any consonant, e.g. (4a-c). The voiced velar then devoices before voiceless consonants, including those which have themselves undergone word-final devoicing, e.g. (4d-f).

(4) *Preconsonantal fortition in Bergüner Romansh*

a.	/lavowra/		ləvogrə	'works'
b.	/skrejvər/		skregvə̥r	'to write'
c.	/la bijza/		la bigza	'snowstorm'
d.	kreja (/krej-a/)	vs.	krekr̥ (/krej-r/)	'believes; to believe'
e.	ʒdreja	vs.	ʒdrekr̥	'destroys; to destroy'
f.	rejə	vs.	rekr̥	'laughs; to laugh'

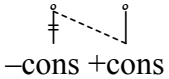
This pattern of glide strengthening before consonants (and devoicing before voiceless consonants) is also apparent in loanwords from German (Gmn.), as well as in words originating from Latin (Lat.), e.g. (5). Such adaptations have not occurred in adjacent and closely related dialects, e.g., nearby dialects have *powr* 'farmer', *dejt* 'finger', and *vejr* 'true'.

(5) *Historical adaptations, including loanwords, in Bergüner Romansh*

bauer (Gmn.)	> pokr̥, pogra	'farmer' (masc., fem.)
stube (Gmn.)	> ʃtegvə	'parlor'
digitu (Lat.)	> /dejt/ dekt	'finger'
filu (Lat.)	> fejl fekl̥	'thread'
malu (Lat.)	> mejl(u) (?) > mekl̥, meglə	'apple' (sg., coll. pl.)
nos (Lat.)	> naws (?) > noks	'we'

Kaisse observes that Bergüner Romansh glides do not strengthen in syllable-final position in general, e.g., *laj* 'lake', *dᶾej* 'juice'. Rather, it seems that /j, w/ change from [–consonantal] to [+consonantal] only when they are followed by [+consonantal] sounds. This suggests an analysis in which [+consonantal] *spreads* from one segment to a preceding one, from which [–consonantal] is simultaneously *delinked*.

(6) *Consonantal assimilation?*



Turning now to the possibility of [±sonorant] spread, consider the Child English data in (7). The glide /j/ strengthens to [ʒ, ʃ] after obstruents, as shown in (7a), but not after sonorants, as shown in (7b). This suggests an analysis in which [–sonorant] spreads from one segment to a following one, from which [+sonorant] is delinked, as represented in (7c). (When the glide changes to an obstruent, it also necessarily changes to [+consonantal].)

(7) *Morgan* (Bernhardt & Stemberger 1998:639): *Obstruent assimilation?*

a.	/niːd juː/	[niːd ʒuː]	‘need you’	c.
	/lʌv juː/	[lʌv ʒuː]	‘love you’	
	/hʌg juː/	[hʌg ʒuː]	‘hug you’	–son +son
	/wʌnt juː/	[wʌnt ʃuː]	‘want you’	
	/laɪk juː/	[laɪk ʃuː]	‘like you’	
	/kiːp juː/	[kʰiːp ʃuː]	‘keep you’	
b.	/koʊm juː/	[kʰoʊm juː]	‘comb you’	
	/spɪn juː/	[pʰɪn juː]	‘spin you’	

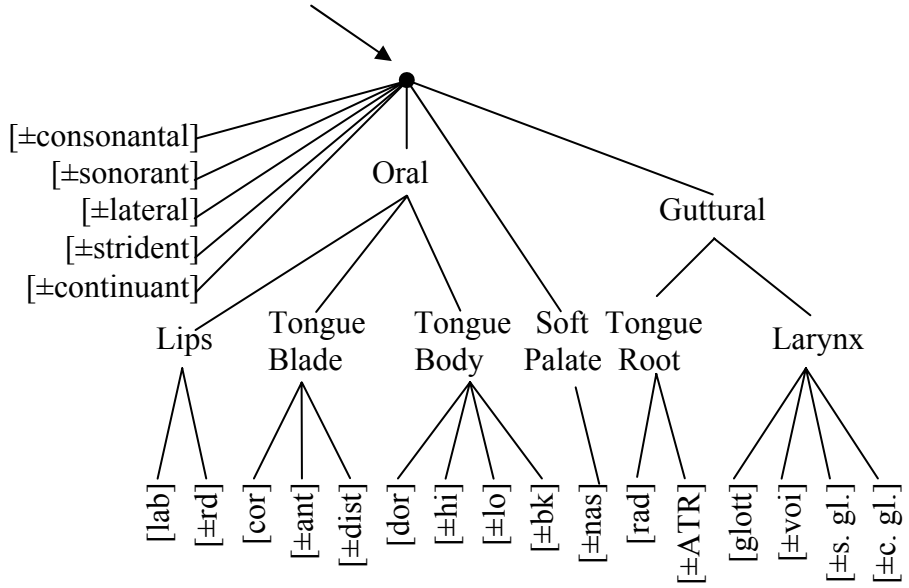
Cases in which major classes features appear to spread, as in Bergüner Romansh or Morgan’s Child English above, turn out to be very rare. In fact, most phonologists deny that such cases even exist. Hume and Odden (1996) claim that [±consonantal] never spreads, contra Kaisse (1992). For instance, they call into question Kaisse’s analysis of Romansh, noting that (p. 369):

> *there are no cases in which a glide is followed by a laryngeal or glide* [i.e., consonants which are not [+consonantal] (DH)]*, and therefore it is impossible to determine whether the context for fortition should be described in terms of ... the featural content of the following segment.*

And Kaisse herself states: “unambiguous spreading of the classical binary feature [sonorant] appears to be unattested” (p. 330, n. 15).

Still, unless phenomena such as glide hardening in Bergüner Romansh or Morgan’s Child English can be shown *not* to involve spreading [±consonantal] and [±sonorant], there is no compelling reason to treat them differently from other articulator-free features, which link directly to the root node of a segment. This interpretation of major class features is assumed by Archangeli & Pulleyblank (1994), following Sagey (1986):

(8) *Major class features outside root node*



3.2.2. The other articulator-free features

Unlike the major class features [±consonantal] and [±sonorant] which are claimed by many to never assimilate or dissimilate, the other articulator-free features [±lateral], [±strident] and [±continuant] are relatively active in syntagmatic segmental phonology.

3.2.2.1. [±lateral]

A case of lateral assimilation is found in Sundanese, an Austronesian language spoken in West Java, Indonesia (Cohn 1992). As shown in (9a-b), the plural marker in this language appears to be a prefix /ar-/. In fact, however, /ar-/ is regularly infixed after root-initial consonants, as the data in (9c-g) show (< > indicates infixation). Interestingly, when the root-initial consonant is /l/, the infix is realised as [al], as shown in (9h-i).

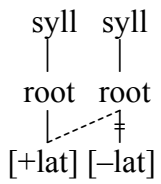
(9) *Sundanese lateral assimilation*

a.	/ar-anɟin/ PL-you	aranɟin
b.	/ar-ajɨm/ PL-patient	arajɨm
c.	/ar-poho/ PL-forget	p<ar>oho
d.	/ar-damaŋ/ PL-well (adj)	d<ar>amaŋ
e.	/ar-kusut/ PL-forget	k<ar>usut
f.	/ar-rɨwat/ PL-startled	k<ar>usut

g. /di-ar-visualisasi-kɨn/ div<ar>isualisasikɨn
PASS-PL-visualise-VSUFFIX
h. /ar-lɨtik/ l<al>ɨtik
PL-little
i. /ar-ləga/ l<al>əga
PL-wide

Cohn (1992:207) gives the following rule: "When the /r/ of the infix is preceded by an /l/ in the previous syllable, the [+lateral] specification of the /l/ spreads to the right, with concomitant delinking of [–lateral]."

(10)



applies to /r/ of the plural marker between two adjacent syllables

Turning now to dissimilation, the feature [lateral] participates in this process in Latin (Steriade 1987, 1995). As shown in (11a), the adjectival suffix *-alis* undergoes no change when added to a stem which has no lateral, but it appears as *-aris* when following a stem with a lateral, as shown in (11b). The data in (11c) show that when an *r* intervenes between the two *l*'s, no dissimilation occurs.

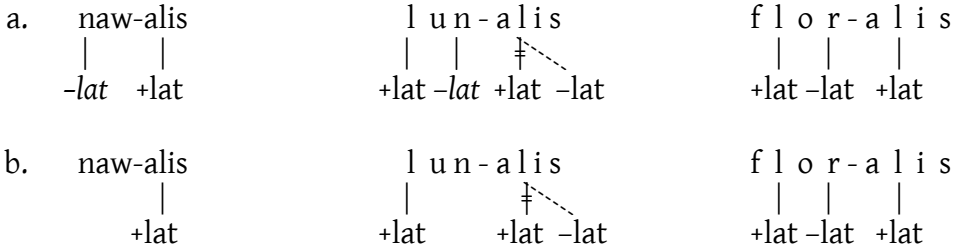
(11) *Latin lateral dissimilation*

a.	na:w-a:lis	'naval'	c.	litor-a:lis	'of the shore'
	semin-a:lis	'seminal'		flo:r-a:lis	'floral'
	wo:c-a:lis	'vocal'		sepulcr-a:lis	'funereal'
	caus-a:lis	'causal'		litter-a:lis	'literal'
	infinit-alis	'negative'		later-a:lis	'lateral'
	mort-a:lis	'mortal'		plu:r-a:lis	'plural'
	na:tur-a:lis	'natural'			
b.	so:l-a:ris	'solar'			
	lu:n-a:ris	'lunar'			
	lati-aris	'of Latium'			
	mi:lit-a:ris	'military'			
	line-a:ris	'linear'			
	aliment-a:ris	'alimentary'			
	popul-a:ris	'popular'			
	re:gul-a:ris	'regular'			

There is no contrast in laterality in nonliquids in Latin; the feature [lateral] is contrastive in nonnasal sonorants, i.e. liquids, but it plays no contrastive role in nonliquids. Thus we find that dissimilation between two [+lateral] features can take place across several intervening nonliquids, but dissimilation is blocked by an intervening [–lateral] feature on /r/. For some phonologists (e.g., Calabrese 1995, Halle, Vaux & Wolfe 2000), this pattern indicates simply that [+lateral] dissimilation in Latin is sensitive only to contrastive values of [±lateral]; non-

contrastive [±lateral] is shown in italics in (12a). For others (Steriade 1987, 1995), this pattern argues that nonliquids are *unspecified* for [±lateral], i.e., they completely lack the feature [±lateral], as shown in (12b).

(12) *Latin lateral dissimilation*



Exercises:

A. Using feature geometry, try to explain the allomorphy of the adjectival suffix in Georgian (Aronson 1990).

(13)				
	asur-uli	'Asyrrian'	asur-uli	'Asyrrian'
	somχ-uri	'Armenian'	dan-uri	'Danish'
	ungr-uli	'Hungarian'	tʃerk'ez-uli	'Cherkessian'
	kimi-uri	'chemical'	fizik-uri	'physical'
	fang-uli	'French'	reakti-uli	'reactive'
	real-uri	'real'	terminal-uri	'terminal'

B. What accounts for the allomorphy in the Latin suffixes *-al/-ar* in the following noun forms? (Spencer 1991:71)

(14)				
	animal	'animal'	kalkar	'spur'
	koklear	'spoon'	exemplar	'copy'
	laku:nar	'type of ceiling'	luperkal	'cave on Palatine hill'
	pulwi:nar	'type of couch'	toral	'valance (of couch)'
	torkular	'wine press'	tribu:nal	'tribunal'

C. Using feature geometry, try to explain the allomorphy of the plural infix in Sundanese (Cohn 1992).

(15)	sing.	pl.	
	kusut	k-ar-usut	'messy'
	visualisasi	v-ar-isualisasi	'visualise'
	damaŋ	d-ar-amaŋ	'well' (adj.)
	poho	p-ar-oho	'forget'
	ŋoplok	ŋ-ar-oplok	'flop down'
	gɨlis	g-ar-ɨlis	'beautiful'
	mahal	m-ar-ahal	'expensive'

dahar	d-al-ahar	‘eat’
hormat	h-al-ormat	‘respect’
pərceka	p-al-ərceka	‘handsome’
combrek	c-al-ombrek	‘cold’
motret	m-al-otret	‘take a picture’
biŋhar	b-al-iŋhar	‘rich’

The French words *raport* ‘report’ and *directeur* ‘director’ are borrowed as *lapor* and *dalektur* in Sundanese. Can you explain this?

D. Do you consider the words *plil* or *bror* to be potential words in English? Try to find monomorphemes that begin with CLVL, where L represents identical liquids (two *l*’s, or two *r*’s).

E. Suggest an explanation for why *colonel* is now pronounced like *kernel*.

F. Suggest a possible historical connection between English *pilgrim* and Latin *peregrin(us)* ‘foreigner’.

3.2.2.2. [±strident]

Obvious cases of assimilation of [±strident] are somewhat rare. This plausibly has to do with the fact that the feature [±strident] is defined *acoustically* (see section 2.2.2.2), whereas assimilation is typically understood *articulatorily*. As Grammont (1933:185) writes:

> *L’assimilation consiste dans l’extension d’un ou de plusieurs mouvements articulatoires au delà de leur domaine originaire. Ces mouvements articulatoires sont propres au phonème agissant; le phonème agi, en se les appropriant aussi, devient plus semblable à l’autre.*

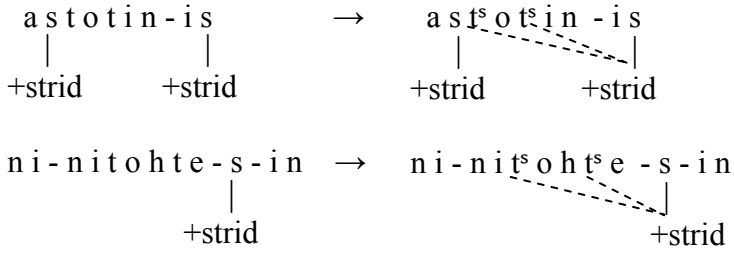
Still, a possible case of [±strident] assimilation is found in Plains Cree (Hirose 1997). Recall from section 2.2.2.2 that in this Algonquian language “plain” /t/’s become [+strident] affricates [tˢ] when they occur with a diminutive affix, -(i)s or -(i)sis:

(16) *Diminutives in Plains Cree*

	Non-diminutives		*Diminutives*	
a.	astotin hat	‘a/the hat’	astˢotˢin-is hat-DIM	‘a little hat’
b.	ni-nitohte-n 1-listen-1	‘I listen’	ni-nitˢohtˢe-s-in 1-listen- DIM-1	‘I listen a little’
c.	atim dog	‘dog’	atˢimo-sis dog-DIM	‘a/the little dog’
d.	ni-tem 1-horse	‘my horse’	ni-tˢem-isis 1-horse-DIM	‘my little horse’

A priori, this looks likes regressive assimilation of [+strident] from the diminutive suffix: an association line is added between a [+strident] feature of the diminutive suffix and any preceding /t/, as represented in (17).

(17) *Strident assimilation in Plains Cree*



A much more common process involving the feature [±strident] is called *assibilation*. This is a process in which a (coronal) stop becomes [+strident], usually preceding a high vowel. For example, in Japanese, the stop /t/ is affricated to [tˢ] before the vowel [u], and to [tʃ] before the vowel [i], e.g. (18a). Assibilation fails before other vowels, e.g. (18b).

(18) *Assibilation in Japanese*

a.	/tat-u/	[tatˢu]	'to stand' + PRES
	/tat-i-mas-u/	[tatʃimasu]	'to stand' + POLITE + PRES
b.	/tat-e/	[tate]	'to stand' + IMP
	/tat-a-nai/	[tatanai]	'to stand' + NEG
	/tat-oo/	[tatoo]	'to stand' + COHORT

Historically, this also happened in the change from Proto-Bantu to Mvumbo (Kim 2001:91): the stops /b d t g k/ of Proto-Bantu became affricated in Mvumbo, to /dʒ tʃ/ before /i/, as in (19a), and to /bᵛ pᶠ/ before /u/, as in (19b). Stops before nonhigh vocoids in Proto-Bantu were not affricated historically, e.g. (19c). In other words, [–sonorant, –continuant] became [+strident] before [–consonantal, +high].

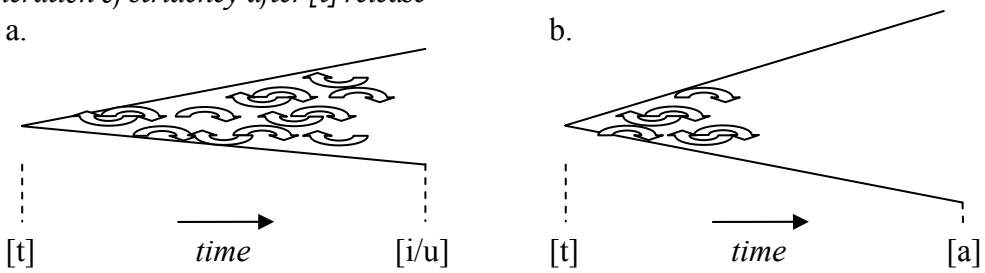
(19)

	ProtoBantu	*Mvumbo*	
a.	*-ti:tʊ	tʃir	'animal'
	*-dib-	dʒiwo	'shut'
	*-gida	ma-tʃie	'blood'
	*-kiŋgo	tʃiuŋ	'neck, nape'
b.	*-buma	bᵛumo	'fruit'
	*-dut	-bᵛure	'pull'
	*-tud-	-pᶠule	'forge'
	*-gubʊ	m-bᵛu:	'hippopotamus'
	*-kuba	pᶠuwo	'chicken'
c.	*-bod	-buo	'become rotten'
	*-dɪ	-di	'eat'
	*-to:g	-tuog	'boil up'
	*-gada	-kala	'mat'
	*-konde	-kwande	'banana'

Assibilation appears to be a kind of "acoustic assimilation". (Again, this is not too sur-surprising, given the acoustic basis of the feature [+strident].) As Kim (2001) explains, the narrow channel which is created in the transition between a stop and a following high vowel (or glide) generates an especially long turbulence, which speakers interpret as a [+strident] feature on the stop. That is, the frication duration after the /t/ release is much longer before the high

vowels /i u/ than before the non-high ones. The longer duration of turbulent aiflow in the release of [t] into a high vowel vs. nonhigh vowel is schematised in (20a) *vs.* (20b).

(20) *Generation of stridency after [t] release*



Here is Kim (2001:102):

> *The generation of air turbulence in the context of phonological assibilation is phonologically interpreted as the insertion of the feature [+strident] into the feature complex characterising the plosive in a plosive + high vocoid sequence, with the deletion of the previous feature [–strident], if present.*

Assibilation appears to be especially common with high front vowels. As shown in the following data, in Modern Korean /t, tʰ/ become [+strident] before [+high, –back] vowels, but not before [+high, –back] vowels.

(21) *Modern Korean*

a.	/mat-i/ -i Nomin.	[ma.dᶻi]	‘first child’
	/pʰiputʰ-i/	[pʰi.pu.tˢʰi]	‘one’s own child’
	/patʰ-ilaŋ/ -ilaŋ ‘and’	[pa.tˢʰi.raŋ]	‘field and’
	/sotʰ-ilaŋ/	[so.tˢʰi.raŋ]	‘kettle and’
b.	/katʰ-u/	[ka.tʰu]	‘to be the same’ + ques
	/putʰ-ɨmjən/	[pu.tʰɨ.mjən]	‘to attach’ + ‘if’

Other languages that exhibit assibilation of /t/ before [i] include Blackfoot, an Algonquian language of Southern Alberta and Northern Montana (Frantz 1991), e.g. (22), and Asháninca (Campa), an Arawakan language of Peru (Spring 1992), e.g. (23).

(22) *Blackfoot*

a.	/nit-i:tsiniki/	[nitˢi:tsiniki]	‘I related (a story)’
	1-relate		
	/nit-a-i:tsiniki/	[nitɛ:tsiniki]	‘I am relating (a story)’
	1-DUR-relate		
b.	/kit-i:tsiniki/	[kitsi:tsiniki]	‘you related (a story)’
	2-relate		
	/kit-a-i:tsiniki/	[kitɛ:tsiniki]	‘you are relating (a story)’
	2-DUR-relate		
cf.	/i:tsiniki-wa/	[i:tsinikiwa]	‘he related (a story)’
	relate-3		

/a-i:tsiniki-wa/ [ɛ:tsinikiwa] ‘he is relating (a story)’
DUR-relate-3

(23) *Asháninca*

a. /no-kant-i/ [nokantˢi] ‘I said’
I-say-NF (nonfuture)
b. /no-ant-i/ [nantˢi] ‘I did’
I-do-NF
c. /no-misi-i/ [nomisitˢi][58] ‘I dreamed’
I-dream-NF

Turning now to dissimilation of [+strident], an example is reported in the isolate Basque. Lacharité (1995:164) gives the following rule for this language:

(24) *Strident dissimilation in Basque*

X X → X X
| | | ǂ
*[+stri][+stri] [+stri][+stri]

As she explains: “When the morphology juxtaposes two [+strident] specifications, the rightmost is deleted, leaving a homorganic stop” (p. 164), e.g.:

(25) *Strident dissimilation in Basque*

a. /ikas-/ ‘learn’ + /-tˢen/ ‘imperfect’ [ikasten]
b. /irabaz-/ ‘earn’ + /-tˢen/ ‘imperfect’ [irabazten]
c. /ipin-/ ‘put’ + /-tˢen/ ‘imperfect’ [ipintˢen]

Modern Yucatec Maya (Straight 1976, Lombardi 1990, LaCharité 1995) is also described as having [+strident] dissimilation, since it forbids C_1VC_2 roots in which C_1 and C_2 are [+strident], e.g.:

(26) *Disallowed root shapes in Yucatec Maya*

*sVtˢ *tˢVs *ʃVs *tʃVs
*sVʃ *tˢVʃ *ʃVtˢ *tʃVtˢ
*sVtʃ *tˢVtʃ *ʃVtʃ *tʃVʃ, etc.

Exercises

A. Examine t/tˢ and d/dᶻ in Canadian French. Are they phonemes or allophones? If they are allophones, what conditions their distribution? If they are phonemes, demonstrate the contrast. (Davenport & Hannahs 1998)

[58] This form has an epenthetic [t], which is regularly added between a vowel-final stem and a vowel-initial suffix.

a.	aktˢɪf	‘active’	i.	tˢy	‘you’
b.	dᶻi	‘say’	j.	twe	‘you’ (obj.)
c.	tu	‘all’ (masc.)	k.	deʒɑ	‘already’
d.	dɔne	‘give’	l.	dᶻʏk	‘duke’
e.	admɛt	‘admit’	m.	dᶻɪsk	‘record’ (noun)
f.	tɔtal	‘total’	n.	dʊt	‘doubt’
g.	tut	‘all’ (fem.)	o.	sɔrtˢi	‘exit’
h.	tˢɪp	‘type’	p.	mɔrdᶻy	‘bitten’

B. Try to explain the form of the following loanwords in Japanese. (N.B.: The “default” vowel for insertion (epenthesis) is [u], e.g., *glove* > gulovu, *public* > paburikːu.)

	Japanese	*Original*	
a.	tˢuːpiːsu	tuːpiːs	English: ‘two piece(s)’
b.	tˢuːruːzu	tuluz	French: ‘Toulouse’ (place name)
c.	katˢuretˢu	kʌtlət	English: ‘cutlet’

Try now to explain this different pattern also observed in loans (Mah 2001):

	Japanese	*Original*	
a.	tosuto	tost	English: ‘toast’
b.	suketo	sket	English: ‘skate’

C. Explain the changes observed in the following Finnish data (Kiparsky

a.	/halut-i/	[halusi]	‘wanted’
	/halut-a/	[haluta]	‘to want’
b.	/hakkat-i/	[hakkasi]	‘hewed’
c.	/turpot-i/	[turposi]	‘swelled’
d.	/avat-i/	[avasi]	‘opened’
e.	/vete/	[vesi][59]	‘water’
	/vete-næ/	[vetenæ]	‘water’ (ess.)

D. Suggest a possible historical explanation for the following alternations:

a.	electri[k]	electri[s]ity
b.	classi[k]al	classi[s]ist
c.	criti[k]al	criti[s]ism
d.	publi[k]	publi[s]ity
e.	Catholi[k]	Catholi[s]ism
f.	medi[k]ate	medi[s]ine
g.	dupli[k]ate	dupli[s]ity

[59] Word-final /e/ is regularly raised to [i] in Finnish.

E. Try to explain the distribution of the [əz] allomorph of the English plural suffix:

(27) *English plurals*

a.	leðz	'lathes'	f.	bædʒəz	'badges'
b.	ɹɪtʃəz	'riches'	g.	bæθs	'baths'
c.	ɹifs	'reefs'	h.	fɹɪkətɪvz	'fricatives'
d.	besəz	'bases'	i.	ɹæʃəz	'rashes'
e.	vɑzəz	'vases'			

Citing Berko (1958), Bernhardt & Stemberger (1998:643) report that 5-year-old children tolerate consonant clusters that are highly unusual in adult English, e.g., [dɪʃs] 'dishes', [bɹɪdʒz] 'bridges'. How do you explain this difference in Child English?

3.2.2.3. [±continuant]

Assimilation of [–continuant] is relatively common. For instance, fricatives ([+continuant]) may become affricates ([–continuant]) following stops ([–continuant]. In Hungarian (Vago 1980) [–continuant] regularly spreads from a nonstrident coronal to a following strident coronal, e.g.:

(28) *Hungarian*

a.	hɛɟ-ʃeːg	[hɛɟtʃeːg]	'mountain range'
b.	bɑrɑːt-ʃɑːg	[bɑrɑːttʃɑːg]	'friendship'
c.	øt-sør	[øttˢør]	'five times'

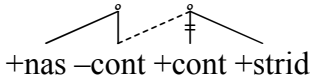
In Venda (Padgett 1995:53), [–continuant] spreads from a nasal to a following fricative, yielding an affricate, e.g. /N+vulɛdᶻa/ [mbᵛulɛdᶻɔ] 'finishing' (cf. /N+bᵛuda/ [mbᵛudɔ] 'a leak'). Similarly, in Zulu (ib.) and Kikongo (Hyman 2001):

(29) *Zulu* (Padgett 1995:54)

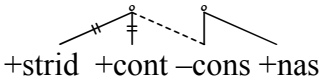
a.	izimpᶠudu	'tortoises'	cf.	uːfudu	'tortoise'
b.	izintˢizi	'sorrows'		uːsizi	'sorrow'
c.	izindᶻime	'walking staffs'		uːzime	'walking staff'

(30) *Kikongo* (Hyman 2001)

a.	/ku-N-fíl-a/	kú-m-pᶠíl-a	'to lead me'
b.	/ku-N-síb-a/	kú-n-tˢíb-a	'to curse me'
c.	/ku-N-vun-á/	kú-m-bᵛun-á/	'to deceive me'
d.	/ku-N-zól-a/	kú-n-dᶻol-a	'to love me'



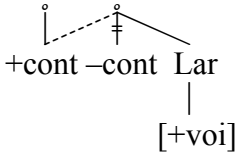
In some dialects of American English, [–continuant] spreads in the opposite direction, from a nasal to a preceding fricative, e.g. [bɪdnɪs] 'business', [ɪdnɪt] 'isn't it' (McCarthy 1988). ([+strident] is lost simultaneously, presumably to avoid [dᶻ], which English lacks.)



Spanish furnishes an example of [+continuant] spread: [b, d, g] give way to [β, ð, ɣ] after [+continuant] segments, i.e., after fricatives, e.g. (31a-c), after [r], e.g. (31d-f), and after [l], e.g. (31g-h) (/b, g/ only).[60] As Morris (1998:189) state, "most studies concur that continuancy assimilation is achieved by the rightward spreading of a feature [continuant]."

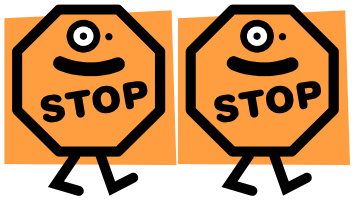
(31) *Spanish* (Morris 1998)

a.	*desvío*	[desβio]	e.	*arde*	[arðe]
b.	*desde*	[desðe]	f.	*mar gruesa*	[marɣruesa]
c.	*afgano*	[afɣano]	g.	*mil veces*	[milβeses]
d.	*carbón*	[karβon]	h.	*alga*	[alɣa]



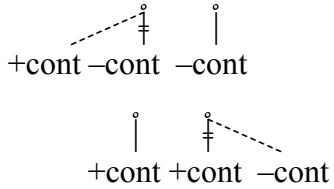
Spanish also shows a tendency to lenite stops to fricatives in syllable-final position, e.g., *adquirir* [aðkirir], *étnico* [eθniko]. As Morris (1998:202) affirms: "Coda obstruents may not be [–cont]." Interestingly, this process of lenition "feeds" continuancy assimilation, i.e., fricatives resulting from lenition cause a following voiced stop to become [+continuant], e.g., *abdica* [aβðika].

Turning to dissimilation of [±continuant], this process was important in the development from Ancient Greek to Modern Greek (Spencer 1991). On the one hand, the first stop in a sequence of two stops changed to a fricative, e.g. (32a-b). On the other hand, the second fricative in a sequence of two fricatives changed to a stop, e.g. (32c-d).[61]



(32) *Greek* (Spencer 1991)

a.	epta	>	efta	'seven'
b.	okto	>	oxto	'eight'
c.	fθinos	>	ftinos	'cheap'
d.	sxolio	>	skolio	'school'



This dissimilation is also evident in certain alternations. For example, the passive aorist suffix is *-θik*, e.g. (33a), except after fricatives, where it is realised as *-tik*, e.g. (33b). This alternation results from the dissimilation of [+continuant], as in (32c-d).

[60] The fact that /d/ fails to change to [ð] after [l] (e.g., [el deðo] 'the finger') leads some (e.g., van de Weijer 1995, Kaisse 1999) to consider [l] [–continuant] in Spanish, but this leaves unexplained the change of /b, g/ to [β, ɣ] after /l/ in the same language.

[61] The fact that both dissimilations resulted in a fricative+stop sequence is probably not accidental. According to Morelli (1999), fricative+stop is the preferred obstruent cluster cross-linguistically.

(33) *Greek* (Spencer 1991)

a.	agap-i-θik-e	'he was loved'	cf.	agap-a-	'love'
	fer-θik-e	'he was carried'	cf.	fer-	'carry'
	stal-θik-e	'he was sent'	cf.	stel-	'send'
b.	akus-tik-e	'he was heard'	cf.	akus-	'hear'
	ðex-tik-e	'it was received'	cf.	ðex-	'receive'
	ɣraf-tik-e	'it was written'	cf.	ɣraf-	'write'

Dissimilation of [+continuant] appears to be especially common. For example, according to McCarthy (1988:98): "In Piro [an Arawakan language of Peru], clusters of two fricatives s, ʃ, and x cannot occur — that is, there is a dissimilatory ... effect of [+continuant]."

The Wakashan language Oowekyala (Howe 2000) has a process of [+continuant] dissimilation which only affects adjacent coronal fricatives. The effect is clearest when a suffix that begins in a coronal fricative is added to a stem that ends in a coronal fricative. For example, the suffix *-sm* 'round and/or bulky object' is realised as *-tˢm* after [ɬ], e.g. (34a-b); cf. (34c-e). Similarly, the suffix *-sista* 'around' is realised as *-tˢista* after [ɬ], e.g. (35a-b); cf. (35c-e). And the suffix *-su* '2sg.' is realised as *-tˢu* after [ɬ], e.g. (36a-c); cf. (36d-f).

(34) *-sm* 'round and/or bulky object'

a.	ʔaluɬ-tˢm	'round and/or bulky thing (e.g. a cooking stone) that is new or that has been renewed, remodeled, renovated'
b.	tˢ'ɬ-tˢm	'to burst open (said of sth. round and/or bulky, such as a paper bag or a box)'
c.	q'axʷ-sm	'sth. round and/or bulky that has become visible after the tide has gone out (such as e.g. a rock); to emerge from the water, reef, place that is high and dry'
d.	tiχ-sm	'sth. round and/or bulky (clumsy) that is green or yellow; green mountain, green rock'
e.	luχʷ-sm	'round thing (such as a drum)'

(35) *-sista* 'around'

a.	tˢ'ik'aɬ-tˢista	'to riot, a riot'
b.	hiɬ-tˢista	'to take a turn for the better'
c.	xʷiɬ-tˢista	'to return, to turn back'
d.	tˡ'iχ-sista	'to spawn all over the area (said of herring)'
e.	nawalaxʷ-sista	"power is around" (name of a potlatch given at the end of a feast when all the food and gifts are seemingly gone, and the hosts' ancestors arrive and do their dances)

(36) *-su* 'you'

a.	ɢʷaɬ-tˢu p'aːla	'you stop working'
b.	q'awɬ-tˢu	'you know'
c.	glɬ-tˢu	'you are tall'
d.	ʔaː-su	'you pour(ed) grease into sth.'
e.	ʔak-su	'you finish(ed) sth. up completely'
f.	ʔəbuxʷ-su	'you are a mother'

Exercises:

A. Using feature geometry, explain the distribution of [β, l, ɣ] vs. [b, d, g] respectively, in Proto-Bantu —the reconstructed latest ancestor of the modern Bantu languages spoken in Eastern, Central, and Southern Africa, including Swahili and Ganda.

(37) *Proto-Bantu* (Halle & Clements 1983)

a.	βale	'two'	m.	kiɣa	'eyebrow'
b.	leme	'tongue'	n.	ɣiɣɛ	'locust'
c.	taβe	'twig'	o.	kulu	'tortoise'
d.	pala	'antelope'	p.	oŋgo	'cooking pot'
e.	kondɛ	'bean'	q.	tɛndɛ	'palm tree'
f.	zɔŋgo	'gall'	r.	zala	'hunger'
g.	βɛɣa	'monkey'	s.	zɔɣu	'elephant'
h.	βɛmbe	'pigeon'	t.	βele	'body'
i.	limo	'god, spirit'	u.	lɛlu	'chin, beard'
j.	kaŋga	'guinea fowl'	v.	eɣi	'water'
k.	ɣɔmbɛ	'cattle'	w.	kiŋgɔ	'neck'
l.	lelɔ	'fire'	x.	nto	'person'

B. Explain why *diphthong* is pronounced [dɪpθɑŋ] by some, [dɪftɑŋ] by others.

C. Try to explain the following changes from Old English to later Old English:[62] *cysiþ* > *cyst* 'he chooses'; *þiefþ* > *þieft* 'theft'; *nosþyrl* > *nosterl* 'nostril'; *gesihþ* > *gesiht* 'vision'. Similarly, try to explain these developments: *wæfs* > *wæps* 'wasp'; *weahsan* > *weaxan* 'grow'. (Campbell 1959)

D. The aspirated stops of Ancient Greek changed to fricatives in Modern Greek, e.g. [tʰeloː] > [θeloː] 'I want'. There appear to be some exceptions to this change, e.g. [eleftʰeria] > [lefteria] (*[lefθeria]) 'freedom'. Similarly, Indo-European voiceless stops changed to fricatives in Germanic, e.g. [pater] > [faθer] 'father'. But again there are exceptions, e.g. [spuo] > [spu] (*[sfu]) 'spew', [oːkt] > Old English [ɛːaxt] (*[ɛaxθ]) 'eight'. How would you explain such exceptions?

E. Chaha is a Semitic language spoken in Ethiopia (Petros 2000). Use the data in (38) and (39) to determine whether [x] and [k] represent separate phonemes or allophones of a single phoneme. Give the underlying phoneme(s) and explain your solution. (N.B.: [β̞] is a bilabial glide.)

(38)	a.	jə-xtɨβ̞	'Let him vaccinate!'	n.	jə-kfɨr	'Let him separate!'
	b.	jə-tɨks	'Let him burn sth.!'	o.	j-a-xɨβ̞d	'Let him respect someone!'
	c.	jə-xətɨt	'Let him surround sth.!'	p.	j-a-kjəs	'Let him joke!'
	d.	jə-kʃəʃ	'Let it be prickly!'	q.	jə-xrəm	'Let him spend a year!'
	e.	j-a-xətɨr	'Let him precede!'	r.	jə-ŋkɨf	'Let him provoke a quarrel!'
	f.	jə-kzəβ̞	'Let it become inferior!'	s.	jə-xi	'Let him dig!'

[62] In Old English orthography, *þ* ("thorn") = [θ], *h* = [x], *x* = [ks].

g.	jə-xdɨm	‘Let him look after!’	t.	jə-ŋkɨs	‘Let him bite/let a plant root!’
h.	jə-kɨft	‘Let him open sth.!’	u.	jə-xərtɨm	‘Let him cut sth. off!’
i.	j-a-xdɨr	‘Let him dress someone!’	v.	j-a-βəŋkɨs	‘Let him assign as a pretext!’
j.	jə-kəʃ	‘Let him crush sth.!’	w.	j-a-xmac	‘Let him strain people!’
k.	jə-xβɨβ	‘Let him encircle!’	x.	j-əkɨs	‘Let him wait!’
l.	jə-ksər	‘Let him strain!’	y.	j-a-xəmbɨr	‘Let him invert cooked food!’
m.	j-a-ŋkɨs	‘Let him light the fire!’	z.	jə-kjaf	‘Let it drizzle!’

(39)

	Jussive	*Imperf.*	*Perf.*	
a.	jə-frəx	jɨ-fərx	fənəx	‘tolerate’
b.	jə-məs(ɨ)x	jɨ-mes(ɨ)x	mesəx	‘ruminate, chew’
c.	jə-fʷ(ɨ)x	jɨ-fʷəx	fʷəx	‘wipe out’
d.	jə-frat(ɨ)x	jɨ-frat(ɨ)x	fɨratəx	‘mess’
e.	jə-srəx	jɨ-sərx	sənəx	‘be weakened’
f.	jə-t-ʃaməx	jɨ-t-ʃaməx	tə-ʃaməx	‘lean on’
g.	jə-marx	jɨ-manx	manəx	‘capture’
h.	jə-rax	jɨ-rəx	nax	‘send’
i.	jə-βtɨx	jɨ-βət(ɨ)x	bətəx	‘uproot’
j.	jə-tɨmx	jɨ-təmx	təməx	‘dip out’
k.	jə-tɨrx	jɨ-tərx	tənəx	‘make incisions’

Similarly, use the following data to determine whether [xʷ] and [kʷ] represent separate phonemes or allophones of a single phoneme.

(40)

a.	jə-xʷərɨr	‘Let him amputate!’
b.	j-a-kʷəʃ	‘Let him remove fibers!’
c.	jə-xʷɨrk’	‘Let him loosen!’
d.	jə-mərkʷɨs	‘Let him be a monk!’ (< Amh)
e.	jə-xʷɛ	‘Let him spill!’
f.	jə-təkʷɨs	‘Let him fire a gun!’ (< Amh)
g.	j-a-xʷramt’	‘Let him chew!’
h.	jə-xʷemt’ɨt’	‘Let it be sour!’

Try to elaborate the analysis you provided above to account for the following data:

(41)

a.	kətəf	‘has hashed’
b.	kɨβəsəs	‘has unraveled fiber’
c.	a-kβabəs	‘has made dirty’
d.	a-ŋ-krawəs	‘has fidgeted’

3.3. Place features

In this section we consider syntagmatic processes which affect the Lips, the Tongue Blade, or the Tongue Body.

3.3.1. Lips

The Lips, as an articulator, may be involved in phonological patterns directly. For instance, according to Yip (1982, 1988), two Lips-articulated segments cannot cooccur within morphemes in Cantonese. This holds for [labial] consonants /p, m, f/, for [+round] consonants /kʷ/ and vowels /o, u, y, ø/, as well as for the [labial, +round] glide /w/. Thus Cantonese has no words like *pim, *fap, *kʷam, *mip, *wam, etc. This state of affairs appears to result from dissimilation of the Lips, not just of [labial] or [±round].

It is more common, however, for the Lips features [labial] and [±round] to be individual participants in assimilatory and dissimilatory processes.

3.3.1.1. [labial]

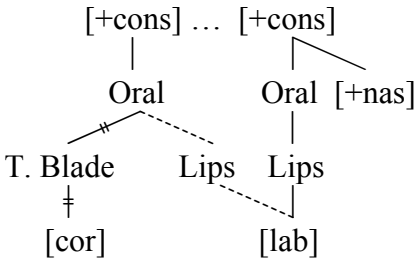
One of the most noticeable patterns of [labial] assimilation is one found exclusively in child language, wherein a [coronal] consonant assimilates to a following [labial] consonant, even across intervening vowels. For instance, the data in (42a) from Dylan (4;6–5;0) illustrate [labial] spread from a nasal [m] to a preceding coronal, as represented in (42b).

(42) *Dylan* (Bernhardt & Stemberger 1998)

a.

/taɪm/	[paĩm]	'time'
/θʌm/	[bɛ̃m]	'thumb'
/sʌmtaɪmz/	[bɛmpaɪm]	'sometimes'
/nʌmbɹz/	[bɐ̃mbə][63]	'numbers'

b.



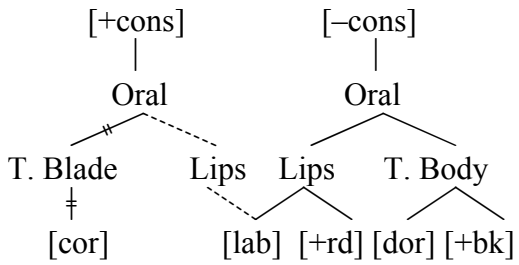
The data in (43a) are also from Dylan. They illustrate another type of [labial] assimilation: from /w/ to an immediately preceding [coronal] consonant, as represented in (43b). (There is also independent stopping and voicing of word-initial consonants, a fact which we ignore.)

[63] The loss of [+nasal] in the initial consonant of this form is unexpected, since "there were no obvious constraints against co-occurrence of [Labial] and [+nasal]" (Bernhardt & Stemberger 1998:625, n. a). Perhaps there was dissimilation of [+nasal], *[mVm]?

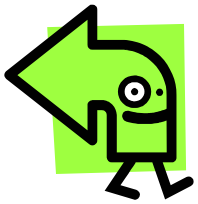
(43) *Dylan* (Bernhardt & Stemberger 1998)

a.	/θɹuː/	[bwu] ~ [bwju]	‘threw/through’
	/θɹoʊ/	[bwɔʊ]	‘throw’
	/θɹoʊ-ɪŋ/	[bwowĩŋ]	‘throwing’
	/swɛɾɹ/	[bwɛʔdʊ]	‘sweater’

b.



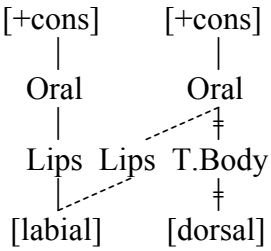
The data in (44) are from Charles (5;10–6;0). They illustrate [labial] spread from /w/ to an immediately preceding consonant, whether [coronal] or [dorsal]. (These data also reveal that Charles requires all word-initial obstruents to be [+continuant], a fact which we ignore.)



(44) *Charles* (Bernhardt & Stemberger 1998)

a.	/bɹɛd/	[vwʌdˠ]	‘bread’
b.	/dɹɛst/	[vwʌθt̪]	‘dressed’
c.	/twɛnti/	[fwɛntiˈ]	‘twenty’
d.	/glʌv/	[vwʌbˠ]	‘glove’
e.	/sliːp/	[fwip]	‘sleep’
f.	/swɛtɹ/	[fwʌdɔ]	‘sweater’
g.	/kwaɪjət/	[fwɑɪjɛt]	‘quiet’
h.	/tɹaj/	[fwɑj]	‘try’
i.	/dɹɑpt/	[fwapt]	‘dropped’

Progressive assimilation of [labial] is rare but not unheard of. One case is found in Hayu, a Himalayish language spoken in Nepal (Michailovsky 1988). As Hyman (2001:176, n. 10) reports, “In this language, a suffix-initial velar consonant will assimilate in place to a preceding labial-final root consonant, for example, /dip-ŋo/ ‘he pinned me (in wrestling)’ [dipmo]”

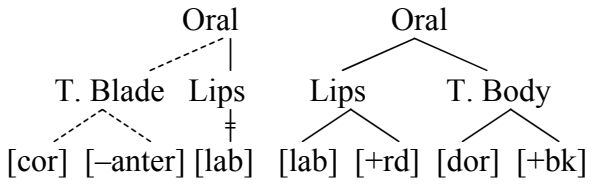


As an example of [labial] dissimilation, consider what happens when the passive suffix -*w*- is added to stem-final [labial] consonants in the Bantu language SiSwati:

(45) *Dissimilatory palatalisation* (Herman 1996)

	Infinitive	*Passive*	
a.	kwélaɸ-a	kwélaʃ-w-a	‘to heal’ / pass
b.	kúgob-a	kúgotʃ-w-a	‘to bend’ / pass
c.	kúlúm-a	kúlúɲ-w-a	‘to bite’ / pass
d.	kúbamb-a	kúbandʒ-w-a	‘to hold’ / pass

It seems that the [labial] feature of the suffix *-w-* causes the stem-final [labial] feature to delink and be replaced by [coronal, –anterior], as represented here:



The following additional data show that this [labial] dissimilation effect can occur "at a distance".

(46) *Dissimilatory palatalisation* (Herman 1996)

	Infinitive	*Passive*	
a.	kúmbómbot-a	kúmbónd^{3}ot-w-a	'to cover' / pass
b.	kúhlíɸit-a	kúhlíʃit-w-a	'to scribble' / pass
c.	kúsebéntis-a	kúset^{ʃ}éntis-w-a	'to use' / pass

A different form of [labial] dissimilation occurs in Modern Georgian (van de Weijer & Butskhrikidze 2001). This language has a general process of metathesis that affects /v/ when following the sonorant consonants /r, l, n/ in infinitival verb forms:

(47)	*root*	*pres. 3sg. (-av-, -ob- them. sfx.)*	*infinitives (-a infin. sfx.)*	
a.	xar	xr-av-s (/xar-av-s/)	xvr-a (/xar-av-a/)	'to gnaw'
b.	k'ar	k'r-av-s	k'vr-a	'to tie'
c.	xan	xn-av-s	xvn-a	'to plough'
d.	k'al	k'l-av-s	k'vl-a	'to kill'
e.	sxal	sxl-av-s	sxvl-a	'to chop off'
f.	d^{z}er	d^{z}r-av-s	d^{z}vr-a	'to move'

Metathesis is blocked, however, when the consonant preceding the sonorant consonant (r, l, or n) is [labial], e.g.:

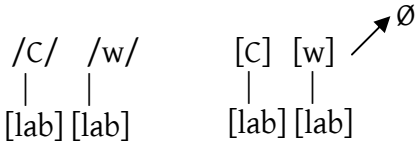
(48)	*root*	*pres. 3sg.*	*infinitives*	
a.	ber	ber-av-s	berv-a (*bvr-a)	'to blow up'
b.	par	par-av-s	da-parv-a (*da-pvr-a)	'string'

The avoidance of adjacent labials is also demonstrated by the fact that /v/ deletes when it immediately precedes /m/, e.g.:

(49)	*gamo-tkv-am-s*	vs.	*gamo-tkma*
	'somebody is pronouncing'		'pronunciation'

Yet another case of [labial] dissimilation is found in Korean. In this language the labio-velar [w] often deletes in ordinary speech, especially after bilabial consonants, e.g. *pwa pa* 'look!', *mweari meari* 'echo', *pwe pe* 'hemp cloth', *p^{h}wita p^{h}ita* 'blossom'. Kang (1996) attributes the loss of [w] to dissimilation of labiality:

(50) *Labial dissimilation in Korean*



Exercises

A. Explain the colloquial pronunciation of *seven* as [sɛbm̩]. What does this pronunciation tells us about the distinction "bilabial" vs. "labiodental"?

B. Formally express the process responsible for the various shapes of the prefixes in the following examples.

(51) *English*

a.	infallible	*imfallible	f.	impale	*inpale
b.	impossible	*inpossible	g.	infamous	*imfamous
c.	involuntary	*imvoluntary	h.	impenitent	*inpenitent
d.	implicit	*inplicit	i.	infinite	*imfinite
e.	invariable	*imvariable	j.	imbue	*inbue

Similarly for these data:

(52) *English*

a.	confess	*comfess	f.	complacent	*conplacent
b.	composit	*conposit	g.	confederacy	*comfederacy
c.	confirm	*comfirm	h.	compassion	*conpassion
d.	combust	*conbust	i.	convert	*comvert
e.	convoke	*comvoke	j.	combine	*conbine

C. Using feature geometry, try to explain the following cases of allomorphy in Tashlhiyt Berber.

(53) *Reflexive prefix alternation: m ~ n*

m-xazar	'scowl'	n-fara	'disentangle'
m-saggal	'look for'	n-ħaʃʃam	'be shy'
m-ʃawar	'ask advice'	n-xalaf	'place crosswise'
mm-ʒla	'lose'	n-kaddab	'consider a liar'

(54) *Agentive prefix alternation: am ~ an*

am-las	'shear'	an-ṛmi	'be tired'
am-krz	'plow'	an-bur	'remain celibate'
am-agur	'remain'	an-ḍfur	'follow'
am-zug	'abscond'	an-ʕazum	'fast'

D. Tagalog has an infix *-um-* which normally occurs after word-initial consonants (there are no vowel-initial words), but some words do not take this infix. Explain the exceptions.

(55) *Tagalog*

a.	sulat	sumalat	'to write'
b.	ʔabot	ʔumabot	'to reach for'
c.	gradwet	grumadwet ~ gumradwet	'to graduate'
d.	preno	prumeno ~ pumreno	'to brake'
e.	mahal	*mumahal	'to become expensive'
f.	walow	*wumalow	'to wallow'
g.	smajl	*summajl ~ smumajl	'to smile'
h.	swiŋ	*sumwiŋ ~ swumiŋ	'to swing'

E. Which consonants may precede [w] at the beginnings of words in English (CwV...)? Explain.

3.3.1.2. [±round]

As you may recall from section 2.3.1.2 (p. 39ff.) above, the Wakashan language Oowekyala has several rounded velars and uvulars phonemes, as is vividly illustrated in the following words:

(56) *Some labiovelars and labiouvulars in Oowekyala*

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

A constraint illustrated in (57) requires that velars and uvulars be rounded after /u/ in Oowekyala.

(57) *Rounding of velars and uvulars after /u/*

a.	dukʷ-a (*duka)	'to troll; Lyall's American stinging nettle (Urtica dioica)'[64]
b.	j'ugʷ-a (*juga)	'to rain'
c.	tɬ'ukʷ'-pa (*tɬ'ukʷ'pa)	'to get spruce roots (for making baskets)'
d.	buxʷ-ls (*buxls)	'illegitimately pregnant'
e.	tˢuqʷ-a (*tˢuqa)	'to beg, to go and ask for something'
f.	huɢʷ-itɬ (*huɢitɬ)	'to run into the house (with a group of people)'
g.	luqʷ'-as (*luq'as)	'Western or Lowland hemlock tree (Tsuga heterophylla)'
h.	luχʷ-a (*luχa)	'to roll (said of a round thing)'

[64] An alternate form for 'stinging nettle' is duxʷa.

This constraint may be stated informally as in (58).

(58) A vowel /u/ must share the feature [+round] with a following velar or uvular obstruent.

That this is not simply a static fact holding of words (e.g. (57)), but a more general constraint in Oowekyala, is apparent from alternations. For example, the initial segment of the inchoative suffix *-xʔit*, illustrated in (59), becomes rounded after u-final stems, as illustrated in (60).

(59) *-xʔit* 'to become, to start'

a.	ɬl'-xʔit	'to become dead'	ɬl'	'dead, inactive, paralysed'
b.	pqʷ'tˢ'-xʔit	'to become sleepy or drowsy'	pqʷ'tˢ'	'drowsy, sleepy'
c.	pusqʾa-xʔit	'to become very hungry'	pusqʾa	'to feel very hungry'

(60) *-xʷʔit* 'to become, to start'

a.	ʔlʾxʷstu-xʷʔit	'to assume the colour of blood'	ʔlʾxʷstu	'colour of blood, having the colour of blood'
b.	tɬ'u'xʷalasu-xʷʔit	'to fall ill, to become sick'	tɬ'u'xʷalasu	'to be ill, sick'
c.	tu-xʷʔit	'to start to walk'	tu-a	'to walk'
d.	su-xʷʔit	'to take, grab, pick up, grasp with the hand'	su-a	'to carry, get, take, hold in one's hand'

Similarly, the initial segment of the suffix *-gila* 'to make', illustrated in (61), becomes rounded after u-final stems, as illustrated in (62).

(61) *-gila* 'to make'

a.	ʔənm-gila-xʔit	'to make a sling'	ʔənm	'sling'
b.	ɢinʾi-gila	'to cook fish eggs'	ɢinʾi	'salmon roe, salmon eggs'
c.	məja-gila	'draw/carve a fish'	məja	'fish (esp. salmon)'

(62) *-gʷila* 'to make'

a.	muː-gʷila	'to get four items'	muːpʾnista	'four round trips'
b.	ʔamastu-gʷila	'to make kindling'	ʔamastu	'kindling'
c.	tu-gʷila	'term used for the second series of the Həmacʾa Dances'	tu-a	'to walk'

The initial obstruent of the suffix *-kʾala* 'noise, sound', illustrated in (63), also becomes rounded after /u/, as illustrated in (64).

(63) *-kʾala* 'noise, sound'

a.	nan-kʾala	'sound of a grizzly bear'	nan	'grizzly bear'
b.	waka-kʾala	'sound of barking'	waka	'to bark (dog), to woof'
c.	nuɬ-kʾala	'sound of foolish talk'	nuɬa	'to behave crazy, or foolish'

(64) *–kʷ'ala* 'noise, sound'

a.	tu-kʷ'ala	(*tuk'ala)	'sound of footsteps'	tu-a	'to walk'
b.	l'əχʷu-kʷ'ala	(*l'əχʷuk'ala)	'sound of coughing'	l'əχʷu-a	'to cough'

The initial segment of the suffix *-ɢu* 'together', illustrated in (65a-c), becomes rounded after /u/, as illustrated in (65d).

(65) *-ɢu* vs. *-ɢʷu* 'together'

a.	bn'-ɢut	'to put things close together'	bən'a	'close to sth.'
b.	laː-ɢu	'to go (fit) together'	labut	'go to the end of sth.'
c.	ʔak-ɢu	'all together'	ʔak	'all'
d.	muː-ɢʷu-ala	'four people walking together'	muːp'ənaχa	'four times down'

Likewise, the initial segment of the suffix *-χs* 'aboard', illustrated in (66a-c), becomes rounded after /u/, as illustrated (66d-e).

(66) –χs vs. –χʷs 'aboard'

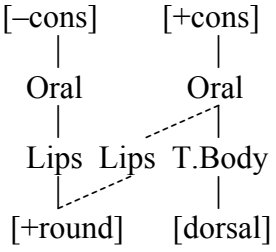
a.	w'n-χs	'to stow away'	w'əna	'to hide, to sneak about'
b.	kʷ'a'-χs	'to sit in a boat'	kʷ'a's	'to sit outside'
c.	xʷlt-χs	'fire on the boat'	xʷlta	'to burn'
d.	muː-χʷs	'to be four aboard'	muːp'ənaχa	'four times down'
e.	q'atu-χʷs	'to meet on the boat'	q'atu	'meeting'

Finally, rounding also occurs across the prefix-root boundary. The most common form of the plural in Oowekyala is a CV-shaped reduplicative prefix. The data below show that a root initial obstruent becomes rounded when the copied vowel in the reduplicative prefix is /u/. (Note that syncope[65] applies within the base, such that /u/ deletes after being copied.)

(67) *Rounding in Oowekyala plural forms*

	singular	*plural*	
a.	kusa	ku-kʷsa	'to shave, scrape off with a knife (skin, fur, fish scales)'
b.	quɬəla	qu-qʷɬəla	'bend, crooked, warped'
c.	quχʷa	qu-qʷχʷa	'to scrape'
d.	ɢul'as	ɢu-ɢʷəl'as	'salmonberry (Rubus spectabilis) bush'
e.	ɢum̓a	ɢu-ɢʷəm̓a	'paddle; propeller'

In sum, one can observe that the feature [+round] regularly spreads from the vowel /u/ onto a following consonant in Oowekyala.



[65] *Syncope* refers to vowel deletion.

Oowekyala also displays a variable pattern of assimilation whereby a velar or uvular obstruent becomes labialised if it immediately follows a labiovelar or a labiouvular. For example, the initial segment of the suffix -ʾχdˡa 'back', which is illustrated in (68), variably becomes rounded after rounded consonants, as shown in (69).

(68) *-ʾχdˡa* 'back'

a.	qɬʾχdˡala	'motor boat'
	qɬka	'to bite (mosquito)'
b.	jipʾχdˡaʔaiɬ	'the binding around the bottom edge of the basket'
	jipa	'to make a cedar bark mat (i.e. one with a special kind of weave)'

(69) *-ʾχʷdˡa ~ -ʾχdˡa* 'back'

a.	kɬqˀʷχʷdˡa ~ kɬqˀʷχdˡa	'incessantly urinating (said of a male)'
	kɬqˀʷa	'to urinate (said of a male)'
b.	gʷukˀʷχʷdˡala ~ gʷukˀʷχdˡala	'boat with a cabin on the stern'
	gʷukˀʷ	'to live in a place, reside, dwell, settle'
c.	buqˀʷχʷdˡa ~ buqˀʷχdˡa	'person who always farts'
	buqˀʷala	'to fart'
d.	duqˀʷ-χʷdˡa ~ duqˀʷ-χdˡa	'to look back'
	duqʷa	'to look for sth.'

Similarly, the initial segment of the inchoative suffix –xʔit, which is illustrated in (70), variably becomes rounded after a labialised consonant, as shown in (71).

(70) *-xʔit* Inchoative

a.	pʾa-xʔit	'begin to work'	pʾa:la	'working'
b.	ɬlʾ-xʔit	'to become dead'	ɬlʾ	'dead, inactive, paralysed'

(71) *-xʷʔit* Inchoative

a.	ʤaqˀʷ-xʷʔit ~ ʤaqˀʷxʔit	'to begin to blow (said of the ʤaqˀʷala wind)'
	ʤaqˀʷ-ala	'north wind off the sea (also W, SW depending on location)'
b.	qakˀʷxʷʔit ~ qakˀʷxʔit	'to begin to lose in the game'
	qakˀʷa	'to suffer a loss (as in a game)'

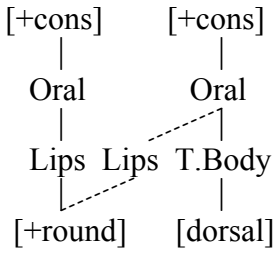
Likewise, the initial segment of the suffix –ʾχu 'neck', which is illustrated in (72), variably becomes rounded after a labialised obstruent, as shown in (73).

(72) *-χu* 'neck'

a.	tqɬʾχu	'itching throat, to have an...'	tqɬa	'to itch'
b.	glt̓χu	'long neck, having a long neck'	glt	'long, tall'

(73) *-χʷu ~ -χu* 'neck'

a.	tsɬkˀʷχʷu ~ tsɬkˀʷχu	'short neck(ed)'	tsɬkˀʷ	'short'
b.	qʷlqˀʷχʷu ~ qʷlqˀʷχu	'to sprain the neck'	qʷlqˀʷa	'to sprain, wrench'
c.	mɬkˀʷχʷu ~ mɬkˀʷχu	'to choke on sth. solid'	mɬkˀʷ-	



Here one can observe that the feature [+round] variably spreads from a labialised consonant onto a following consonant in Oowekyala. Note that this process is different from the one seen above in which the feature [+round] regularly spreads from the vowel /u/ onto a following consonant. Rounding assimilation between consonants is *variable*, and there are some exceptions: it does not apply between obstruents across a reduplicative prefix boundary, e.g. (74), and there are lexical exceptions to rounding assimilation between obstruents, e.g. (75-78).

(74) *Some reduplications in Oowekyala*

a.	Kɬχʷ-kɬqʷa (*Kɬχʷkʲʷlqʷa)	‘refers to a man urinating repeatedly’
	kɬqʷa	‘to urinate (said of a male)’
b.	kʲɬχʷ-kʲɬχʷa (*kʲɬχʷkʲʷiχʷa)	‘run, stop, run (repeatedly)’
	kʲɬχʷa	‘to run away, escape, flee from’
c.	ɢuχʷ-ɢuχʷa (*ɢuχʷɢʷuχʷa)	‘to scoop repeatedly’
	ɢuχʷa	‘to scoop up loose things with one's hand’
d.	qˀcxʷ-qˀckʷa (*qˀcxʷqˀʷckʷa)	‘to eat meat’
	qˀckʷ	‘hair seal meat that has been cut up’

(75) *-χs* ‘aboard’

a.	qʲɬkʷχs (*qʲɬkʷχʷs)	‘to lie in the boat (said of animate beings)’
	qʲɬkʷa	‘to lie on sth. (said of animate beings)’
b.	sukʷχsa (*sukʷχʷsa)	‘to pick up, lift, grab sth. in the boat’
	sukʷa	‘to pick up, lift, grasp, grab with the hand’
c.	ləqʷχsa (*ləqʷχʷsa)	‘to light the stove in the boat’
	ləqʷa	‘wood, firewood’
d.	χʷisiqʷχs (*χʷisiqʷχʷs)	‘(on) the other (or: the far) side of the boat one is in’
	χʷisiqʷa	‘to travel on the other (or: the far) side of the channel’

(76) *-qəja* ‘forehead’

a.	tʰʲuqʷqəja (*tʰʲuqʷqʷəja)	‘bald head, to be bald-headed’
	tʰʲuqʷa	‘to make bald or bare, to cut off all hair’
b.	tʰʲaqʷqəja (*tʰʲaqʷqʷəja)	‘red hair(ed)’
	tʰʲaqʷa	‘red’
c.	mukʷqəjaut (*mukʷqʷəjaut)	‘to tie sth. to the top of the head’
	mukʷa	‘to tie a rope to something’
d.	buqʷqəja (*buqʷqʷəja)	‘toque’

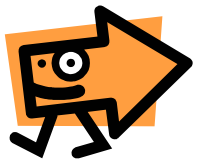
(77) *-(k)ga* ‘inside’

a.	tˢʲutˢʲχʷga (*tˢʲutˢʲχʷgʷa)	‘to wash the inside of things (e.g. of a pail), to do dishes’
b.	wʲukʷga (*wʲukʷgʷa)	‘inside of sth. hollow (e.g. of a boat, cup, dish)’

(78) *-kaswʲu* ‘plural’

a.	bukʷkaswʲu (*bukʷkʲʷaswʲu)	‘books’
b.	tˢʲikʲʷkaswʲu (*tˢʲikʲʷkʲʷaswʲu)	‘birds’

Observe that rounding assimilation operates exclusively from left to right. For example, the suffix –gʷuɬ 'ago' does not cause rounding when it attaches to nɬ̓ik̓ 'siphon': nɬ̓ik̓gʷuɬ (*nɬ̓ikʷgʷuɬ). The nominaliser –kʷ also fails to induce rounding in a preceding (labialisable) consonant, as exemplified here:



(79) *-kʷ 'nominaliser'*

a.	t̓əmakkʷ	'(door) locked with a key'
	t̓əmaka	'to lock up with a key (door, trunk, etc.); to tie shoelaces'
b.	ʔanqkʷ	'stripped from a branch with the fingers (as berries)'
	ʔanqa	'to strip berries off the branches with the fingers'
c.	kiχkʷ	'(sth.) sawn, lumber, board'
	kiχa	'to use a saw'

To understand the rightward bias of rounding assimilation in Oowekyala, it is surely significant that in terms of timing, rounding is heavily skewed to the right edge of a consonant. As Ladefoged and Maddieson (1996:357) describe, in consonants rounding "is typically concentrated on the release phase of the primary articulation that it accompanies." Similarly, Watson (1999:298):

> In labialization, protrusion of the lips tends to occur on or after the hold phase of the primary articulation... As a result, the second formant of a vowel *following* a labialized consonant is lower than the second formant of a vowel *preceding* a labialized consonant.

In a phonological theory that is not constrained by phonetic factors, the left-to-right formulation of rounding assimilation is a stipulation. In such a theory[66] it is unclear why there should be cases of progressive rounding assimilation, as in Oowekyala, but never any cases of regressive rounding assimilation. But in a phonetically-constrained phonological theory (e.g., Archangeli & Pulleyblank 1994) the progressive nature of rounding assimilation can be understood as appropriately reflecting the physical fact that rounded consonants are post-labialised, such that a following (labialisable) consonant is naturally rounded.

Turning now to long-distance assimilation of [±round], consider the phenomenon of rounding harmony. For example, in Yowlumne (a California Penutian language), suffixes show alternations between [i] and [u], depending on whether the root has [u]. Compare (a) vs. (b) in each of (80)-(82).

(80) *-hin ~ -hun 'aorist'* (Archangeli 1984:137)

a.	lihim-hin	'ran'	b.	ʔukun-hun	'drank'

[66] Consider, for instance, the position of Gussenhoven and Jacobs (1998:197):

> *The two place nodes in a segment with secondary articulation are not sequenced in time. Although in the IPA symbols the superscripts indicating labialization, velarization, etc. conventionally appear to the right of the consonant symbol, the two components of a secondary articulation segment are phonologically simultaneous. That is, a side-view would show a straight line.*

(81) *-(ʔ)in'in ~ -(ʔ)un'un 'resident of'* (Archangeli 1984:145)
a. ʔal'tʰ-in'in 'resident of salt-grass' (Poso Creek tribe)
b. pal'(u)w-un'un 'resident of west; westerner'

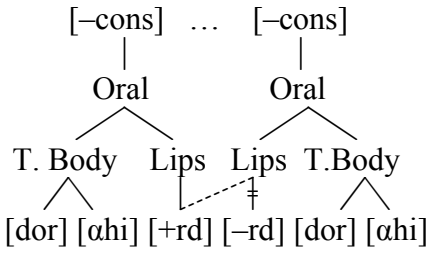
(82) *-ijin ~ -ujun 'intensive possessor'* (Archangeli 1984:146)
a. piṯk'-ijin 'one who is always excreting'
b. tʰuk'-ujun 'one with large ears; jackrabbit'

Similarly, suffixes show alternations between [a] and [o] depending on whether the root has [o]. Compare (a) vs. (b) in (83-84).

(83) *-al ~ -ol 'dubitative'* (Archangeli 1984:78)
a. ṯiʔs-al 'might make'
b. hotʰn-ol 'might take the scent'

(84) *-hatin ~ -hotin 'desiderative'* (Archangeli 1984:79)
a. t'aw-hatin-xo:hin 'was trying to win'
b. ṯos-hotin-xo:hin 'was trying to sell'

In other words, Yowlumne grammar spreads the feature [+round] from one vowel to a following vowel of the same height, even across intervening consonants. (In the representation of this process here, "α" represents a variable that ranges over the values "+" and "–".)



Exercise:

What other features are changed in Yowlumne vowel harmony [i] > [u], [a] > [o]? How do you explain these changes?

3.3.2. Tongue Blade

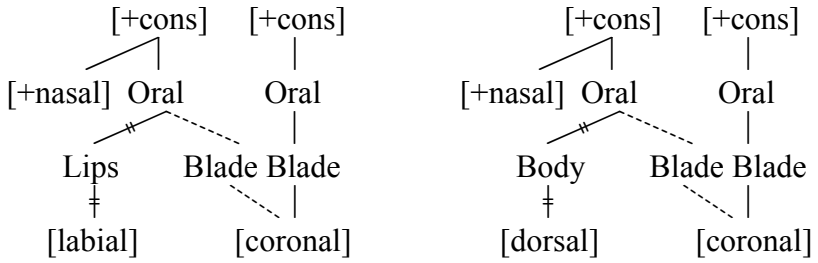
In this section we consider assimilatory and dissimilatory processes which involve the Tongue Blade features [coronal], [±anterior], and [±distributed].

3.3.2.1. [coronal]

An example of [coronal] assimilation occurs in the Sri Lankan Portuguese Creole (De Lacy 2002:326). In this language, a labial nasal becomes [coronal] preceding a [coronal] consonant, as shown in (85a), and similarly, a velar nasal becomes [coronal] before a [coronal] consonant, as shown in (85b). The reverse is not true: a [coronal] nasal does not change to [labial] preceding a [labial] consonant, nor to [dorsal] preceding a [dorsal] consonant, as shown in (85c).

(85) *Sri Lankan Portuguese Creole*

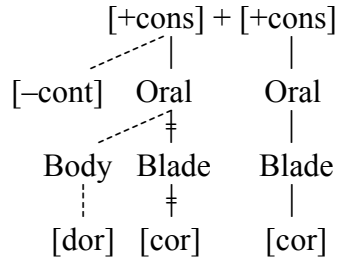
a.	/maːm-su/	[maːnsu]	‘hand’ (genitive)
	/pərim-təsuwaː/	[pərintəsuwaː]	‘I am sweating’
	/ɾezaːm lej/	[ɾezaːnlej]	‘reasonably’
b.	/miːtiŋ-su/	[miːtiŋsu]	‘meeting’ (gen.)
	/uŋ diːjəpə/	[un diːjəpə]	‘for one day’
c.	/kəkluːn-pə/	[kəkluːnpə]	‘turkey’ (dative sg.)
	/siːn-ki/	[siːnki]	‘bell’ (verbal noun)



As an example of [coronal] dissimilation, consider the case of reduplication in Dakota, a Siouan language (Shaw 1980). In general a CVC-shaped portion of the word is faithfully copied in reduplication, as shown in (86a). However, when both C’s of the copied syllable are [coronal], one is realised as [k] in reduplication, as shown in (86b). This change in Dakota reduplication is an instance of [coronal] dissimilation.

(86) *Dakota reduplication*

a.	ʃapa	ʃap+ʃápa	‘be dirty’
	zúka	zuk+zúka	‘hang in mucuous strings’
	tʃéka	tʃek+tʃéka	‘be staggering’
b.	sutá	suk+súta	‘be hard, firm’
	ʃétʃa	ʃek+ʃétʃa	‘be dry and dead’
	ʒĩtʃa	ʒĩk+ʒĩtʃa	‘to sniffle’
	títã	tik+titã	‘to have force exerted’



Exercises:

A. Building on the above discussion of Dakota reduplication, try to account for the following additional data:

tʃóna-la	tʃók-tʃóna-la	‘to be few’
líla	líklila	‘very’

B. One feature that distinguishes the Canadian and British dialects of English is the distribution of the [ju] sequence. Examine the following data and explain the difference (Kenstowicz 1994).

(87)

Canadian	*British*	*Canadian*	*British*
am[ju]se	am[ju]se	n[u]ws (news)	p[ju]ny
b[ju]ty (beauty)	b[ju]ty	p[ju]ny (puny)	p[ju]ny
c[ju]be	c[ju]be	pre[zu]me	pre[zju]me
d[u]pe	d[ju]pe	st[u]pid	st[ju]pid
f[ju]me	f[ju]me	s[u]t (suit)	s[ju]t
l[u]rid	l[ju]rid		

3.3.2.2. [±anterior]

[+anterior]	[–anterior]
t	ʈ
s	ʂ
n	ɳ
	ɽ

The Indo-Aryan language Sankrit makes a [±anterior] contrast between alveolar and retroflex consonants, and it also shows alternations between alveolar and retroflex consonants. For example, a process of *n*-retroflexion requires that [n] become retroflex [ɳ] in a suffix when preceded by a retroflex continuant [ʂ] or [ɽ] in the stem. Consider the right-hand column of the following data:

(88)

a. <u>*-na:* present</u>

mɽd-na:	'be gracious'	iʂ-ɳa:	'seek'

b. <u>*-na* passive participle</u>

bʱug-na-	'bend'	puːɽ-ɳa	'fill'
		vɽk-ɳa-	'cut up'

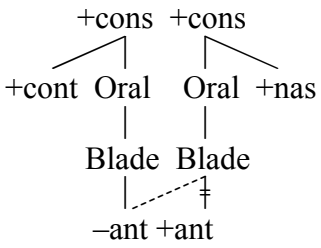
c. <u>*-a:na* middle participle</u>

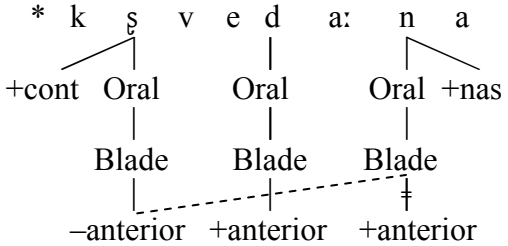
maɽj-aːna-	'wipe'	puɽ-aːɳa	'fill'
kʂved-aːna-	'hum'	kʂubʱ-aːɳa	'quake'

d. <u>*-ma:na* middle participle</u>

kɽt-a-maːna	'cut'	kɽp-a-maːɳa	'lament'

Observe that the source of assimilation and its target are not necessarily adjacent, e.g., in [kʂubʱ-aːɳa] and [kɽp-a-maːɳa], the target [n] is separated from the source [ʂ] or [ɽ] by one and even two intervening labial consonants. However, intervening coronals such as the [t] in *kɽt-a-maːna* (cf. *kɽp-a-maːɳa*) block the assimilation process. This blocking effect suggests that this spreading rule is sensitive to contrastive features, i.e., the spreading [–anterior] is not permitted to cross an intervening [+anterior] feature in order to target a nasal:





A similar case of long-distance assimilation occurs in Barbareño, a Chumashan language spoken in the vicinity of Santa Barbara, California (Mithun 2001). This language has the sibilants in (89). Pairs such as slow' 'eagle' vs. ʃlow' 'goal line' show that [±anterior] is contrastive.

(89) *Sibilants in Barbareño Chumash*

	[+anterior]	[–anterior]
[–continuant]	tˢ	tʃ
	tˢʰ	tʃʰ
	tˢ’	tʃ’
[+continuant]	s	ʃ
	sʰ	ʃʰ

Barbareño has a process of "sibilant harmony"whereby sibilants must agree in anteriority within a word, e.g.:

(90) *Barbareño Chumash sibilant harmony in stems*

[+anterior]		[–anterior]	
sqojis	'kelp'	ʃoʃo	'flying squirrel'
tˢ'axs	'scum'	tʃʰumaʃ	'Santa Cruz Islander'
swoʔs	'feather ornament'	tʃ'imujaʃ	'escurpe' (a fish)

That this is not simply a static fact holding of words but an active process in the language, is apparent from alternations in morphologically-complex words. Thus the prefixes in (91) alternate in terms of [±anterior] in words with the suffixes in (92), as illustrated in (93).

(91) *Barbareño prefixes with sibilants*

[+anterior]		[–anterior]	
s-	'3rd person subj.'	iʃ-	'dual subject'
saʔ-	'future'	itʃ-	'associative'
su-	'causative'	uʃ-	'with the hand'
sili-	'desiderative'		

(92) *Barbareño suffixes with sibilants*

[+anterior]		[–anterior]	
-us	'3rd sg. benefactive'	-ʃiʃ/-ʃaʃ	'reflective/reciprocal'
		-Vtʃ	'affected by'
		-Vʃ	'resultative'
		-ʃ	'imperfective'
		(i)-waʃ	'past'

(93) *Barbareño regressive sibilant harmony*

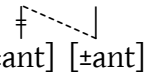
	[+anterior]		[–anterior]	
a.	/s-iniwe/ 3-kill	siniwe 'he killed (it)'	/s-iniwe-ʃiʃ/ 3-kill-reflex.	ʃinweʃiʃ 'he killed himself'
b.	/k-saʔ-tiwoliʔlaj/ 1-future-flute	ksaʔtiwoliʔlaj 'I'll play the flute'	/k-saʔ-tiwoliʔlaji-n-ʃ/ 1-fut.-flute-verb-imp.	kʃaʔtiwoliʔlajitʃ 'I'll play the flute'
c.	/k-saʔ-su-kuj/ 1-future-caus.-boil	ksaʔsukuj 'I will boil it'	/s-su-kuj-aʃ/ 3-caus.-boil-result.	ʃʰujujaʃ 'boiled islay'

Specifically, then, Barbareño has a process of "consonant harmony" in which a sibilant assimilates to the [±anterior] specification of a following sibilant. Unlike in Sanskrit, assimilation is regressive in this case, but just as in Sanskrit, the source and the target of assimilation may be far removed from each other. Additional data illustrating sibilant harmony with the affixes in (91)-(92) are provided in (94) (from Shaw 1991). As shown, [s] assimilates [–anterior] from [ʃ] or [tʲ] in (94a,b,c); and [ʃ] assimilates [+anterior] from [s] in (94d).

(94)	a.	/k-sunon-ʃ/	kʃunonʃ	'I am obedient'
	cf.	/k-sunon-us/	ksunonus	'I obey him'
	b.	/saxtun-itʃ/	ʃaxtunitʃ	'to be paid'
	cf.	/saxtun/	saxtun	'to pay'
	c.	/s-ilakʃ/	ʃilakʃ	'it is soft'
		/s-am-motʃ/	ʃammotʃ	'they paint it'
		/s-kuti-waʃ/	ʃkutiwaʃ	'he saw'
	cf.	/s-ixut/	sixut	'it burns'
		/s-aqunimak/	saqunimak	'he hides'
	d.	/s-iʃ-tiʃi-jep-us/	sistisijepus	'they two show him'
	cf.	/p-iʃ-al-nan'/	piʃanan'	'don't you two go'

In other words, the harmony process spreads both values of [anterior] from the source, and delinks both values of [anterior] from the target.

(95)



The forms in (96) highlight an important distinction between long-distance assimilations in Sanskrit and Barbareño: the nonsibilant coronals [t, n, l] do not trigger (96a), do not undergo (96b) and do not block (96c) the assimilation of [±anterior]. (There are several examples of these facts also in (93) and (94) above.)

(96)	a.	ʃ-api-tʲo-i**t**	'I have good luck'
		s-api-tˢo-us	'he has good luck'
	b.	k-ʃu**n**o**n**-ʃ	'I am obedient'
		k-sunos-us	'I obey him'
	c.	ha-ʃ-xi**nt**i**l**a-waʃ	'his former Indian name'
		ha-s-xintila	'his Indian name'

To explain the first two facts —that [+anterior] [t, n, l] neither trigger nor undergo sibilant harmony— we might consider adding a restriction on the process (95): that the source and the target be both specified [+strident]. But this would leave unexplained the fact that [+anterior] [t, n, l] do not block the spread of [±anterior] across them. Indeed recall that the spread of [–anterior] was blocked by [+anterior] [t] in Sanskrit. So why the difference?

As Kenstowicz (1994) suggests, the explanation for this difference probably lies in the fact that [+anterior] is *contrastive* for [t, n] in Sanskrit (they contrast with /ʈ, ɳ/, respectively),[67] whereas [+anterior] is *not contrastive* for [t, n, l] in Chumash (they do not contrast, nor do they alternate, with [ʈ, ɳ, ɭ] in this language). That is, in both languages, segments that are contrastively-specified for [±anterior] fully participate in [±anterior] assimilation (as "source", "tar-

[67] Interestingly, Hall (1997, fn. 39) mentions that "[Sanskrit Coronal Assimilation] does not affect /l/." This is consistent with the fact that [±anterior] is not contrastive in /l/ in Sanskrit.

get", or "blocker"). But segments in which [±anterior] is not contrastive are inert to [±anterior] assimilation: they do not trigger it, nor undergo it, nor block it.

Finally, many researchers, such as Shaw (1991) and Kenstowicz (1994), suggest that [+anterior] is inert on [t, n, l] in Chumash because these segments are actually *unspecified* for this feature, again because this feature is not contrastive in them.

Exercises:

A. Michif is the traditional language of Canada's Métis people (Bakker 1997).[68] Explain the difference between the following words in French and Michif:

(97)	*French*	*Michif*	
a.	sɛʃ	ʃɛʃ	'dry'
b.	savaʒ	ʃavaːʒ	'First Nations' (F. *sauvage*)
c.	ʃasi	saːsiː	'window' (F. *chassis*)
d.	ʃɛz	sɛz	'chair'
e.	ʒezy	zezy	'Jesus'

B. Try to explain the changes illustrated in the following data from Tsuut'ina (Athapaskan, Alberta) (Cook 1984).

(98)				
a.	/si-tˢogo/	ʃitˢógò	'my flank'
b.	/na-s-ɣatˢ/	naʃɣátˢ	'I killed them again'
c.	/mi-tˢ'i-di-s-wuʃt/	mítˢ'idiʃwùʃt	'someone whistled at him'
d.	/i-si-s-jí/	ìʃíʃjí	'I thawed it out'

3.3.2.3. [±distributed]

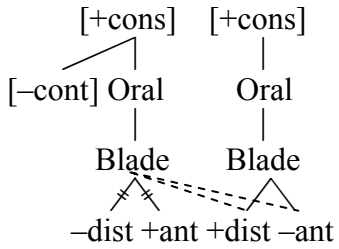
The feature [±distributed] often patterns with the other Tongue Blade feature, [±anterior], in phonological processes. Consider a first example from English (99). In casual speech, the coronal stops /t,d,n/ become dental before [θ], postalveolar before [ʃ, ʒ], and retroflex before [ɹ].

(99)	[t]	[d]	[n]	
_____ θ	eigh**t**h	hundre**d**th	te**n**th	[+distrib, +anter]
_____ ʃ	eigh**t** shoes	eigh**t** gems	i**n**sure	[+distrib, –anter]
_____ ɹ	**t**ree	**d**ream	e**n**roll	[–distrib, –anter]
_____ s	ha**t**s	rea**d**s	e**n**sue	[–distrib, +anter]

These changes can be understood as both Tongue Blade features [–anterior] and [+distributed] being spread individually to a preceding coronal stop.

[68] Michif is a fascinating example of a contact language. It is spoken by many of Canada's Métis, descendants of Cree women and fur trappers who were mostly French Canadian. It uses Plains Cree for verbs and Canadian French for nouns, and uses two separate sets of grammatical rules. However, Michif is not mutually intelligible with either Cree or French. Of the thousand or so modern speakers of Michif in the Canadian Prairies as well as in Montana and North Dakota in the US, few know French, and even fewer know Cree.

Note that in this case, the features [–anterior] and [+distributed] spread to segments in which they are not necessarily contrastive: [ɲ] is not a phoneme in English, nor are [ʈ, ɖ, ɳ], nor are [t̪, d̪, n̪], yet they result from coronal assimilation in English.



In this context, it is worth noting that Sanskrit has a similar rule that spreads [–anterior] and [+distributed] to a preceding [+anterior, –distributed] consonant, as illustrated in the following data (Hall 1997:80):

(100)	a.	/taːn-ɖjimbʱaːn/	[taːɳɖjimbʱaːn]	‘those infants’
	b.	/taːn-dʒanaːn/	[taːɲdʒanaːn]	‘those people’
	c.	/etat-tʃʰattram/	[etatʃtʃʰattram]	‘this umbrella’
	d.	/tat-ɖaukate/	[taʈɖaukate]	‘it approaches’
	e.	/tatas-tʃa/	[tataʃtʃa]	‘and then’
	f.	/paːtas-ʈalati/	[paːtaʂʈalati]	‘the foot is disturbed’

The interesting difference is that all the sounds that result from assimilation are actual phonemes in Sanskrit: the features [±anterior] and [±distributed] make a three-way contrast among alveolar, palatal, and retroflex in the phonemic inventory of this language.

(101)

alveolar	*palatal*	*retroflex*
t	tʃ	ʈ
s	ʃ	ʂ
n	ɲ	ɳ
		ɾ
[+ anter, – distrib]	[– anter, + distrib]	[– anter, – distrib]

Finally, the following additional data show that /n/ does not assimilate to a following velar or labial consonant in Sanskrit. This confirms that the relevant process is *coronal assimilation*: only the Tongue Blade features [anterior] and [distributed] are spread.

(102)	a.	/maha:n-kavih/	[maha:nkavih]	‘great poet’
	b.	/maha:n-bʱaːgah/	[maha:nbʱaːgah]	‘illustrious’

“The Sanskrit language ...; more perfect than the Greek, more copious than the Latin, and more exquisitely refined than either, yet bearing to both of them a stronger affinity, both in the roots of verbs and in the forms of grammar, than could possibly have been produced by accident; so strong indeed that no philologer could examine them all three, without believing them to have sprung from some common source, which perhaps no longer exists; there is a similar reason, though not quite so forcible, for supposing that both the Gothic and the Celtic, though blended with a very different idiom, had the same origin as the Sanskrit; and the old Persian might be added to the same family...” (Sir William Jones, 1786)

ENGLISH:	brother	mead	is	he bears
SANSKRIT:	bhrater	medhu	asti	bharati

Exercise:

Tahltan, an Athapaskan language of British Columbia, has the following consonant inventory:

b	d	d^{l}	$d^{ð}$	d^{z}	$d^{ʒ}$	g	g^{w}	ɢ	
	t	$t^{ɬ}$	$t^{θ}$	t^{s}	$t^{ʃ}$	k	k^{w}	q	
	t’	$t^{ɬ’}$	$t^{θ’}$	$t^{s’}$	$t^{ʃ’}$	k’	$k^{w’}$	q’	
		ɬ	θ	s	ʃ	x	x^{w}	χ	
		l	ð	z	ʒ	ɣ	$ɣ^{w}$	ʁ	
m	n				j		w		h
	n’								ʔ

Provide a full explanation for the following alternations.

1. *Alternations in* ‘1st person sing.’ (underlined)

a.	θε<u>θ</u>ðεɬ	‘I’m hot’
b.	hudiʃt^{ʃ}a	‘I love them’
c.	ε<u>s</u>k’a:	‘I’m gutting fish’
d.	dε<u>θ</u>k^{w}υθ	‘I cough’
e.	εʃd^{ʒ}ɪni	‘I’m singing’
f.	nadɛdɛ:<u>s</u>ba:t^{ɬ}	‘I hung myself’
g.	ε<u>θ</u>du:θ	‘I whipped him’
h.	ɬɛnɛʃt^{ʃ}u:ʃ	‘I’m folding it’
i.	ε<u>s</u>dan	‘I’m drinking’
j.	mεθε<u>θ</u>εθ	‘I’m wearing (on feet)’
k.	nɛʃ<u>j</u>ɛɬ	‘I’m growing’
l.	sɛ<u>s</u>xɛɬ	‘I’m going to kill it’
m.	na<u>θ</u>t^{θ}’ɛt	‘I fell off’
n.	nɛ<u>s</u>tɛɬ	‘I’m sleepy’
o.	ɛdɛdɛ<u>θ</u>du:θ	‘I whipped myself’
p.	noʔɛdɛ:ʃɬɛd^{ʒ}i	‘I melted it over and over’
q.	ta<u>θ</u>t^{θ}aɬ	‘I’m dying’
r.	jaʃt^{ɬ}’ɛt^{ʃ}	‘I splashed it’
s.	xaʔɛ<u>θ</u>t’aθ	‘I’m cutting the hair off’

2. *Alternations in* ‘1st pers. pl.’ (underlined)

a.	dε<u>θ</u>igit^{ɬ}	‘we threw it’
b.	dε<u>s</u>id^{z}ɛl	‘we shouted’
c.	iʃit^{ʃ}ot^{ɬ}	‘we blew it up’
d.	na<u>θ</u>iba:t^{ɬ}	‘we hung it’
e.	xa<u>s</u>i:dɛt^{s}	‘we plucked it’
f.	tɛ:dɛnɛʃid^{ʒ}u:t	‘we chased it away’
g.	<u>θ</u>i:t^{θ}ædi	‘we ate it’
h.	dε<u>s</u>it’ʌs	‘we are walking’
i.	uʃid^{ʒ}ɛ	‘we are called’
j.	ni<u>s</u>it’a:t^{s}	‘we got up’
k.	mɛʔɛʃit’ot^{ʃ}	‘we are breastfeeding’

3.3.3. Tongue Body

In this section we turn to intersegmental processes involving the Tongue Body features: [dorsal], [±high], [±back], and [±low].

3.3.3.1. [dorsal]

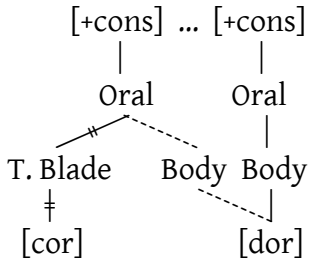
Assimilation of the feature [dorsal] is perhaps most dramatically illustrated by "velar harmony" in child phonology, e.g. (103a). In most cases, this process of [dorsal]-spread targets coronals, and it is usually regressive. As Bernhardt and Stemberger (1998:558) observe, "there is often velar harmony in *take* (/teɪk/ [kʰeɪk]) but not in *Kate* (/keɪt/ [kʰeɪt])." This process can therefore be represented as in (103b).

(103) *Velar harmony* (Bernhardt & Stemberger 1998)

a.

/tɪkl/	[gɪgʊ]	'tickle'
/dʌk/	[gʌk]	'duck'
/nɪk/	[ŋɪk]	'Nick'

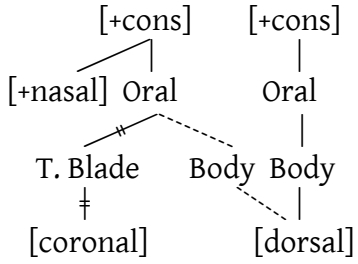
b.



In section 3.3.1.1 (p. 105ff.), we saw that a nasal assimilates to a following [labial] consonant in many languages; compare *in-destructible* vs. *im-possible*. In English, a nasal does not always assimilate to a following [dorsal] consonant, e.g., *in-competent*, but velar assimilation is indeed obligatory within morphemes, e.g., *bu*[ŋk]*er*, *hu*[ŋg]*er*. And more generally, velar assimilation is responsible for the sound *ŋ* in English, as Sapir (1925:45) remarks:

> In spite of what phoneticians tell us about this sound (*b:m* as *d:n* as *g:ŋ*), no naïve English-speaking person can be made to feel in his bones that it belongs to a single series with *m* and *n*. Psychologically it cannot be grouped with them because, unlike them, it is not a freely movable consonant (there are no words beginning with *ŋ*). It still *feels* like *ŋg*, however little it sounds like it. The relation *ant:and* = *sink-sing* is psychologically as well as historically correct. Orthography is by no means solely responsible for the "*ng* feeling" of *ŋ*. Cases like *-ŋg-* in *finger* and *anger* do not disprove the reality of this feeling, for there is in English a pattern equivalence of *-ŋg-:-ŋ* and *-nd-:-nd*. What cases like *singer* with *-ŋ-* indicate is not so much a pattern difference *-ŋg-:-ŋ-*, which is not to be construed as analogous to *-nd-;-n-* (e.g., *window:winnow*), as an analogical treatment of medial elements in terms of their final form (*singer:sing* like *cutter:cut*). ... [S]uch a form as *singer* betrays an unconscious analysis into a word of absolute significance *sing* and a semi-independent agentive element *-er* ... *-er*, for instance, might almost be construed as a "word" which occurs only as the second element of a compound, cf. *-man* in words like *longshoreman*. ... the agentive *-er* contrasts with the comparative *-er*, which allows the adjective to keep its radical form in *-ŋg-* (e.g., *long* with *-ŋ-*: *longer* with *-ŋg-*).

Other languages with velar assimilation include Gã (Padgett 1995). In this Kwa language of Ghana, the first person is [ŋ] before velars (104a) and labiovelars (104b,c). That is, [dorsal] seems to spread from a velar consonant or a labiovelar consonant to a preceding nasal consonant. (Compare: *n-taoɔ* 'I want'.)



(104)

a.	ŋ-klɛmpɛ	'my basin'
b.	ŋ-gbekɛ	'my child'
c.	ŋ-kpai	'my cheeks'

Most reported cases of [dorsal] assimilation are regressive.[69] A rare example of progressive [dorsal] assimilation is reported by Hyman (2001:145) in Noni, a Bantoid language spoken in Cameroon. According to Hyman's description, "[t]he forms in [(105a)] show that /-te/ is realized without change after a root-final /m/. ... It is the examples in [(105b)] that interest us here: the input sequence /ŋ+t/ is realized [ŋk]. The /t/ has assimilated to the velar place of the preceding [ŋ]."[70]

(105) *Noni*

a.	cím	'dig'	cim-tè	'be digging'
	dvum	'groan'	dvùm-tè	'be groaning'
b.	cíŋ	'tremble'	ciːŋ-kè	'be trembling'
	káŋ	'fry'	kaːŋ-kè	'be frying'

Turning to dissimilation of [dorsal], this process is presumably at work in speech errors like *extracted* >^{e} [ɛkstɹæptɪd] (Fromkin 1971). It is also operative in some of the exercises below.

Exercises:

A. How many English words begin with skVC, where V is a vowel and C is [dorsal]? What do you suspect is happening?

B. Explain the alternations in the class 10 plural prefix in the following data from Zulu (Padgett 1995). (ǀ, ǂ, ǁ are dental, palatoalveolar and lateral, respectively.)

(106)

izim-papʰɛ	'feathers'	iziŋ-lezu	'slices'
izin-ti	'sticks'	iziŋ-ǂuŋǂulu	'species of bird' (pl.)
iziŋ-kɛzɔ	'spoons'	iziŋ-ǁaŋǁa	'green frogs'

[69] As Ohala (1990) explains, in consonant clusters the first usually assimilates to the second, because the first tends to be unreleased, hence less salient perceptually than the second, which is released into a following vowel. This is why, according to Ohala, nasals tend to assimilate in place to the following consonant, not vice versa.

[70] Hyman (ib., p. 147) adds: "He [Ohala] criticizes feature geometry for its ability to express the disfavored left-to-right place assimilation process ... as easily as the favored right-to-left ... However, this is exactly what is needed: the Noni example shows that an input sequence /ŋ+t/ may undergo place assimilation in either direction. ... The reason why the [t] of the progressive suffix /-te/ assimilates to a preceding velar is that it is a suffix. Besides phonetic principles, phonology is subject to (possibly conflicting) grammatical ones. The relevant principle here is the paradigmatic one: languages frequently preserve base features over affixal ones."

C. In Lithuanian the prefix cognate with English/Latin 'con-' shows various shapes depending on the following consonant. Explain the prefixal variants in feature geometry.

sam-buːris	'assembly'	buːriːs	'crowd'
sam-pilas	'stock'	pilnas	'full'
san-dora	'covenant'	dora	'virtue'
san-taka	'confluence'	tekeːti	'to flow'
saŋ-kaba	'connection'	kabeː	'hook'
saː-voka	'idea'	vokti	'to understand'
saː-skambis	'harmony'	skambeːti	'to ring'
saː-ʃlavos	'sweepings'	ʃluoti	'to sweep'
saː-ʒine	'conscience'	ʒinoti	'to know'
saː-raʃas	'list, register'	raʃiːti	'to write'

D. Two brothers living with their parents in Cambride, MA, aged 4 and 5.5, were observed to speak a dialect of English. What rules distinguish the children's phonology from the phonology of the adult community? (Halle & Clements 1983)

puppy	pəʔij	can	kænd	walked	wɑkt
kick	kɪʔ	did	dɪʔ	Bobby	bɑʔij
baby	bejʔij	beat	bijt	tag	tæg
walks	wɑkt	cake	kejʔ	paper	pejʔəɹ
ran	rənd	died	dajʔ	takes	tejkt
men	mænd	took	tʊk	dogs	dɑgd
pet	pɛt	bit	bɪt	toot	tuwʔ
				suit	tuwʔ

E. At age two years, two months, S is a lively and intelligent child. State the rules needed to derive S's forms from the adult forms, for consonants only. (N.B.: This exercise is hard!)

sock	gɔk	other	ʌdə	brush	bʌt
leg	gɛk	scream	giːm	bath	baːt
signing	giŋiŋ	uncle	ʌgu	John	dɔn
chockie	gɔgiː	dark	gaːk	bump	bʌp
stop	bɔp	lock	gɔk	drink	gik
spoon	buːn	table	beːbu	skin	gin
zoo	duː	bus	bʌt	stuck	gʌk
nipple	mibu	smith	mit	nipple	mibu
tent	dɛt	brush	bʌt	smith	mit
snake	ŋeːk	thank you	gɛgu	new	nuː
knife	majp	tickle	gigu	swing	wiŋ
swing	wiŋ	apple	ɛbu	crumb	gʌm

3.3.3.2. [±back]

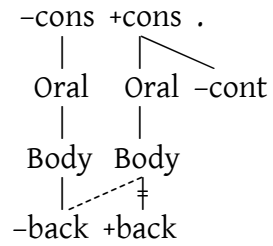
Mataco, a Macro-Guaicuruan language spoken in Argentina and Bolivia, contrasts velars [kʷ ~ k] with uvulars [q] (Claesson 1994):

(107) *Mataco velars vs. uvulars*

a.	ʔitaːkʷàh ~ ʔitaːkàh	name	ʔnoːqàs	'plant'
b.	ʔakʷah ~ ʔakah	'ow!'	qamax	'still'
c.	ʔnoːwukʷe ~ ʔnoːwuke	'house'	qelhih	'hurry!'
d.	ʔakʷih ~ ʔakih	'oh!'	ʔnoːqileʔ	'picked bone'
e.	niːjàkʷ ~ niːjàk	'cord'	ʔnolhàq	'food'
f.	teːtakʷ ~ teːtak	tree	qalaːq	'heron'
g.	ʔõːkʷéjʔ	'my hand'	ʔõːqéjʔ	'my habit'
h.	tokʷ	'not'	toːq	'toucan'

As shown, the uvular /q/ occurs at the beginning of a syllable before /a, e, i, o/ as well as at the end of a syllable after /a, o/. But /q/ is not found syllable-finally after /e, i/. By contrast, /k/ regularly occurs after /e, i/. To account for this gap, Claesson (1994:16) gives the following rule:

q k / {e, i}__.
i.e., a syllable-final uvular becomes velar when preceded by front vowels.[71]



We can give a feature-geometric interpretation of this rule as the spreading of [–back], with simultaneous delinking of [+back].[72]

The feature [–back] can also spread regressively. This happens in Polish, where [–back] feature spreads from [i] onto a preceding consonant which consequenly becomes palatalised.

(108) *Polish (Rubach 1984, Gussmann 1992)*

a.	pisk	[pʲisk]	'scream'
b.	ring	[rʲink]	'ring'
c.	kino	[kʲino]	'cinema'
d.	brat i siostra	[bratʲiɕɔstra]	'Brother and sister'
e.	chłop idzie	[xwɔpʲidʑe]	'the farmer walks'

A related phenomenon occurs in Acadian French (Hume 1994). The consonants affected in this case are /k, g/. As illustrated in (109), [kʲ, gʲ] and [tʃ, dʒ] are found only before front vowels and glides, whereas [k, g] are found elsewhere: at the end of words (e.g., [sark] 'circle'), before consonants (e.g., [griʃe] 'ruffled'), and before (nonfront) vowels (e.g., [kʊt] 'cost'). The change from /k, g/ to /kʲ, gʲ/ is the same as palatalisation in Polish. The variable change to [tʃ, dʒ] (*coronalisation*) is really a change from [dorsal, –back] to [coronal, –anterior], a switch which is rather common across languages but which we will not discuss further here. (For discussion, see, e.g., Hume 1994; Halle, Vaux & Wolfe 2000).

[71] Reference to the syllable boundary (show by a period ".") appears necessary as the assimilation occurs only between segments in the same syllable; cf., e.g., ʔiːqatˢih 's/he is there' (Claesson 1994:17).
[72] A [–back] [k] is almost always [+high], so this feature must also be added to the [k] derived from /q/.

(109) *Acadian French*

a.	[kø] ~ [kʲø] ~ [tˢø]	‘tail’
	[kɥir] ~ [kʲɥir] ~ [tˢɥir]	‘leather/to cook’
	[okɛ̃] ~ [okʲɛ̃] ~ [otˢɛ̃]	‘no, not any’
	[ki] ~ [kʲi] ~ [tˢi]	‘who’
	[kɛ] ~ [kʲɛ] ~ [tˢɛ]	‘quay’
	[kœr] ~ [kʲœr] ~ [tˢœr]	‘heart’
	[sarkœj] ~ [sarkʲœj] ~ [sartˢœj]	‘coffin’
	[gɛte] ~ [gʲɛte] ~ [dᶾɛte]	‘to watch for’
	[gœl] ~ [gʲœl] ~ [dᶾœl]	‘mouth’
b.	[ka]	‘case’
	[kʊt]	‘cost’
	[kote]	‘side’
	[gar]	‘station’
	[gʊt]	‘drop (N.)’

Vaux (1999) reports a pattern of consonant harmony involving [–back] in Karaim, a Turkic language spoken in Lithuania. [–back] spreads from consonants in the stem to consonants in affixes, such that all consonants in the word become palatalised. For example, the plural suffix is [lʲɑrʲ] after stems with palatalised consonants, and [lɑr] otherwise; the ablative suffix is [dʲɑnʲ] after stems with palatalised consonants, and [dɑn] otherwise. Compare kuŋ-lɑr-dɑn ‘servant-PL-ABL’ vs. kʲunʲ-lʲɑrʲ-dʲɑnʲ ‘day-PL-ABL’. This pattern is especially difficult to understand because [–back] spreads across intervening [+back] vowels, yet these remain unaffected by the harmony process. A full analysis is expected in Vaux (in progress).

(110)

	stem	*ablative*	
a.	suv	suv-dɑn	‘water’
	tɑʃ	tɑʃ-tɑn	‘stone’
b.	kʲunʲ	kʲunʲ-dʲɑnʲ	‘day’
	mʲenʲ	mʲenʲ-dʲɑnʲ	‘I’
	kʲopʲ	kʲopʲ-tʲɑnʲ	‘very’

In contrast to consonant harmony, vowel harmony with [±back] is common. Vowels in classical Mongolian words are all [–back] (e.g., [køgegyn] ‘boy’, [køtelbyri] ‘instruction’), or all [+back] (e.g., [uɣuta] ‘bag’).

In Hungarian and Turkish (which are unrelated), suffix vowels alternate in [±back] depending on the [±back] specification of the stem vowels. Compare (111a) vs. (111b), and (112a) vs. (112b).

(111) *Hungarian*

			‘to’	*‘from’*
a.	ørøm	‘joy’	ørøm-nek	ørøm-tøːl
	idøː	‘time’	idøː-nek	idøː-tøːl
	tømeg	‘crowd’	tømeg-nek	tømeg-tøːl
b.	hɑːz	‘house’	hɑːz-nɑk	hɑːz-toːl
	vɑros	‘city’	vɑros-nɑk	vɑros-toːl
	moːkus	‘squirrel’	moːkus-nɑk	moːkus-toːl

(112) *Turkish*

	Nom. sg.	*Gen. sg.*	*Nom. pl.*	*Gen. pl.*
‘rope’	ip	ipin	ipler	iplerin
‘hand’	el	elin	eller	ellerin
‘girl’	kɯz	kɯzɯn	kɯzlɑr	kɯzlɑrɯn
‘stalk’	sɑp	sɑpɯn	sɑplɑr	sɑplɑrɯn

Turning now to dissimilation, consider the following pattern from Ainu, a linguistic isolate of northern Japan. The transitivising suffix alternates between [i] and [u]; it surfaces as [–back, +high] when the root vowel is [+back], e.g. (113a), and it surfaces as [+back, +high] when the root vowel is [–back], e.g. (113b). Roots with [a] also take the [–back] [i] suffix, e.g., (113c). This appears to be a case of dissimilation on [back]: the transitivising vowel alternates in [±back] in order to avoid a situation in which two [+back], or two [–back], occur in the same word.

(113) *Transitivising suffix in Ainu*

a.	hum-i	'to chop up'	mus-i	'to choke'
	pok-i	'to lower'	hop-i	'to leave behind'
b.	pir-u	'to wipe'	kir-u	'to alter'
	ket-u	'to rub'	rek-u	'to ring'
c.	kar-i	'to rotate'	sar-i	'to look back'

Exercises:

A. Explain the alternations in the following data from Chamorro, an Austronesian language spoken in the Marianas Islands.

(114) a.	hulɑt	'tongue'	i hilɑt	'the tongue'
b.	fogon	'stove'	i fegon	'the stove'
c.	lɑhi	'man'	i læhi	'the man'
d.	hulo	'up'	sæn hilo	'in the direction up'
e.	tuŋo	'to know'	in tiŋo	'we (excl.) know'
			en tiŋo	'you (pl.) know'

B. See Turkish exercise from Roca & Johnson (1999a).

C. See Finnish exercise from Roca & Johnson (1999a).

D. See Eastern Cheremis exercise from Roca & Johnson (1999b).

E. Explain the alternations in the aorist suffix in Wikchimani (a California Penutian language).

(115) *-ʃi ~ -ʃy ~ -ʃu 'aorist'* (Archangeli 1984:159)

a.	pʰin'-ʃi	'stung'
	t̪ʰan-ʃi	'went'
	mo:xit̪-ʃi	'got old'
b.	t̪yʔys-ʃy	'made'
c.	hut̪-ʃu	'knew'

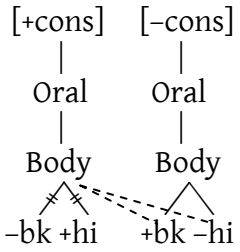
F. Give a possible historical explanation of the development Modern English *goose* vs. *geese*, *tooth* vs. *teeth*, from Old English *gos* vs. *gosi*, *toθ* vs. *toθi*. (The Old English forms have plural *-i*.)

G. Explain the changes in stem-final nasals in these data from modern Irish (Halle, Vaux & Wolfe 2000):

a.	dʲekʲhʲinʲ	‘I would see’
	dʲekʲhʲiŋʲ gan eː	‘I would see without it’
b.	dʲiːlən	‘a diary’
	dʲiːləŋgʲiːvʲrʲi	‘a winter’s diary’

3.3.3.3. [±high]

Turkana, a Nilotic language of Kenya, has uvular consonants, but they are predictable: they always derive from underlying velars. Specifically, /k/ is realised as [q] when it occurs in the same syllable as a [–high, +back] vowel: [ɑ, ɔ, o], e.g. (116a). Elsewhere, /k/ simply surfaces as [k], e.g. (116b). In other words, /k/ adjusts its Body features to the following vowel.



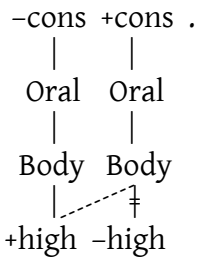
(116) *Turkana* (Zetterstrand 1996)

a.	ɛ-kɔrɪ	[ɛ.qɔ.rɪ]	‘rattle’ (sg.)	b.	ɑ-kiru	[ɑ.ki.ru]	‘rain’
	ɛ-kɔlɔcɔr	[ɛ.qɔl.cɔrː]	‘pelican’		ɑ-mɑkuk	[ɑ.mɑ.kuk]	‘stool’
	e-kod	[e.qod]	‘tax’ (sg.)		ŋi-keno	[ŋi.ke.no]	‘fireplace’ (pl.)
	e-koji	[e.qoj]	‘matter’		ŋɑ-kɪmɑ-k	[ŋɑ.kɪ.mɑq]	‘old woman’
	ɛ-kɑːleːs	[ɛ.qɑ.leːs]	‘ostrich’		ɑ-rʊkʊm	[ɑ.rʊ.kʊm]	‘cough’
	ŋɪ-kɑjo	[ŋɪ.qɑ.jo]	‘tree’ (pl.)		ɑ-kɛpʊ	[ɑ.kɛ.pʊ]	‘vein’

When /k/ is preceded by a high vowel (*i*, *ɪ*, *u*, *ʊ*), it has a tendency not to uvularise. This is suggestive of a variable process which spreads [+high], thereby countering uvularisation.

(117) *Turkana* (Zetterstrand 1996)

ŋɪ.kɑ.do.χot	~ ŋɪ.qɑ.do.χot	‘monkeys’
ɑ.mʊ.kɑt	~ ɑ.mʊ.qɑt	‘shoes’
ni.kor	~ ni.qor	‘Samburu’ (pl.)
lo.u.ko	~ lo.u.qo	‘in this lung’



Many Bantu languages show a type of vowel harmony which also involves [±high]. The examples in (118)–(121) are from Shona, a Southern Bantu language (Beckman 1998). As shown, a suffix vowel which is otherwise [+high] *i* (see (a) examples) becomes [–high] *e* when it is preceded by a [–high] midvowel in the stem (see (b) examples).

(118) *‘Applicative’ -ira ~ -era*

a.	fat-a	‘hold’	fat-ir-a	‘hold for’
	vav-a	‘itch’	vav-ir-a	‘itch at’
	pofomadᶻ-a	‘blind’	pofomadᶻ-ir-a	‘blind for’
	ip-a	‘be evil’	ip-ir-a	‘be evil for’
	svetuk-a	‘jump’	svetuk-ir-a	‘jump in’

b.	per-a	‘end’	per-er-a	‘end in’
	tsvet-a	‘stick’	tsvet-er-a	‘stick to’
	son-a	‘sew’	son-er-a	‘sew for’
	pon-a	‘give birth’	pon-er-a	‘give birth at’

(119) *‘Neuter’ suffix -ik- ~ -ek-*

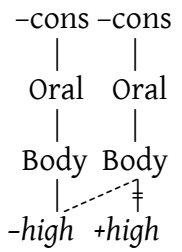
a.	taris-a	‘look at’	taris-ik-a	‘easy to look at’
	kwir-a	‘climb’	kwir-ik-a	‘easy to climb’
	bvis-a	‘remove’	bvis-ik-a	‘be easily removed’
b.	gon-a	‘be able’	gon-ek-a	‘be feasible’
	vereŋg-a	‘count’	vereŋg-ek-a	‘be numerable’
	tʃeŋget-a	‘keep’	tʃeŋget-ek-a	‘get kept’

(120) *‘Perfective’ suffix -irir- ~ -erer-*

a.	pind-a	‘pass’	pind-irir-a	‘to pass right through’
	ɓudˀa	‘come out’	ɓudˀ-irir-a	‘to come out well’
b.	pot-a	‘go round’	pot-erer-a	‘go right round’
	tʃek-a	‘cut’	tʃek-erer-a	‘cut up small’
	sek-a	‘laugh’	sek-erer-a	‘laugh on and on’

(121) *‘Causative’ suffix -is- ~ -es-*

a.	ʃamb-a	‘wash’	ʃamb-is-a	‘make wash’
	pamh-a	‘do again’	pamh-is-a	‘make do again’
	tʃejam-a	‘be twisted’	tʃejam-is-a	‘make be twisted’
	bvum-a	‘agree’	bvum-is-a	‘make agree’
b.	tond-a	‘face’	tond-es-a	‘make to face’
	ʃoŋg-a	‘adorn self’	ʃoŋg-es-a	‘make adorn’
	om-a	‘be dry’	om-es-a	‘cause to get dry’



There is another pattern which is likely related to the one just illustrated. [+high] *u* of the ‘reversive’ suffix *-ur-* in Shona, e.g., *naman-ur-a* ‘unstick’, appears to lower following [–high] *o*, e.g., *monon-or-a* ‘uncoil’. The fact that midvowels (*e*, *o*), but not the low vowel *a*, trigger this lowering pattern suggests that the latter is sensitive only to *contrastive* [±high] (in italics). Indeed, [±high] is contrastive in nonlow vowels (/e/ vs. /i/; /o/ vs. /u/), but noncontrastive (redundant, predictable) in the low vowel *a* ([+low] implies [–high]).

Turning now to [±high] dissimilation, an apparent case is found in Yowlumne, a California Penutian language. As the following data show, in this language the singular and the plural differ in shape: singular forms have a short vowel in the first syllable, and a long vowel in the second syllable; plural forms show the opposite: the vowel in the first syllable is long and the vowel in the second syllable is short. We will not concern ourselves with this difference here. Another point of difference is that vowels are usually identical in the singular forms, while the vowels are always different in the plural forms. According to Archangeli (1984), this difference results from [±high] dissimilation in plural forms: in a sequence of two vowels with identical values for [high], the second switches to the opposite value.

(122) *Yowlumne*

	sing.	*plural*	*pl.:* expected	
a.	naʔaːt̪	naːʔiṯ	*naːʔaṯ	‘older sister’
	napaːt̪^{h}m	naːpt̪^{h}im	*naːpt̪^{h}am	‘male relation by marriage’
b.	nop^{h}oːp^{h}	noːp^{h}ip^{h}	*noːp^{h}op^{h}	‘father’
	t̪’oo͂ːtm	t̪’oːñ̪tim	*t̪’oːñ̪tom	‘transvestite’
c.	niʔiːs	niːʔas	*niːʔis	‘younger brother’
	tipniː	tiːpan	*tiːpin	‘one endowed with magic powers’
d.	nuṣuːṣ	nuːṣaṣ	*nuːṣuṣ	‘paternal aunt’
	huluːsc’	huːlsac’	*huːlsuc’	‘one who is sitting down’

Exercises:

A. Explain the alternations in the following sets of data from Veneto Italian (Walker 2001).

(123) *Singular vs. plural*

a.	fior	‘flower’ (masc. sg.)	fiur-i	‘flower’ (masc. pl.)
b.	ver-o	‘true’ (masc. sg.)	vir-i	‘true’ (masc. pl.)
c.	amor	‘love’ (masc. sg.)	amur-i	‘love’ (masc. pl.)
d.	negr-o	‘negro’ (masc. sg.)	nigr-i	‘negro’ (masc. pl.)
e.	ov-o	‘egg’ (masc. sg.)	uv-i	‘egg’ (masc. pl.)
f.	calset-o	‘sock’ (masc. sg.)	calsit-i	‘sock’ (masc. pl.)

(124) *1st person vs. 2nd person*

a.	met-o	‘I put’	mit-i	‘you put’
b.	scolt-o	‘I listen’	scult-i	‘you listen’
c.	bev-o	‘I drink’	bi-vi	‘you drink’

B. Moore is a Gur language in Burkina Faso with the seven-vowel system indicated below. Give an autosegmental rule to explain why the suffixes -go and -re change to -gu and -ri, respectively. Illustrate how your rule works with some examples.

	i	ɪ	u	ʊ	e	o	a
high	+	+	+	+	–	–	–
back	–	–	+	+	–	+	+
ATR	+	–	+	–	+	+	–

kor-go	‘sack’	kug-ri	‘stone’
laŋ-go	‘hole’	tʊb-re	‘ear’
bɪd-go	‘sorrel’	gob-re	‘left hand’
zu-gu	‘granary’	rakil-ri	‘fagot of wood’
rʊg-go	‘pot’	gel-re	‘egg’
sen-go	‘rainy season’		

3.3.3.4. [±low]

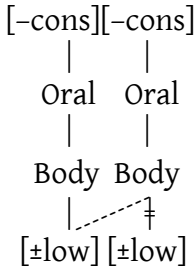
Within so-called "sound symbolic words" in Korean, vowels are normally all [+low], or else all [–low], as shown in (125). In a related pattern, the infinitival suffix is [+low] *a* if the verb vowel is [+low] (æ, ɑ, ɒ), and [–low] *ə* if the verb vowel is [–low] (*ə, e, i, u, ɯ*), as shown in (126).

(125) *Korean sound symbolic words*

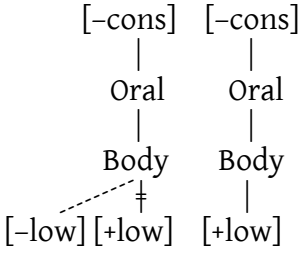
[+low]	[–low]	
k'ɑŋcɒŋ	k'əŋcuŋ	'skipping'
cʰɑls'ɑk	cʰəls'ək	'lapping'
pɑnc'ɑk	pənc'ək	'flashing'
k'ɒlk'ɑk	k'ulk'ək	'swallowing'
sɒkt'ɑk	sukt'ək	'whispering'
p'æcɒk	p'icuk	'protruding'
cælkɑŋ	cilkəŋ	'chewing'
tɑlkɑkɑk	təlkəkək	'rattling'
cɒmɒllɑk	cumullek	'kneading'
cæcɑl	cicəl	'chattering'
cʰɒllɑŋ	cʰulləŋ	'splashing'
ɑllɒk	əlluk	'molted'

(126) *Korean infinitives*

[+low]		[–low]	
cɑp-ɑ	'grasp'	mək-ə	'eat'
nɒk-ɑ	'melt'	cuk-ə	'die'
		me-ə	'carry'
		ki-ə	'crawl'
		nuc-ə	'be late'



As an example of [+low] dissimilation, John Lynch has recently remarked (LinguistList posting 11-13-2002) that in the languages of Micronesia and Vanuatu, the first /a/ of an /aCa/ sequence regularly dissimilates, usually to [–low] /e/. Thus the form /matana/ (no gloss) becomes [matena] or [metena]. (Note here that [+low] dissimilation leads also to a change in [±back]; compare Turkish plural allomorphy in section 3.3.3.2.)



3.4. Soft Palate

Recall from section 2.4 that in Southern Barasano words are generally composed either of completely oral segments or completely nasal segments, as shown in (127), repeated from (106) from section 2.4. The generalisation is best understood under two assumptions: first, it is assumed that nasal words are lexically marked by the inclusion of a [+nasal] feature, while oral words lack such a specification (or else carry a [–nasal] specification). Second, it is assumed that this [+nasal] feature spreads throughout the word. This analysis is illustrated here:

(127) *Southern Barasano*

[+nasal]		[–nasal]	
mãnõ	'none'	juka	'vulture'
mĩnĩ	'bird'	wati	'going?'
mãñãŋ̃ĩ	'comer'	wesika	'above'
ŋãmõr̃õnĩ	'ear'	hikoro	'tail'
ẽõnõ	'mirror'		

(128)

Underlying representations	b a d o [+nas]	w a t i
Link & spread nasality	b a d o [+nas]	n/a
Surface Representations	[mãnõ] 'none'	[wati] 'going?'

Cases of long-distance assimilation of [+nasal] are found in several Bantu languages. In Pangwa, for instance, [+nasal] spreads from any suffix to a preceding stem-final consonant, e.g. /pulix-an-/ → [-puliŋ-an-] 'listen to each other' (Hansson 2001). By contrast, in Kikongo (Bantu: Congo; Ao 1991), nasal assimilation operates in the opposite direction, e.g., the perfective suffix *-idi* and the perfective passive suffix *-ulu* become *-ini* and *-unu*, respectively, if the verb stem contains a nasal consonant.

(129)

a-bud-idi	'he hit'	tu-kun-ini	'we planted'
a-bul-ulu	'he was hit'	masangu ma-kin-unu	'the maize was planted'
a-suk-idi	'he washed'	tu-nik-ini	'we ground'
a-suk-ulu	'he was washed'	masangu ma-nik-unu	'the maize was ground'

Similarly, in Tshiluba (Odden 1994), the benefactive suffix *-il-* is realised *-in-* when it is preceded by a nasal anywhere in the stem.

(130)

kutoːt-a	'to harvest'	kutoːt-il-a	'to harvest for'
kukin-a	'to dance'	kukin-in-a	'to dance for'
kukinis-a	'to make dance'	kukinis-in-a	'to dance for'

Nasal dissimilation is rare, but not unattested. For example, Proto-Germanic *himin 'heaven' evolved into *hibin then *heaven* in English, and into *Himmel* in German. That is, historically dissimilation affected the first nasal in English, the second in German.

An example of synchronic nasal dissimilation is found in Takelma, a Penutian language of Oregon. As described by Sapir (1912:45), "If a (generally) final *n* of a stem is immediately followed ... by a suffix containing a nasal, it dissimilates to *l*."

(131) Takelma

a.	gʷãn	'road'	ha-gʷaːl-am	'in the road'
b.	xãn	'urine'	xaːl-amtk	'my urine'
			xaːl-ax-amte	'I urinate'

Exercise: How many English words begin with *sNVN* (N any nasal, V any vowel)? Explain your finding.

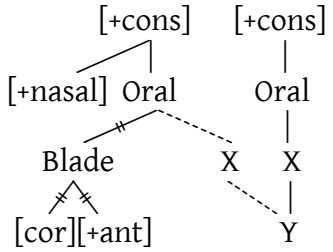
3.5. Guttural

The grouping of [radical] and [glottal] as "Guttural" is suggested by the fact that Oral articulators often spread to the exclusion of these features. For example, as mentioned earlier, in Sudanese Arabic (Kenstowicz 1994) the coronal nasal [n] assimilates the point of articulation of the following consonant, becoming [m] before [labial] consonants, [ɲ] before [coronal, –anterior], and [ŋ] before [dorsal] consonants. Crucially, the coronal nasal [n] does not change before [radical] [ħ, ʕ] or [glottal] [h, ʔ], as illustrated in (132j-l). This is expected. Assimilation here results from spreading Oral features to a preceding nasal, delinking its original [coronal] specification. Gutturals have no such Oral node to spread.

(132)

	perfect	*imperfect*			*perfect*	*imperfect*	
a.	nabaħ	ja-mbaħ	'bark'	g.	nakar	ja-ŋkur	'deny'
b.	nafad	ja-mfid	'save'	h.	naxar	ja-ŋxar	'puncture'
c.	nazal	ja-nzil	'descend'	i.	nagal	ja-ŋgul	'transfer'
d.	nasaf	ja-nsif	'demolish'	j.	naħar	ja-nħar	'slaughter'
e.	naʃar	ja-ɲʃur	'spread'	k.	niʕis	ja-nʕas	'fall asleep'
f.	naʤaħ	ja-ɲʤaħ	'succeed'	l.	nahab	ja-nhab	'rob'

As Kenstowicz (1994:158) observes:



"[T]he tree structure the phonological evidence leads us to impose on the feature bundle by and large matches the structure motivated on phonetic grounds – in particular, the organization into laryngeal and (oral) place articulators. This remarkable convergence is presumably no accident but rather indicates a deep connection between the phonology and the phonetics - in other words, that the sounds of language reflect a special linguistic organization and are thus different from the sounds produced when blowing out a candle, yawning, and so forth."

3.5.1. Tongue Root

3.5.1.1. [radical]

I am not aware of any cases in which the feature [radical] spreads, e.g., a laryngeal (h or ʔ) assimilating to an adjacent pharyngeal (ħ, ʕ), but dissimilation of [radical] is relatively common. Notably, Arabic dialects disallow the cooccurrence of any two pharyngeals in the same root, regardless of whether they are adjacent (McCarthy 1981).

3.5.1.2. [±ATR]

Palestinian Arabic (Davis 1995) shows a pattern of regressive [–ATR] assimilation: as shown in (133a), segments become pharyngealised, or [–ATR], when they precede an "emphatic" —a pharyngealised segment. This often leads to the whole word being [–ATR], as shown in (133b). (The diacritic [ˌ] indicates pharyngealisation, or [–ATR], on a segment.)

(133) *Palestinian Arabic*

a.	ʕa̪ʦʃaːn	‘thirsty’	b.	ba̪lla̪ːsˠ	‘thief’
	mˠa̪ʒa̪sˠːa̪sˠiʃ	‘it didn’t become solid’		ħa̪ðˠː	‘luck’
	na̪siːħa	‘advice’		ʔa̪bsˠa̪ʦ	‘simpler’
	ka̪ʦːuːʕa	‘piece of mat’		ba̪ːsˠ	‘bus’
	sˠiħːa	‘health’		mˠa̪na̪ːfˠiðˠ	‘ashtrays’
	zarːiʕa	‘offspring’		xa̪jːa̪ːʦ	‘tailor’
				na̪ʃa̪ːʦ	‘energy’
				ʦa̪mʃiːʦa̪	‘hair stylist’

In other languages, [±ATR] spreads only to vowels. In the West African language Akan, however, the [ATR] specification of vowels in prefixes and suffixes agrees with the [ATR] specification of neighbouring vowels in stems. For example, the prefix is [+ATR] *o-* in (134a), as it is next to a [+ATR] vowel in the stem *bi̱sa*. But the same prefix is [–ATR] *ɔ-* in (134b), as it is next to a [–ATR] vowel in the stem, *ka̱ri*. Conversely, the suffix is [–ATR] *-ɪ* in (134a), as it is next to a [–ATR] vowel in the stem *bisa̱*, while it is [+ATR] *-i* in (134b), as it is next to a [+ATR] vowel in the stem, *kari̱*.

(134) *Akan: affixation to “regular” roots*

a.	o-bisɑ-ɪ	‘he asked’	b i s ɑ | | [+atr][–atr]	‘to ask’
b.	ɔ-kɑri-i	‘he weighed’	k ɑ r i | | [–atr][+atr]	‘to weigh’

In Wolof, another (albeit unrelated) West African language, all vowels in each word agree in terms of [±ATR]. The productivity of this [±ATR] harmony process is also apparent in affix vowels.

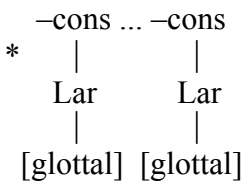
(135) *Wolof* (West Atlantic Africa)

	[+ATR]		[–ATR]	
a.	doːr-e	‘to hit with’	xɔːl-ɛ	‘to look with’
	reːr-e	‘to be lost in’	dɛm-ɛ	‘to go with’
	gæn-e	‘to be better in’	xɑm-ɛ	‘to know in’
b.	doːr-le	‘to help hit’	jɔx-lɛ	‘to help give’
	reːr-le	‘to lose property’	dɛː-lɛ	‘to lose a relative’
	yæg-le	‘to be better in’	tɑkk-lɛ	‘to help tie’
c.	reːr-oːn	‘was lost’	rɛːr-ɔːn	‘had dinner’
	ɲow-oːn	‘came’	jɔx-ɔːn	‘gave’
	bægg-oːn	‘wanted’	tɑkk-ɔːn	‘tied’
d.	leːb-æl	‘to tell stories for’	bey-ɑl	‘to cultivate for’
	foːt-æl	‘to launder for’	wɔːr-ɑl	‘to fast for’
	jænd-æl	‘to buy for’	wɑx-ɑl	‘to speak for’
e.	genn-ændoː	‘to go out together’	dɛnd-ɑndɔː	‘to be neighbours’
	tox-ændoː	‘to smoke together’	tɔpp-ɑndɔː	‘to imitate’
	dækk-ændoː	‘to live together’	wɑx-ɑndɔː	‘to say together’

3.5.2. Larynx

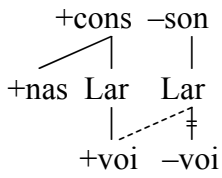
3.5.2.1. [glottal]

As with [radical], I am not aware of any cases in which the feature [glottal] spreads, but dissimilation of [glottal] is relatively common. Arabic dialects disallow the cooccurrence of any two laryngeals (h, ʔ) in the same root, whether or not they are adjacent (McCarthy 1981).

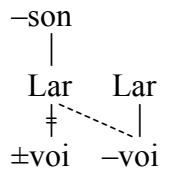


3.5.2.2. [±voice]

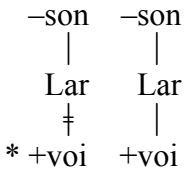
Assimilation of [+voice] is very common, especially with nasals. For example, in Japanese an obstruent regularly becomes voiced after a nasal. Thus the gerundive suffix *-te* (e.g., *mi-te* 'seeing') becomes *-de* after a nasal (e.g., *jon-de* 'reading', *in-de* 'dying'). Similarly, in the Puyo Pungo dialect of Quechua, the genitive suffix *-pa* (e.g., *sinik-pa* 'porcupine's') changes to -ba after a nasal (e.g., *kam-ba* 'yours', *hatum-ba* 'the big one's').



[±voice] assimilation triggered by obstruents is also very common. A well-known case of progressive assimilation is that observed with the regular verbal and nominal inflections in English, such as the plural *pot*+[s] vs. *pan*+[z] and the past tense *hack*+[t] (*hacked*) vs. *drag*+[d] (*dragged*).[73] Regressive assimilation occurs with other suffixes in English.For example, devoicing occurs before the suffix *-th*, e.g., *fi*[f]*-th* vs. *fi*[v]*e*. The [–voice] feature of [θ] spreads to a preceding stem-final obstruent, which consequently loses its own [voice] specification.



Dissimilation of [+voice] is found in Japanese. Recall from section 2.5.2.2 that in the native vocabulary of Japanese (Yamato), [+voice] is assigned to the initial consonant of the second member of a compound, as illustrated in (136a-d). This process ("rendaku") is blocked (or undone) in (136e-h). This is due to a kind of dissimilation on [+voice]: no more than one voiced obstruent is permitted in each native Japanese root (i.e., there are no forms like **dabi*, **gugi*, etc.).



(136) *Compounds in Japanese*

a.	jo	sakura	→ jozakura	e.	mori	soba	→ morisoba
	'night'	'cherry'	'blossoms at night'		'serve'	'soba'	'soba serving'
b.	ko	tanuki	→ kodanuki	f.	iro	tabi	→ irotabi
	'child'	'raccoon'	'baby raccoon'		'white'	'tabi'	'white tabi'
c.	mizu	seme	→ mizuzeme	g.	ore	kugi	→ orekugi
	'water'	'torture'	'water torture'		'broken'	'nail'	'broken nail'
d.	ori	kami	→ origami	h.	kami	kaze	→ kamikaze
	'fold'	'paper'	'origami'		'heaven'	'wind'	'divine wind'

[73] Because these suffixes always adjust to the voicing of the final segment of the stem, it is often suggested that they have no underlying voicing specification of their own.

3.5.2.3. [±spread glottis]

In the New Julfa dialect of Armenian (Vaux 1998), the future prefix is *k(ə)-* preceding voiceless unaspirated stops (137a), and *kʰ(ə)-* preceding voiceless aspirated stops and fricatives (137b). In other words, the feature [+spread glottis] spreads regressively in this dialect.

(137) *New Julfa Armenian*

a.	k-ertʰɑm	'I will go'	b.	kʰə-tʰoʁɲiem	'I will allow'
	kə-tɑm	'I will give'		kʰə-tʃʰɑpʰiem	'I will measure'
	kə-kienɑm	'I will exist'		kʰə-sɑvoriem[74]	'I will grow accustomed to'

Ancient Greek is an example in which the features [±voice] and [±spread glottis] spread together as a result of their grouping under the Larynx node. Ancient Greek has the stops shown in (138a). The data in (138b) illustrate that the laryngeal features of a suffix-initial stop spread to a preceding stop, which thereby loses its own lexically-specified laryngeal features (Kenstowicz 1994).

An example of dissimilation of [+spread glottis] is found in Exercise E below.

(138) a.

p,t,k	= [–voice, –spread gl]
pʰ,tʰ, kʰ	= [–voice, +spread gl]
b,d,g	= [+voice, –spread gl]

b.

triːb-oː	tɛtriːp-tai	'rub'
grapʰ-oː	gɛgrap-tai	'write'
pɛmp-o	ɛpɛmpʰ-tʰeːn	'send'
triːb-oː	etriːpʰ-tʰeːn	'rub'
klɛpt-oː	klɛb-deːn	'steal'
grapʰ-oː	grab-deːn	'write'

3.5.2.4. [±constricted glottis]

In Tepehua, a language isolate spoken in Eastern Mexico, the 2nd person singular is marked on verbs by mapping a [+constricted glottis] feature onto all glottalisable segments, i.e., stops and /h/ in this language (Watters 1985). (Note that only prevocalic stops are eligible docking sites.) This pattern, which is illustrated in ((139), suggests that the 2nd person singular is the feature [+constricted glottis], and that this feature is spread across the word.

(139)

	3sg. (unmarked)	2sg.	
a.	ʔaqtajhuː-j	ʔaqt̰ʔajʔuː-j	help-IMPF
b.	paːtahuː-j	p̰aːt̰aʔuː-j	fall-IMPF
c.	nahun	naʔun	say
d.	wahin	waʔin	eat (intrans.)
e.	paʃaː-j	p̰aʃaː-j	bathe
f.	ʃapa-j	ʃap̰a-j	plane

Another possible example of [+constricted glottis] spreading is found in Cowichan (Hukari 1977). In this Salish language spoken on Vancouver Island, morphological reduplication is accompanied by the glottalisation of all sonorants, except word-initial ones, as shown in (140).

[74] Note that /s/ behaves as [+spread glottis] here. See Vaux (1998) for additional information.

Again, this pattern suggests that a [+constricted glottis] feature is spread across the word (targeting sonorants in this case).

(140)	*Perfective (unmarked)*	*Imperfective*
a.	lémət ‘look at (it)’	lél̓əm̓ət
b.	wénʃ ‘throw (it)’	wéẘən̓ʃ
c.	hésəm ‘sneeze’	héʔsəm̓

Turning to dissimilation of [+constricted glottis], this process is also relatively common. A typical example is Quechua: it allows only one glottalised segment per root, e.g., it has no roots of the general shape C’VC’.

Exercises:

A. In these data from Isthmus Zapotec, determine the underlying form of the stems and explain the phonological alternations.

geta	‘corncake’	sketabe	‘his corncake’	sketaluʔ	‘your corncake’
bere	‘chicken’	sperebe	‘his chicken’	spereluʔ	‘your chicken’
doʔo	‘rope’	stoʔobe	‘his rope’	stoʔoluʔ	‘your rope’
jaːga	‘wood’	sjaːgabe	‘his wood’	sjaːgaluʔ	‘your wood’
diʔidᶾa	‘word’	stiʔidᶾabe	‘his word’	stiʔidᶾaluʔ	‘your word’
palu	‘stick’	spalube	‘his stick’	spaluluʔ	‘your stick’
kuːba	‘dough’	skuːbabe	‘his dough’	skuːbaluʔ	‘your dough’
tapa	‘four’	stapabe	‘his four’	stapaluʃ	‘your four’

B. Gitksan is a Tsimshian language spoken in the Skeena River valley of British Columbia, mainly between Kispiox and Kitwanga. The following data are from Hoard (1978). Explain the changes in the stops.

/xpiɬ̰/	[xbiʔɬ̰]	‘ten’	/kitˈ/	[gɪʔtˈ]	‘vermillion’
/paχ/	[bɐχ]	‘to run’	/tkʷantxʷ/	[tʰgʷantxʷ]	‘to trip, stumble’
/pan/	[bɑn]	‘belly’	/qan/	[ɢɑn]	‘tree, wood’
/taw/	[dɐw]	‘ice’	/quːt/	[ɢəːtʰ]	‘heart’
/xtiː/	[xdiː]	‘tea’	/qatˢ/	[qɑtˢ]	‘spill’
/tuːs/	[duːs]	‘cat’	/nikʷuːt/	[nɪgʷə́ːtʰ]	‘father’
/tˢakʷ/	[dᶾɐkʷʰ]	‘kill’	/nikʷuːt+i/	[nɪgʷə́ːdi]	‘my father’
/tˢákʷasxʷ/	[dᶾɐgʷɐsxʷ]	‘animal’	/wak/	[wɛkʲ]	‘brother’
/kat/	[gʲɐ̟tʰ]	‘man’	/wak+m/	[wɐ̟gʲm̩] ~	‘our brother’
/kup/	[gup]	‘to eat’		[wɐ̟gʲɪm]	

Next, try to explain why implosives derive from underlying ejectives in Gitksan:

/pˈtˈal/	[pˈɗal]	‘rib’	/qˈujpˈáx/	[ɢəjɓáx]	‘bright’
/tˈaː/	[ɗaː]	‘to sit’	/tˈis/	[ɗɪs]	‘to punch’
/tˈkˈa/	[tˈɠa]	‘skin’	/qˈilt/	[ɠɛlt]	‘top (of hill)’

C. The following historical changes occurred in Greek and Sanskrit. Give an explanation in feature geometry.

Greek				*Sanskrit*			
pʰepʰuka	→	pepʰuka	‘converted’	bʰabʰuːva	→	babʰuːva	‘became’
tʰitʰeːmi	→	titʰeːmi	‘I put’	bʰodʰati	→	bodʰati	‘he/she knows’
tʰrikʰos	→	trikʰos	‘hair’	bʰubʰodʰa	→	bubodʰa	‘he/she knew’
tʰrepʰo	→	trepʰo	‘I rear’	dʰadʰaːmi	→	dadʰaːmi	‘I put’

D. Examine the following data from Yiddish (Lombardi 1994), and explain all of the alternations.

ʃrajb	‘I write’	red	‘I speak’
vog	‘weight’	ajz	‘ice’
briv	‘letter’		
vokʃoj	‘scale’	ajskastn	‘ice box’
briftreger	‘mailman’		
bak	‘cheek’	bagbejn	‘cheekbone’
ʃvitsn	‘sweat’ (v)	ʃvidzbod	‘steambath’
zis	‘sweet’	zizvarg	‘candy’
kop	‘head’	kobvejtik	‘headache’
ʃrajb+st	ʃrajpst	‘you (fam.) write’	
red+st	retst	‘you (fam.) speak’	

E. Examine the following data from Polish (Kenstowicz 1994), and try to explain the alternations. (N.B.: This one is hard!)

singular	*plural*		*gen.pl.*	*nom.sg.*	
klup	klube	*club*	swuf	swova	*word*
trup	trupe	*corpse*	brut	broda	*beard*
dom	dome	*house*	prusʲp	pruzʲba	*request*
ʃum	ʃume	*noise*	druk	droga	*road*
snop	snope	*sheaf*	bʒus	bʒoza	*birch*
ʒwup	ʒwobe	*crib*	komur	komora	*closet*
trut	trude	*labor*	pul	pola	*field*
dzvon	dzvone	*bell*			
kot	kote	*cat*			
lut	lode	*ice*	*imper.*	*1sg.*	
grus	gruze	*rubble*	rup	robʲe	*do*
nos	nose	*nose*	vuts	vodze	*lead*
vus	voze	*cart*	odvuʃ	odvoʒe	*open*
koʃ	koʃe	*basket*	zwuf	zwovʲe	*catch*
nuʃ	noʒe	*knife*	stuj	stoje	*stand*
wuk	wuge	*lye*	ogul	ogole	*shave*
wuk	wuke	*bow*			
sok	soke	*juice*			

ruk	roge	*horn*
bur	bore	*forest*
ʒur	ʒure	*soup*
vuw	vowe	*ox*
ul	ule	*beehive*
sul	sole	*salt*
buj	boje	*fight*

Have a great holiday!

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