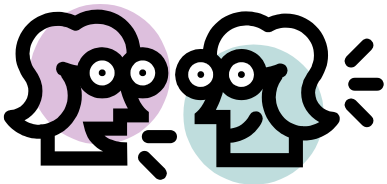

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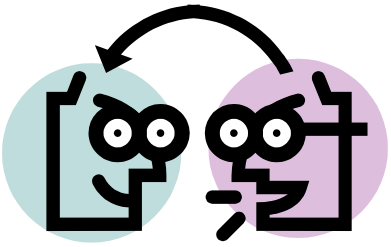
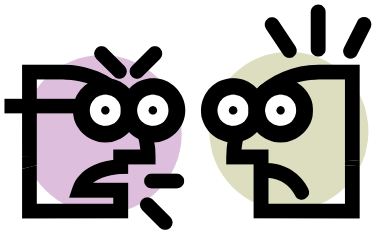


PHONOLOGY



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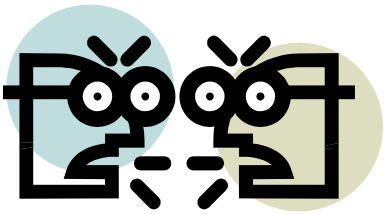

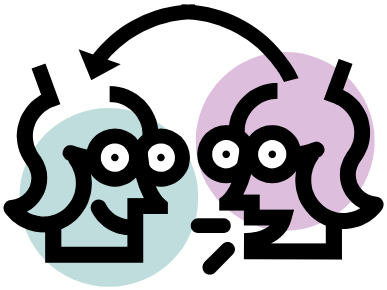

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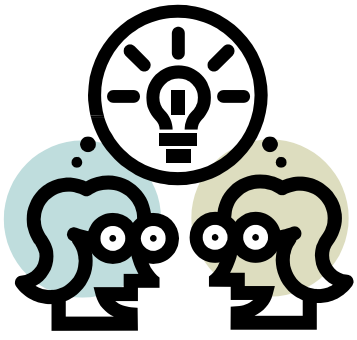

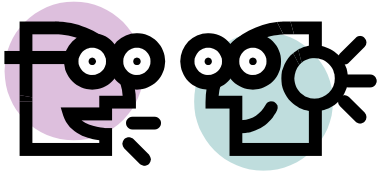

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Acknowledgments

For their support I wish to express my heartfelt gratitude to my colleagues in the Department of Linguistics and language departments at the University of Calgary. Students in my undergraduate and graduate courses in phonology have also been a source of energy and inspiration for me.

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

International Phonetic Alphabet chart

THE INTERNATIONAL PHONETIC ALPHABET (revised to 1993, updated 1996)

CONSONANTS (PULMONIC)

	Bilabial	Labiodental	Dental	Alveolar	Postalveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Glottal
Plosive	p b			t d		ʈ ɖ	c ɟ	k g	q ɢ		ʔ
Nasal	m	ɱ		n		ɳ	ɲ	ŋ	ɴ		
Trill	ʙ			r					ʀ		
Tap or Flap				ɾ		ɽ					
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	h ɦ
Lateral fricative				ɬ ɮ							
Approximant		ʋ		ɹ		ɻ	j	ɰ			
Lateral approximant				l		ɭ	ʎ	ʟ			

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

CONSONANTS (NON-PULMONIC)

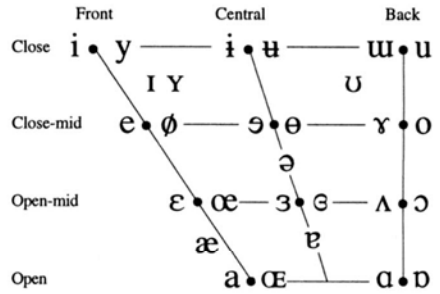
Clicks		Voiced implosives		Ejectives	
ʘ	Bilabial	ɓ	Bilabial	’	Examples:
|	Dental	ɗ	Dental/alveolar	pʼ	Bilabial
!	(Post)alveolar	ʄ	Palatal	tʼ	Dental/alveolar
ǂ	Palatoalveolar	ɠ	Velar	kʼ	Velar
‖	Alveolar lateral	ʛ	Uvular	sʼ	Alveolar fricative

OTHER SYMBOLS

ʍ	Voiceless labial-velar fricative	ɕ ʑ	Alveolo-palatal fricatives
w	Voiced labial-velar approximant	ɺ	Alveolar lateral flap
ɥ	Voiced labial-palatal approximant	ʧ	Simultaneous ʃ and x
ʜ	Voiceless epiglottal fricative		
ʢ	Voiced epiglottal fricative		
ʡ	Epiglottal plosive		

Affricates and double articulations can be represented by two symbols joined by a tie bar if necessary. k͡p t͡s

VOWELS



Where symbols appear in pairs, the one to the right represents a rounded vowel.

SUPRASEGMENTALS

ˈ	Primary stress
ˌ	Secondary stress ˌfoʊnəˈtɪʃən
ː	Long eː
ˑ	Half-long eˑ
˘	Extra-short ĕ
|	Minor (foot) group
‖	Major (intonation) group
.	Syllable break ɹi.ækt
‿	Linking (absence of a break)

TONES AND WORD ACCENTS

LEVEL		CONTOUR	
é͡ or ˥	Extra high	ě or ˩˥	Rising
é ˦	High	ê ˥˩	Falling
ē ˧	Mid	e᷄ ˧˥	High rising
è ˨	Low	e᷅ ˨˩	Low rising
ȅ ˩	Extra low	e᷈ ˥˩˥	Rising-falling
↓	Downstep	↗	Global rise
↑	Upstep	↘	Global fall

DIACRITICS

Diacritics may be placed above a symbol with a descender, e.g. ŋ̊

◌̥	Voiceless	n̥ d̥	◌̤	Breathy voiced	b̤ a̤
◌̬	Voiced	s̬ t̬	◌̰	Creaky voiced	b̰ a̰
◌ʰ	Aspirated	tʰ dʰ	◌̼	Linguolabial	t̼ d̼
◌̹	More rounded	ɔ̹	◌ʷ	Labialized	tʷ dʷ
◌̜	Less rounded	ɔ̜	◌ʲ	Palatalized	tʲ dʲ
◌̟	Advanced	u̟	◌ˠ	Velarized	tˠ dˠ
◌̠	Retracted	e̠	◌ˤ	Pharyngealized	tˤ dˤ
◌̈	Centralized	ë	◌̴	Velarized or pharyngealized	ɫ
◌̽	Mid-centralized	e̽	◌̝	Raised	e̝ (ɹ̝ = voiced alveolar fricative)
◌̩	Syllabic	n̩	◌̞	Lowered	e̞ (β̞ = voiced bilabial approximant)
◌̯	Non-syllabic	e̯	◌̘	Advanced Tongue Root	e̘
◌˞	Rhoticity	ə˞ a˞	◌̙	Retracted Tongue Root	e̙
◌̪	Dental	t̪ d̪	◌̺	Apical	t̺ d̺
◌̻	Laminal	t̻ d̻	◌̃	Nasalized	ẽ
◌ⁿ	Nasal release	dⁿ	◌ˡ	Lateral release	dˡ
◌̚	No audible release	d̚			

A game of chess is like an artificial realization of what language offers in a natural form.

–Ferdinand de Saussure, 1916
Course in General Linguistics, I, Ch. 3.

1. Introduction

Phonology is the study of sound patterns,[1] where *sound* refers to the auditory effect of articulations made by the vocal apparatus during speech,[2] and *patterns*, to abstract structures that correlate to mind —they "attract our notice, they grab our attention, they seem in varying degrees to somehow *fit* human processes of cognition, to be sense making, to bear intelligibility" (Ratzsch 2001:3). As a core discipline of generative linguistics, phonology is driven by the following assumption (Halle 2002a:1):

> [T]he overt aspects of language—the articulatory actions and the acoustic signal they produce—cannot be properly understood without reference to the covert aspect of language, that is, to the implicit knowledge that enables individuals to speak and understand a language.[3]

The modern view of phonology —as the study of an aspect of human cognition rather than the study of an external, physical or 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.[4] While phonology has never been used for telepathy (by definition, it can't!),[5] to be sure it now has many other applications outside linguistics. For instance, it is of great consequence to language instructors and has received attention among educators because of its importance to reading. It is important

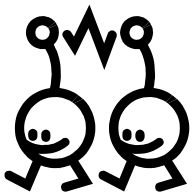
[1] The term is also used to refer to the sound system, or pronunciation, of particular languages, e.g., 'the phonology of French'.

[2] In this text I focus on the phonology of spoken languages, but the reader should keep in mind that there is also the phonology of sign languages. (See comment by Chomsky in fn. 5.) 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. Well-known researchers in this area include Wendy Sandler (Sandler 1989, 1993a, 1993b, 1996a, 1996b, 2000) and Diane Brentari (Brentari 1993, 1998). Incidentally, local Plains First Nations had sign language(s) before European contact (Wurtzburg and Campbell 1995).

[3] As Sapir (1925:171) warned, "it is a great fallacy to think of the articulation of a speech sound as a motor habit."

[4] A recent overview of the history of phonological theory in the twentieth century is available in a special issue of *Folia Linguistica* (Goldsmith and Laks 2000).

[5] "[I]f 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)

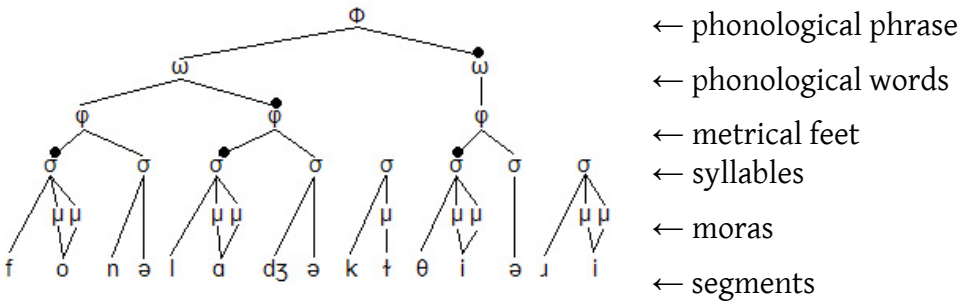


to pathologists who treat individuals with abnormal speech. It has a place in the development of software for high-technology businesses (e.g., speech recognition, voice synthesis).[6] It is used by writers and poets. It even has forensic applications.[7] And more indirectly, phonology can inspire new perspectives in other fields.[8]

Phonology has as its main goals, first, to discover the universals concerning sound patterns in language, i.e., the common elements of all phonological systems, and 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 do not occur.

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 (Trubetzkoy 1939, Jakobson 1941). Segmental phonology is therefore concerned with phonological features: what are they, and how are they organized inside segments and between segments? These questions are addressed in this textbook.

The other major area, prosodic phonology, focuses on aspects of the sound system "above" the level of segments, such as 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 organized into prosodic structure: segments into *moras* and *syllables*, syllables into *metrical feet*, metrical feet into *prosodic words*, prosodic words into *phonological phrases*, and so on. For example, the prosodic structure associated with the utterance 'phonological theory' might be represented as follows:



[6] 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."

[7] 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 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.

[8] The generative study of language, including phonology, has influenced new approaches to several areas including religion (e.g., Boyer 1994, 2001) and evolution (e.g., Barbieri 2002). For instance, the bioinformaticist Heikki Lehväslaiho and his students apply phonological analysis to genomics.

A primary objective of prosodic phonology is to spell out the formal properties of this *prosodic hierarchy*, which contributes to the organizational structure of utterances, hence presumably to the overall efficiency of human language.

Prosodic structure is largely ignored in this text,[9] though several references are made to *syllables* since, as Selkirk (1982:337) states, "it can be argued that only via the syllable can one give the proper characterization of the domain of application of a wide range of rules of segmental phonology." For our purposes we can assume a simple view of the syllable as consisting of a relatively sonorous *peak* and, optionally, of *margins* preceding or following the peak.[10] For example, the word *ahead* [ə.ɦɛd] has two syllables.[11] Both syllables have peaks ([ə] and [ɛ], respectively) but only the second syllable has margins ([ɦ] and [d]).

Finally, *tone* (the use of pitch to distinguish words) is widely considered part of prosody, not melody (e.g., Fox 2000). In fact, however, it shares few properties with prosodic structure (syllables, feet, ...) but many with segmental features. Tone is therefore included in this manual of segmental phonology.[12]

---

[9] McMahon (2003:110) warns against thinking of

> ... phonology as a single domain, and not as two rather separate and potentially incompatible ones, which happen both to involve systematic behaviour of sound. ... The distinction between the prosodic and melodic domains is already very familiar in terms of phonological practice. Although phonologists almost invariably pay lip-service to the unity of phonology, there is a tendency for each phonologist to be interested in one domain or the other. ... This is not only a characteristic of individual phonologists, but also of phonological theories.

McMahon also believes that there are "good grounds for hypothesising a difference between prosody and melody in terms of the evolution of language" (p. 111), and concludes "that prosody and melody are essentially separate, with very different histories, and that we should not expect a theory which deals successfully with one, to extend to the other" (p. 114).

Hammond (1999) and Carr (1999) offer good introductions to prosody, both focusing on English. For a broader empirical perspective on prosody, see relevant chapters in Kenstowicz (1994), Goldsmith (1995a), Gussenhoven and Jacobs (1998), or Roca and Johnson (2000). For a harder but thoroughgoing read, see Fox (2000).

[10] Approaches to syllables are numerous and varied (e.g., Gussmann 2002, Gordon 2002, Kiparsky 2002, Murray 2000, Bao 2000, Jensen 2000, Breen and Pensalfini 1999, Zec 1995a, 1995b, Cook 1994, Shaw 1994, Prince and Smolensky 1993, Kaye 1990, Kaye et al. 1990, Hayes 1989, Dell and Elmedlaoui 1985, 1988etc.). For a recent review, see van der Hulst and Ritter (1999).

[11] The International Phonetic Alphabet symbol for a syllable break is a period.

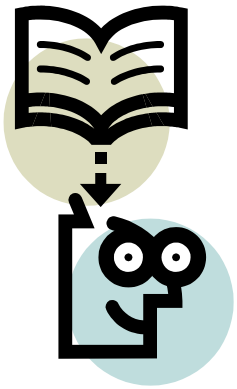
[12] Yip (2003:60) defends a segmental approach to tone, as does McMahon (2003:113): "If stress and intonation definitely belong in the prosodic domain, the other outstanding question is, what else does? Tone, for instance, seems to belong fairly conclusively with the segmental rather than the prosodic set."

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 organized 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.[13]

We begin by introducing the notion of *phonemes*, their status and number within *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 vocalization distinguished by native speakers of a given language. Unlike non-human animal vocalizations, 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

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

Synchronic vs. *diachronic*: Saussure emphasized 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 that they only reflect the underlying language system. Phonologists study langue/competence, not parole/performance. "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 2001, see also Chomsky 1965:9).

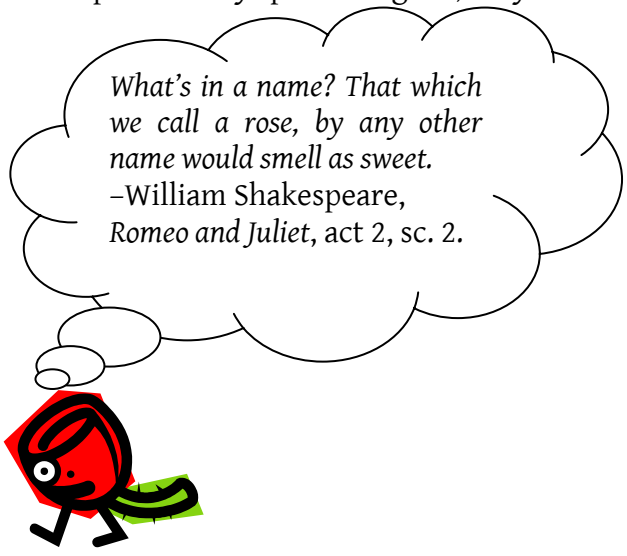
English: /ækts/ ‘acts’, /kæts/ ‘cats’, /skæt/ ‘scat’, /stæk/ ‘stack’, /tæks/ ‘tax’, /tæsk/ ‘task’, /kæst/ ‘cast’, /ækst/ ‘axed’. Shorter English words built on these phonemes include /kæt/ ‘cat’, /tæk/ ‘tack’, /ækt/ ‘act’, /sæk/ ‘sack’, /sæt/ ‘sat’, /æs/ ‘ass’, and /æt/ ‘at’. We can also reassemble these 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.

(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		

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

In actuality, chances are you have between 75,000 and 100,000 words in your speaking vocabulary (Oldfield 1963, cf. Miller 1991) —still nothing to balk at. These are words that you *really* know. Indeed you are probably able to recognize and repeat the words dəstɹojd, bɹɛst, dæmp, ditɛktɪv, toz, ok, lowəst, fajɹd, səbmɪtəd, kæst in spite of their being some of the least frequent words of present-day spoken English; they are used approximately once every 100,000 words (Leech et al. 2001). You acquired about a third of your vocabulary as a child, starting around your first birthday, at an average rate of one word every waking hour (Pinker 1994). Children everywhere are able 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.[14] As Studdert-Kennedy (2000:165) remarks:

> The dissociation of sound and meaning has no precedent in other animal vocalisations, whose signal inventories are limited and not subject to cultural modification. The dissociation is, in fact, the critical discontinuity that separates human language from other primate systems of vocal communication – critical because ... meaningless units at the base of a hierarchy are essential to operation of the particulate principle in all its domains. In language, it is only if they are meaningless that the same units can be repeatedly permuted and combined to form different units of meaning. And only because the basic units are meaningless can the meanings assigned to their combinations be arbitrary – as required for a lexicon of unbounded semantic scope.

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 and Firchow 1969), whose Papuan speakers get by with just 11 segments (p, t, k, β, ɾ, g, i, u, e, o, a),[15] and !Xóõ (Snyman 1970, 1975, 1979), 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 and Maddieson 1996:280).

(2) *Cree (Alberta, Algonquian)*

p	t	tˢ	k		i, iː	
	s			h	Eː	o, oː
m	n				A, aː	
		j	w			

(3) *Cayuga (Ontario, Iroquoian)*

t	tˢ	k		ʔ	i	
s					E	o
n					ẽ	õ
r					A	
	j		w	h		

[14] Carstairs-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.

[15] Iau (Indonesia: Bateman 1990) has just six consonant phonemes /b, f, t, d, s, k/.

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.

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

p	t^{θ}	t	t^{s}	$t^{ɬ}$	$t^{ʃ}$	k	k^{w}			ì	ù		ì̃	ù̃
	$t^{\theta h}$	t^{h}	t^{sh}	$t^{ɬh}$	$t^{ʃh}$	k^{h}	k^{wh}			è	ò		è̃	ò̃
	$t^{\theta'}$	t’	$t^{s'}$	$t^{ɬ'}$	$t^{ʃ'}$	k’	$k^{w'}$	ʔ		à				
	θ		s	ɬ	ʃ	x	x^{w}			à			à̃	
	ð		z		ʒ	ɣ								
m		n								í	ú		ĩ	ũ
			r	l						é	ó		ẽ	õ
					j		w	h		á			ã	

(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’	$t^{s'}$	$t^{ɬ'}$	K’	$k^{w'}$	q’	$q^{w'}$		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 and Precoda 1990).

(6) *Some possible speech sounds*

p, ^{m}p, b, ^{m}b, p^{h}, p’, $b^{ɦ}$, b̪, ɓ, ɓ̥, p^{w}, $^{m}p^{w}$, b^{w}, $^{m}b^{w}$, p^{wh}, $p^{w'}$, $b^{wɦ}$, b̪^{w}, ɓ^{w}, ɓ̥^{w}, p^{j}, $^{m}p^{j}$, b^{j}, $^{m}b^{j}$, p^{jh}, $p^{j'}$, $b^{jɦ}$, b̪^{j}, ɓ^{j}, ɓ̥^{j}, $p^{ɣ}$, $^{m}p^{ɣ}$, $b^{ɣ}$, $^{m}b^{ɣ}$, $p^{ɣ'}$, $b^{ɣɦ}$, b̪^{ɣ}, ɓ^{ɣ}, ɓ̥^{ɣ}, $^{m}p^{ʕ}$, $b^{ʕ}$, $^{m}b^{ʕ}$, $p^{ʕ'}$, $b^{ʕɦ}$, b̪^{ʕ}, ɓ^{ʕ}, ɓ̥^{ʕ}, p͡t, b͡d, p͡t^{w}, b͡d^{w}, p͡t^{j}, b͡d^{j}, p͡t^{ʕ}, b͡d^{ʕ}, p͡c, b͡ɟ, p͡c^{w}, b͡ɟ^{w}, p͡c^{j}, b͡ɟ^{j}, p͡c^{ʕ}, b͡ɟ^{ʕ}, t̪, ^{n}t̪, d̪, ^{n}d̪, t^{h}, t̪’, d̪^{ɦ}, d̪, d̪̥, t̪, ^{n}t̪, d̪, ^{n}d̪, t̪^{h}, t̪’, d̪^{ɦ}, d̪, d̪̥, t̪^{w}, ^{n}t̪^{w}, d̪^{w}, ^{n}d̪^{w}, t̪^{wh}, t̪$^{w'}$, d̪^{wɦ}, d̪^{w}, d̪̥^{w}, t̪^{j}, ^{n}t̪^{j}, d̪^{j}, ^{n}d̪^{j}, t̪^{jh}, t̪$^{j'}$, d̪^{jɦ}, d̪^{j}, d̪̥^{j}, t̪^{ɣ}, ^{n}t̪^{ɣ}, d̪^{ɣ}, ^{n}d̪^{ɣ}, t̪$^{ɣ'}$, ^{n}d̪^{ɣ}, t̪$^{ɣ'}$, d̪^{ɣɦ}, d̪^{ɣ}, d̪̥^{ɣ}, t̪^{ʕ}, ^{n}t̪^{ʕ}, d̪^{ʕ}, ^{n}d̪^{ʕ}, t̪$^{ʕ'}$, ^{n}d̪^{ʕ}, t̪$^{ʕ'}$, d̪^{ʕɦ}, d̪^{ʕ}, d̪̥^{ʕ}, t, ^{n}t, d, ^{n}d, t^{h}, t’, $d^{ɦ}$, d̪, d̪̥, t^{w}, $^{n}t^{w}$, d^{w}, $^{n}d^{w}$, t^{wh}, $t^{w'}$, $d^{wɦ}$, d̪^{w}, d̪̥^{w}, t^{j}, $^{n}t^{j}$, d^{j}, $^{n}d^{j}$, t^{jh}, $t^{j'}$, $d^{jɦ}$, d̪^{j}, d̪̥^{j}, $t^{ɣ}$, $^{n}t^{ɣ}$, $d^{ɣ}$, $^{n}d^{ɣ}$, $t^{ɣ'}$,

dˠʱ, ɖˠ, ᶑˠ, tˢ, ⁿtˢ, dˢ, ⁿdˢ, tˢʼ, dˢʱ, ɖˢ, ᶑˢ, ȹp, ȡb, ȹpʷ, ȡbʷ, ȹk, ȡg, ȹkʷ, ȡgʷ, ʈ, ⁿʈ, ɖ, ⁿɖ, ʈʰ, ʈʼ, ɖʱ, ɖ, !, ʈʷ, ⁿʈʷ, ɖʷ, ⁿɖʷ, ʈʷʰ, ʈʷʼ, ɖʷʱ, ɖ͡p, ɖ͡b, ɖ͡pʷ, ɖ͡bʷ, c, ᶮc, ɟ, ᶮɟ, cʰ, cʼ, ɟʱ, ʃ, ʄ, k, ᵑk, g, ᵑg, kʰ, kʼ, gʱ, g, ɠ, ɠ, kʘ, gʘ, kʘʰ, kʘʼ, kʘˀ, kǀ, gǀ, kǀʰ, kǀʼ, kǀˀ, k!, g!, k!ʰ, k!ʼ, k!ˀ, kǁ, gǁ, kǁʰ, kǁʼ, kǁˀ, kǂ, gǂ, kǂʰ, kǂʼ, kǂˀ, kʷ, ᵑkʷ, gʷ, ᵑgʷ, kʷʰ, kʷʼ, gʷʱ, gʷ, ɠʷ, ɠ̊ʷ, kʷˢ, ᵑkʷˢ, gʷˢ, ᵑgʷˢ, kʷˢʼ, gʷˢ, ɠʷˢ, ɠ̊ʷˢ, kʲ, ᵑkʲ, gʲ, ᵑgʲ, kʲʰ, kʲʼ, gʲʱ, gʲ, ɠʲ, ɠ̊ʲ, kˢ, ᵑkˢ, gˢ, ᵑgˢ, kˢʼ, gˢʱ, gˢ, ɠˢ, ɠ̊ˢ, k͡p, ᶮᵐk͡p, ᵑk͡p, g͡b, ᶮᵐg͡b, ᵑg͡b, k͡pʰ, k͡pʼ, g͡bʱ, g͡b, k͡ʙ, k͡pʷ, g͡bʷ, q, ᴺq, ɢ, ᴺɢ, qʰ, qʼ, ɢʱ, ɢ, ɠ, qʘ, ɢʘ, qʘʰ, qʘʼ, qʘˀ, qǀ, ɢǀ, qǀʰ, qǀʼ, qǀˀ, q!, ɢ!, q!ʰ, q!ʼ, q!ˀ, qǁ, ɢǁ, qǁʰ, qǁʼ, qǁˀ, qǂ, ɢǂ, qǂʰ, qǂʼ, qǂˀ, qʷ, ᴺqʷ, ɢʷ, ᴺɢʷ, qʷʰ, qʷʼ, ɢʷʱ, ɢ̆ʷ, ɠʷ, q͡p, q͡b, ʔ, ʔʷ, pᶠ, ᵐpᶠ, bᵛ, ᵐbᵛ, pᶠʱ, pᶠʼ, bᵛʱ, b̆ᵛ, tᶿ, ⁿtᶿ, dᵟ, ⁿdᵟ, tᶿʼ, dᵟʱ, ɖ̆ᵟ, tˢ, ⁿtˢ, dᶻ, ⁿdᶻ, tˢʰ, tˢʼ, dᶻʱ, ɖ̆ᶻ, tɬ, ⁿtɬ, dɮ, ⁿdɮ, tɬʰ, tɬʼ, dɮʱ, ɖ̆ɮ, tᶜ, ⁿtᶜ, dᶻ, ⁿdᶻ, tᶜʰ, tᶜʼ, dᶻʱ, ɖ̆ᶻ, tᶜʲ, dᶻʲ, ⁿdᶻʲ, tᶜʲʰ, tᶜʲʼ, tʃ, ⁿtʃ, dʒ, ⁿdʒ, tʃʰ, tʃʼ, dʒʱ, ɖ̆ʒ, cᶜ, ᶮcᶜ, dʲ, ⁿdʲ, cᶜʰ, dʲʱ, ɟ̆, cᶜ, ᶮcᶜ, ɟʲ, ⁿɟʲ, cᶜʰ, ɟʲʱ, ɟ̆ʲ, cʎ̝, ᶮcʎ̝, ɟˠ, ⁿɟˠ, cʎ̝ʰ, cʎ̝ʼ, ɟˠʱ, ɟ̆ˠ, kˣ, gˠ, kˣʰ, kˣʼ, kʘˣ, kǀˣ, kǀʱˣ, kǂˣ, kˡ, ᵑkˡ, gˡ, ᵑgˡ, kˡʰ, kˡʼ, gˡʱ, g̊ˡ, kˡʷ, ᵑkˡʷ, gˡʷ, ᵑgˡʷ, kˡʷʰ, kˡʷʼ, gˡʷʱ, g̊ˡʷ, ɸ, β, β̞, βʒ, ɸ͡ç, β͡ʒ, ʙ, ʙ̥, f, v, ṽ, fʰ, fʼ, fʷ, vʷ, ṽʷ, fʷʰ, fʷʼ, fʲ, vʲ, ṽʲ, fʲʰ, fʲʼ, fˤ, vˤ, ṽˤ, fˤʼ, fs, fʃ, θ̪, ð̪, ð̪̊, θ, ð, ð̊, θʰ, θʼ, ðˤ, s̪, z̪, z̪̃, s̪ʰ, s̪ʼ, ɬ, ɮ, ɮ̃, ɬʰ, ɬʼ, ɬˤ, ɮˤ, ɬˤʼ, ɻ̊, ɻ, ɕ, ʑ, ʑ̃, ɕʰ, ɕʼ, ʃ, ʒ, ʒ̃, ʃʰ, ʃˤ, ʃʷ, ʒʷ, ʒ̃ʷ, ʃʷʰ, ʃʷʼ, ʃʲ, ʒʲ, ʒ̃ʲ, ʃʲʰ, ʃʲʼ, ʃˤ, ʒˤ, ʒ̃ˤ, ʃˤʼ, ʂ, ʐ, ʐ̃, ʂʰ, ʂʼ, ç, ʝ, ʝ̃, çʰ, çʼ, ʃ, ɻ̊, ɻ, x, ɣ, ɣ̃, xʰ, xʼ, xʷ, ɣʷ, ɣ̃ʷ, xʷʰ, xʷʼ, xʲ, ɣʲ, ɣ̃ʲ, xʲʰ, xʲʼ, χ, ʁ, ʁ̃, χʰ, χʼ, χʷ, ʁʷ, ʁ̃ʷ, χʷʰ, χʷʼ, ħ, ʕ, ʕʼ, ħʷ, ʕʷ, ʕʷʼ, ʜ, ʢ, ʜʷ, ʢʷ, m, m̥, m̃, mʷ, m̥ʷ, m̃ʷ, mˠ, mʲ, mˠ, mˢ, n̪, n̪̊, ñ̪, n̪, n̪̊, ñ̪, n̪ʷ, n̪̊ʷ, ṅ̪ʷ, n, n̥, ñ, nʷ, n̥ʷ, ñʷ, nʲ, nˠ, nˢ, n͡m, n͡mʷ, ŋ, ŋ̊, ŋ̃, ŋʷ, ŋ̊ʷ, ŋ̃ʷ, ɳ, ɳ̊, ɳ̃, ŋ, ŋ̊, ɲ, ŋʘ, ŋ̊ʘ, ʔŋʘ, ŋ̊ʘʰ, ŋǀ, ŋ̊ǀ, ʔŋǀ, ŋ̊ǀʰ, ŋ!, ŋ̊!, ʔŋ!, ŋ̊!ʰ, ŋǁ, ŋ̊ǁ, ʔŋǁ, ŋ̊ǁʰ, ŋǂ, ŋ̊ǂ, ʔŋǂ, ŋ̊ǂʰ, ŋʷ, ŋ̊ʷ, ŋ̃ʷ, ŋʲ, ŋˢ, ŋ͡m, ŋ̊͡mʷ, ɴ, ɴ̥, ɴ̃, ɴʷ, ɴ̥ʷ, ɴ̃ʷ, l̥·, l̃·, l̥̃·, l̃·, l̥̃·ʷ, l̃·ʷ, l̥̃·ʷ, l̥̃·ˠ, l, l̊, l̥, l̃, lʷ, ɬʷ, l̥ʷ, l̃ʷ, lʲ, ɬʲ, l̥ʲ, l̃ʲ, lˠ, l̥ˠ, l̊ˠ, l̃ˠ, l̥ʷ, l̊ʷ, l̃ʷ, l̃ʷ, ɭ, ɭ̊, ɭ̃, ɭʷ, ʎ, ʎ̊, ʎ̥, ʎ̃, ɮ, ɮ̊, ɮ̃, ɮʷ, ɮ̊ʷ, ɮ̃ʷ, ʟ, ʟ̃, ʟ̥, ʟ̃, ʟʷ, ʟ̃ʷ, ʟ̥ʷ, ʟ̃ʷ, ɻ, ɻ̊ʷ, r, r̃, rʷ, rʲ, rˠ, rˢ, ɾ, ɾ̃, ɾʷ, ɾʲ, ɾˠ, ɾˢ, ɹ, ɹʷ, ɾ̥, ɾ̥ʷ, ɽ, ɽ̊, ɽ̃, ɽʰ, ɽʷ, ɻ, ɻʷ, ʀ, ʀʷ, ʁ, ʁʷ, ʊ, ʊ̃, ʊ̥, ʊ̃, ʊ̆, j, j̃, ʲ̊, ʲ, jʷ, j̃ʷ, ʲ̊ʷ, jʷ, jˢ, ɥ, ɥ̃, ɥ̊, ɥ̃, ɯ, ɯ̃, ɯʷ, ɯ̃ʷ, ɯ̊ʷ, ɯ̃ʷ, ɯ̊ʷ, ɯ̃ʷ, h, hʷ, hʲ, hˢ, ɦ, ɦʷ, ɦ̃ʷ, ɦʲ, ɦˢ, ʔ, ʔʷ, ʔʲ, ʔˢ, i, ĩ, i̥, ĩ̥, y, ỹ, ẙ, y̥, ỹ̥, ɨ, ɨ̃, ɨ̥, ɨ̥̃, ʉ, ʉ̃, ʉ̥, ʉ̥̃, ɯ, ɯ̃, ɯ̥, ɯ̥̃, u, ũ, u̥, ũ̥, ɪ, ɪ̃, ɪ̥, ɪ̥̃, ʏ, ʏ̃, ʏ̥, ʏ̥̃, ʊ, ʊ̃, ʊ̥, ʊ̥̃, e, ẽ, e̥, ẽ̥, ø, ø̃, ø̥, ø̥̃, ɘ, ɘ̃, ɘ̥, ɘ̥̃, ɵ, ɵ̃, ɵ̥, ɵ̥̃, ɤ, ɤ̃, ɤ̥, ɤ̥̃, o, õ, o̥, õ̥, ə, ɛ, ɛ̃, ɛ̥, ɛ̥̃, œ, œ̃, œ̥, œ̥̃, ɜ, ɜ̃, ɜ̥, ɜ̥̃, ɞ, ɞ̃, ɞ̥, ɞ̥̃, ʌ, ʌ̃, ʌ̥, ʌ̥̃, ɔ, ɔ̃, ɔ̥, ɔ̥̃, æ, æ̃, æ̥, æ̥̃, ɐ, ɐ̃, ɐ̥, ɐ̥̃, a, ã, ḁ, ḁ̃, œ, œ̃, œ̥, œ̥̃, ɑ, ɑ̃, ɑ̥, ɑ̥̃, ɒ, ɒ̃, ɒ̥, ɒ̥̃

Until the mid-twentieth century the diversity of human speech sounds seemed unbounded, but today's linguists 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 rearrangements 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, it has long been suspected that a limited set of articulatory settings are sufficient to characterize any speech sound. Notably, in 1443 King Sejong of Korea employed several scholars to create the Hangul writing system, which is still in use today. Hangul systematically encodes not only syllables but also consonants and vowels, and interestingly, many of its 'letters' have features that represent place or manner of articulation. For example, Hangul itself is written 한글. The first syllable has the letters ㅎ (h), ㅏ (a) and ㄴ (n), and the second syllable has the letters ㄱ (g), ㅡ (u) and ㄹ (l). Crucially, ㄴ is used for both [n] and [l] to represents tongue tip raising, ㄱ is used for [g] to represents tongue body raising, and ㅇ is used to represent the glottal articulation of [h].

The belief that segments are composed of discrete *articulatory features* is also unmistakable in Alexander Melville Bell's Visible Speech alphabet (Bell 1867 see figure on next page). As Bell's famous son Alexander Graham (1911:38-9) reasoned,

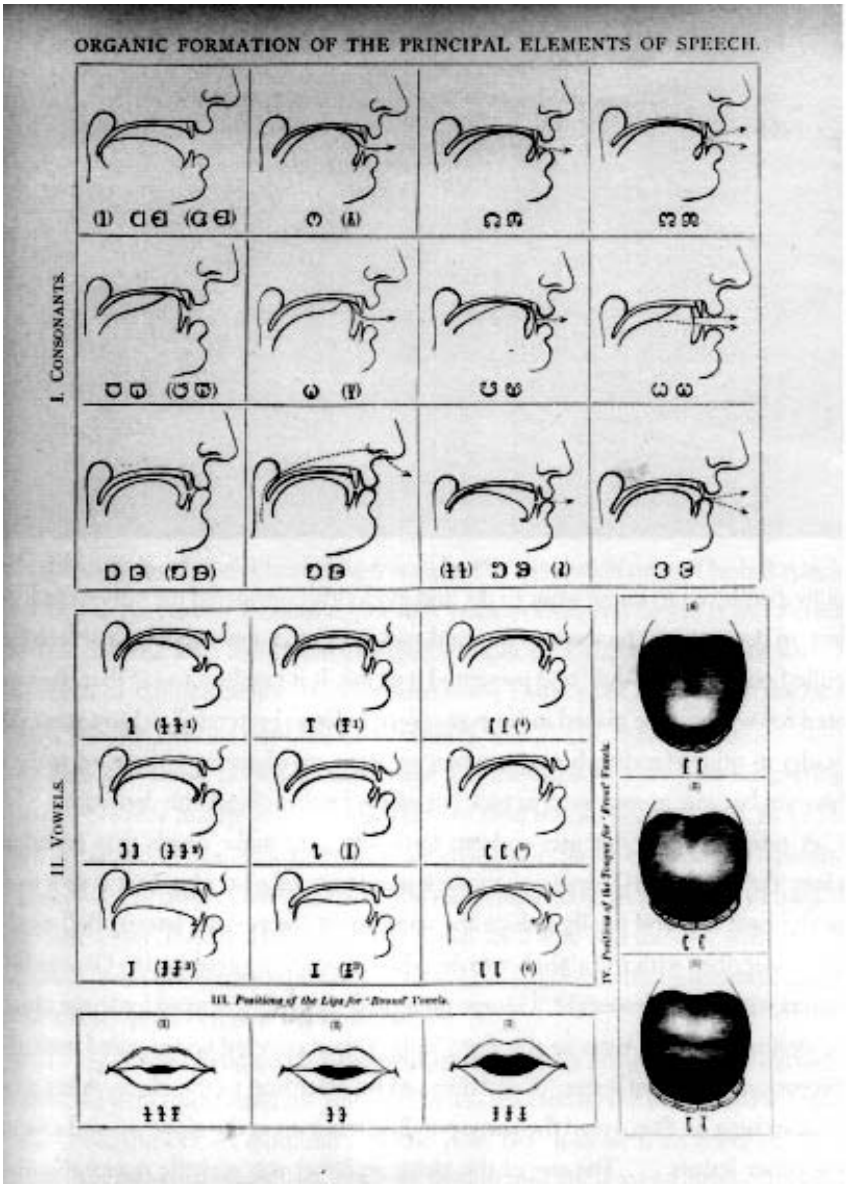
> What we term an "element of speech" may in reality ... be a combination of positions. The true element of articulation, I think, is a constriction or position of the vocal organs rather than a sound. Combinations of positions yield new sounds, just as combinations of chemical elements yield new substances. Water is a substance of very different character from either of the gases of which it is formed; and the vowel *oo* is a sound of very different character from that of any of its elementary positions. When we symbolize positions, the organic relations of speech sounds to one another can be shown by means of an equation; for example English *wh* = P + P' [where P is labiality and P' is dorsality], German *ch* = P', hence German *ch* = English *wh* – P.

Both King Sejong and A. M. Bell intended for their ingenious scripts to be applied generally, to transcribe any sound that can be articulated.

> Though only twenty eight letters are used, their shifts and changes in function are endless. These transformational rules are simple and succinct, reduced to a minimum, yet universally applicable. ... There is no

> usage not provided for, no direction in which they do not extend. Even the sound of the winds, the cry of the crane, the cackle of the fowl and the barking of the dogs —all may be transcribed.
>
> –King Sejong, *Hwumin Cengum Haylyey*, 1446:8.9-8.11. C.Post. (cited in Kim-Cho 2002:80)

Similarly, in early public demonstrations of the Visible Speech alphabet, audiences provided difficult sounds from various languages and even nonlinguistic sounds and gestures such as yawns, which A. M. Bell transcribed while Bell Jr. waited outside. Reading his father's transcriptions young Alexander was able to reproduce all oral sounds and gestures faithfully. But he could not reproduce 'body language' (such as arms being stretched out above the head). This disappointed some audience members but was in fact a good thing: it showed that the Visible Speech alphabet was actually about speech (Ronell 1991).



Today's most widely accepted set of phonological features is presented below. These features refer to articulations[16] as in Hangul and Visible Speech, and are mostly drawn from Chomsky and Halle's (1968) monumental work *The Sound Pattern of English*. Each feature is assumed to be *binary* (Trubetzkoy 1939, Chomsky and 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 normally considered *unary* (a.k.a. *monovalent, singulary, privative*) elements (Sagey 1986b, 1990, Clements and Hume 1995, Pulleyblank 1995, Halle et al. 2000, Halle 2003). Unlike other features, articulator features do not take values (such as + or –); they can only be either present or absent.

(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	
[±upper] [±raised] (Tone)		

(A dotted line separates off the Tone features because they do not often pattern with other Larynx features, or indeed with any segmental features, as will be discussed below.)

[16] An auditory-acoustic distinctive feature theory was proposed earlier by Jakobson, Fant and Halle (1952).

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 behavior 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 and Halle 1968:302). Since Jakobson, Fant and Halle (1952, 1969, Jakobson and Halle 1956), 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" (Halle 1995:3).[17]

[17] Hume and Odden (1996) propose that [±consonantal] be abandoned in favor of using separate

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. 39ff— "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, 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, p̪t, b̪d, p̪tʷ, b̪dʷ, p̪tʲ, b̪dʲ, p̪tˤ, b̪dˤ, p̪c, b̪ɟ, p̪cʷ, b̪ɟʷ, p̪cʲ, b̪ɟʲ, p̪cˤ, b̪ɟˤ, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪', d̪ʱ, d̪̊, t̪ʷ, ⁿt̪ʷ, d̪ʷ, d̪̊ʷ, t̪ʲ, ⁿt̪ʲ, d̪ʲ, d̪̊ʲ, t̪ʰʲ, t̪ʲ', d̪ʱʲ, d̪̊ʲ, t̪ˠ, ⁿt̪ˠ, d̪ˠ, d̪̊ˠ, t̪ʰˠ, t̪ˠ', d̪ʱˠ, d̪̊ˠ, t̪ˤ, ⁿt̪ˤ, d̪ˤ, d̪̊ˤ, t̪ʰˤ, t̪ˤ', d̪ʱˤ, d̪̊ˤ, tˤ, ⁿtˤ, dˤ, ⁿdˤ, tʰˤ, tˤ', dˤʱ, d̪̊ˤ, !, tˤʷ, ⁿtˤʷ, dˤʷ, ⁿdˤʷ, tʰˤʷ, tˤʷ', dˤʷʱ, d̪̊ˤʷ, t͡p, d͡b, t͡pʷ, d͡bʷ, c͡k, ɟ͡g, c͡kʷ, ɟ͡gʷ, t̪͡k, d̪͡g, t̪͡kʷ, d̪͡gʷ, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪', d̪ʱ, d̪̊, t̪ʷ, ⁿt̪ʷ, d̪ʷ, ⁿd̪ʷ, t̪ʰʷ, t̪ʷ', d̪ʷʱ, d̪̊ʷ, ʈ, ⁿʈ, ɖ, ⁿɖ, ʈʰ, ʈ', ɖʱ, ɖ̊, !, ʈʷ, ⁿʈʷ, ɖʷ, ⁿɖʷ, ʈʰʷ, ʈʷ', ɖʷʱ, ɖ̊ʷ, ʈ͡p, ɖ͡b, ʈ͡pʷ, ɖ͡bʷ, c, ɲc, ɟ, ɲɟ, cʰ, c', ɟʱ, ʃ, ʄ, k, ŋk, g, ŋg, kʰ, k', gʱ, g̊, ɠ, ɠ̊, 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, g̊ʷ, ɠʷ, ɠ̊ʷ, kʲ, ŋkʲ, gʲ, ŋgʲ, kʲʰ, kʲ', gʲʱ, g̊ʲ, ɠʲ, ɠ̊ʲ, kˠ, ŋkˠ, gˠ, ŋgˠ, kˠ', gˠʱ, g̊ˠ, ɠˠ, ɠ̊ˠ, k͡p, ŋ͡mk͡p, ŋ͡kp, g͡b, ŋ͡mg͡b, ŋ͡gb, k͡pʰ, k͡p', g͡bʱ, g͡b̊, k͡pʷ, g͡bʷ, q, ɴq, ɢ, ɴɢ, qʰ, q', ɢʱ, ɢ̊, 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, ɴqʷ, ɢʷ, ɴɢʷ, qʷʰ, qʷ', ɢʷʱ, ɢ̊ʷ, ɠʷ, q͡p, q͡b, ʔ, ʔʷ, etc.

b. **Affricates**, e.g., pᶠ, ᵐpᶠ, bᵛ, ᵐbᵛ, pᶠʰ, pᶠ', bᵛʱ, b̪ᵛ, tᶿ, ⁿt̪ᶿ, dᶞ, ⁿd̪ᶞ, tᶿ, tᶿ', dᶞʱ, d̪̊ᶞ, tˢ, ⁿtˢ, dᶻ, ⁿdᶻ, tˢʰ, tˢ', dᶻʱ, d̪̊ᶻ, tɬ, ⁿtɬ, dɮ, ⁿdɮ, tɬʰ, tɬ', dɮʱ, d̪̊ɮ, tᶝ, ⁿtᶝ, dᶻ, ⁿdᶻ, tᶝʰ, tᶝ', dᶻʱ, d̪̊ᶻ, tᶜʲ, ⁿtᶜʲ, dᶻʲ, ⁿdᶻʲ, tᶜʲʰ, tᶜʲ', tʃ, ⁿtʃ, dʒ, ⁿdʒ, tʃʰ, tʃ', dʒʱ, d̪̊ʒ, cᶜ, ɲcᶜ, ɟʲ, ɲɟʲ, cᶜʰ, ɟʲʱ, c̊ᶜ, ɲc̊ᶜ, ɟˠ, ɲɟˠ, c̊ᶜʰ, c̊ᶜ', ɟˠʱ, ɟ̊ˠ, kˣ, gˠ, kˣʰ, kˣ', kʘˣ, klˣ, k!ˣ, kǁˣ, kǂˣ, kˡ, ŋkˡ, gˡ, ŋgˡ, kˡʰ, kˡ', gˡʱ, g̊ˡ, kˡʷ, ŋkˡʷ, gˡʷ, ŋgˡʷ, kˡʷʰ, kˡʷ', gˡʷʱ, g̊ˡʷ, etc.

c. **Fricatives**, e.g., ɸ, β, β̞, βʒ, ɸɕ, β̞ʑ, ʙ, ʙ̥, f, v, ṽ, fʱ, f', fʷ, vʷ, ṽʷ, fʷʰ, fʷ', fʲ, vʲ, ṽʲ, fʲʰ, fʲ', fˤ, vˤ, ṽˤ, fˤ', fs, fʃ, θ̪, ð̪, ð̪̊, θ, ð, ð̥, θʰ, θ', ðˤ, s̪, z̪, z̪̃, s̪ʰ, s̪', ɬ, ɮ, ɮ̃, ɬʰ, ɬ', ɬˤ, ɮˤ, ɮ̃ˤ, ɬˤ', ɻ, ɻ̥, ɕ, ʑ, ʑ̃, ɕʰ, ɕ', ʃ, ʒ, ʒ̃, ʃʱ, ʃ, ʃʷ, ʒʷ, ʒ̃ʷ, ʃʷʰ, ʃʷ', ʃʲ, ʒʲ, ʒ̃ʲ, ʃʲʰ, ʃʲ', ʃˤ, ʒˤ, ʒ̃ˤ, ʃˤ', ʂ, ʐ, ʐ̃, ʂʰ, ʂ', ç, ʝ, ʝ̃, çʰ, ç', ɧ, ɻ̊, ɻ, x, ɣ, ɣ̃, xʰ, x', xʷ, ɣʷ, ɣ̃ʷ, xʷʰ, xʷ', xʲ, ɣʲ, ɣ̃ʲ, xʲʰ, xʲ', χ, ʁ, ʁ̃, χʰ, χ', χʷ, ʁʷ, ʁ̃ʷ, χʷʰ, χʷ', etc.

d. **Nasals**, e.g, m, m̥, m̰, mʷ, m̥ʷ, m̰ʷ, mˠ, mʲ, mˤ, n̪, n̪̊, n̰, n̪, ñ̪, n̪̊ʷ, n̰ʷ, nʷ, n̥ʷ, n̰ʷ, nʲ, nˠ, nˤ, ñ̪m, ñ̪mʷ, ɳ, ɳ̊, ɳ̰, ɳʷ, ɳ̊ʷ, ɳ̰ʷ, ɳˠ, ɳ̊ˠ, ɳ̰ˠ, ɳ̊ʷ, ɳ̰ʷ, ɲ, ɲ̊, ɲ̰, ɲʷ, ɲ̊ʷ, ɲ̰ʷ, 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, ŋˤ, ŋ̃m, ŋ̃mʷ, ɴ, ɴ̥, ɴ̰, ɴʷ, ɴ̥ʷ, ɴ̰ʷ, etc.

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consonant features and vowel features (e.g., C-Place vs. V-Place). For more information on this approach to features, see Clements and Hume (1995).

e. **Liquids**, e.g, l̪·, r̪·, l̪·, r̪·, l̪·ʷ, r̪·ʷ, l̪·ʷ, l̪·ˠ, l, ɭ, l̥, l̃, lʷ, ɬʷ, l̥ʷ, l̃ʷ, lʲ, ɬʲ, l̥ʲ, l̃ʲ, lˤ, l̥, ɭ̥, l̥, l̃, l̥ʷ, ɭ̥ʷ, l̃ʷ, l̥, ɭ̥, ɭ̃, lʷ, ɭ̥ʷ, ɭ̃ʷ, ʟ, ʟ̃, ʟ̥, ʟ̃, ʟʷ, ʟ̃ʷ, ʟ̥ʷ, ʟ̃ʷ, ɻ, ɻʷ, r, r̃, rʷ, rʲ, rˠ, rˤ, ɾ, ɾ̃, ɾʷ, ɾʲ, ɾˠ, ɾˤ, ɹ, ɹʷ, ɾ̥, ɾ̥ʷ, ɽ, ɽʱ, ɽʷ, ɻ, ɻʷ, 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, i̥, i̜, y, ỹ, y̥, y̜, ɨ, ɨ̃, ɨ̥, ɨ̜, ʉ, ʉ̃, ʉ̥, ʉ̜, u, ũ, u̥, u̜, ɪ, ɪ̃, ɪ̥, ɪ̜, ʏ, ʏ̃, ʏ̥, ʏ̜, ʊ, ʊ̃, ʊ̥, ʊ̜, e, ẽ, e̥, e̜, ø, ø̃, ø̥, ø̜, ɘ, ɘ̃, ɘ̥, ɘ̜, ɵ, ɵ̃, ɵ̥, ɵ̜, ɤ, ɤ̃, ɤ̥, ɤ̜, o, õ, o̥, o̜, ə, ɛ, ɛ̃, ɛ̥, ɛ̜, œ, œ̃, œ̥, œ̜, ɜ, ɜ̃, ɜ̥, ɜ̜, ɞ, ɞ̃, ɞ̥, ɞ̜, ʌ, ʌ̃, ʌ̥, ʌ̜, ɔ, ɔ̃, ɔ̥, ɔ̜, æ, æ̃, æ̥, æ̜, ɐ, ɐ̃, ɐ̥, ɐ̜, a, ã, ḁ, a̜, ɶ, ɶ̃, ɶ̥, ɶ̜, ɑ, ɑ̃, ɑ̥, ɑ̜, ɒ, ɒ̃, ɒ̥, ɒ̜, etc.

b. **Semivowels**, e.g., ʊ, ʊ̃, ʊ̥, ʊ̜, ʊ̆, j, j̃, j̥, j̜, jʷ, j̃ʷ, j̥ʷ, j̜ʷ, jˤ, ɥ, ɥ̃, ɥ̊, ɥ̜, w, w̃, w̥, w̜, wˤ, w̃, ɯ, ɯ̃, ɯ̊, ɯ̜, ɯʷ, ɯ̃ʷ, ɯ̊ʷ, ɯ̜ʷ, 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[18]

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 form the *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] correspond to the vowels [u, y, i] respectively, when syllabic. To see this, compare the glides and vowels in the following examples from French:

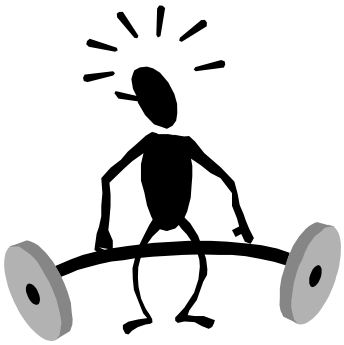
[18] N is a nasal glide which lacks a fixed place of articulation. It is also known as Sanskrit *anusvāra* (Trigo 1988, Trigo 1991, Halle 1995). See section 2.4 below.

(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][19]	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 favor 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.

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 (*vocalization*) 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 and Odden 1994, Hume and Odden 1996). Observe that the uvular consonant /ʁ/, which is either word-final[20] or prevocalic[21] in the first column, corresponds to [ɑ̯] elsewhere in the second column.[22] 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. 53ff— 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).

[19] [ɥ] is the symbol used for [y] in non-peak position, in parallel with [w] for [u], and [j] for [i].
[20] At the end of a word.
[21] Before a vowel.
[22] The subscript [̯] indicates that the vowel [ɑ] is short, perhaps like [ʁ].

(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] (Rubach 1984). And in some varieties of southern Brazilian Portuguese, palatal nasals and laterals /ɲ, ʎ/ are always realized as palatal glides, [j̃, j], respectively.

(12) *Brazilian Portuguese* (Harris 1990:266, Quednau 1994)

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 and Meredith 2001, Rickford 1993, Rickford 1999, Pollock and Berni 1996, Pollock and Berni 1997a, Pollock and Berni 1997b). 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).[23] To illustrate the latter, compare the following word pairs:[24]

(13) Persian (Hayes 1986)

a.	/nov-ru:z/	→ nowru:z	'New Year'
	new-day		
	/nov-i:n/	→ novi:n	'new kind'
	new-SUFF		
b.	/dʒæv/	→ dʒow	'barley'
	barley		

[23] Actually, the process is more complicated: weakening does not apply to syllable-final *v*'s after long vowels, e.g. *ga:v* 'bull', *hi:vdæh* '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.

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

	/dʒæv-i:n/	→ dʒævi:n	'made of barley'
	barley-SUFF		
c.	/bo-ræv/	→ borow	'go!'
	IMP-go		
	/mi:-ræv-æm/	→ mi:rævæm	'I am going'
	PRES-go-1s		
d.	/pa:-dæv/	→ pa:dow	'gofer'
	foot-run(ner)		
	/mi:-dæv-i:d/	→ mi:dævi:d	'you are running'
	PRES-run-2p		

The change from syllable-final /l/ to a back[25] 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* (Fasold and Wolfram 1970, Bailey and Thomas 1998). It is also reported in the southern Arabian Semitic language Mehri (Walsh Dickey 1997, Johnstone 1975, Walsh 1995), e.g., /ɬlθ/ 'third': [ɬo:ləθ] 'third (masc.)' *vs.* [ɬəwθe:t] 'third' (fem.). Historically, too, syllable-final /l/ weakened to *u* in Old French, as can be surmized from a comparison of (orthographic) words in modern French and its Romance sisters.

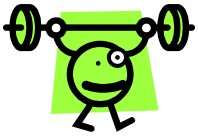
(14) *Comparative evidence of l-vocalization in Old French* (Manz 2000)

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"

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].

[25] 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.

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 favored 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 and Odden 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][26]	'a piece of ice'

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

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

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

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 characterizing 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.[27] 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[28]: *[lə ɔm], *[le ɔm], *[la ide], *[le ide], etc.[29] Now consider the behavior 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’

[27] 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.”

[28] The technical term for adjacent vowels (e.g., English [keɑs] ‘chaos’) is *hiatus*.

[29] The asterisk here means “ungrammatical”.

	l ide	lez ide	‘idea’
	l eʁɔin	lez eʁɔin	‘heroine’
c.	lə eʁo	le eʁo	‘hero’
	lə ibu	le ibu	‘owl’
	la ɔ̃t	le ɔ̃t	‘shame’
	la ɛn	le ɛn	‘hatred’

Also in French, certain adjectives and specifiers have quite distinct forms for different genders. For example, as shown in (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 [eʁɔin] ‘heroine’ (*[ma eʁɔin]). We needn’t be concerned with the motivation behind this gender shift, but again we can assume that it occurs in order to avoid adjacent vowels (hiatus): *[vjø ɔm], *[bo ami], *[ma eʁɔin]. Turning now to (17c), observe how the “*h*-aspiré” forms do not trigger this gender shift, thus displaying the behavior 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 eʁɔin	‘my (MASC.) heroine (FEM.)’
	c.	vjø eʁo	‘old (MASC.) hero (MASC.)’
		bo ibu	‘nice (MASC.) owl (MASC.)’
		ma ɛn	‘my (FEM.) hatred (FEM.)’
		ma aʃ	‘my (FEM.) axe (FEM.)’

Adapting previous proposals (Schane 1972, Clements and Keyser 1983, Encrevé 1988, Piggott 1991, etc.), 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 1988, Marlett 1981, Marlett and Moser 1994a, Marlett and Moser 1994b, Marlett and Stemberger 1983, Marlett 1997), in Onondaga, an Iroquoian language of New York (Michelson 1985), in Oowekyala, a Wakashan language of British Columbia (Howe 2000), and in the Bantu language Kikamba (Roberts-Kohno 1999, Roberts-Kohno 1995, Roberts-Kohno 2000).

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 realized in both nominative and genitive forms.

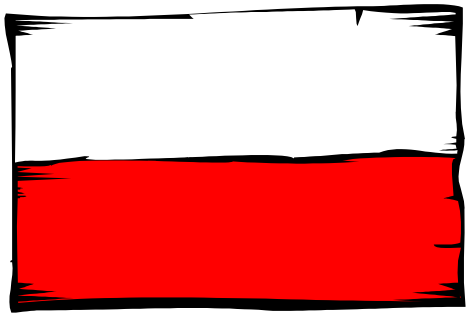
(18)	*nom. sg.*	*gen. sg.*	
a.	s**e**n	sn-u	'dream'
	gen	gen-a	'gene'
b.	b**e**z	bz-u	'lilac'
	bez-a	bez	'meringue'
c.	p^{j}**e**s	ps-a	'dog'
	b^{j}es	b^{j}es-a	'devil'
d.	svet**e**r	svetr-a	'sweater'
	seter	seter-a	'setter'
e.	rob**e**r	robr-a	'rubber (in bridge)'
	rower	rower-u	'bicycle'

Next compare the pairs in (19). The yers (again in bold) are vocalized in at least some forms, either nominative or genitive. By contrast, forms without yer show no comparable vocalization.

(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.	sɨn-**e**k	sɨn-k-a	'son'
	szɨnk		'pub'

f.	bar**e**k		‘bar’
	bark		‘shoulder’
g.		par**e**k	‘couple’
		park	‘park’
h.		szi̇n**e**k	‘ham’
		szi̇nk	‘pub’

To account for contrasts like those in (18-19), yers are often considered “empty” vowels that are variably vocalized. In particular, Bethin (1998) treats each yer as a “floating” [–consonantal] which is realized as the “default” vowel [e] under certain (syllable-defined) conditions, but otherwise remains unfilled.



2.2.1.2. [±sonorant]

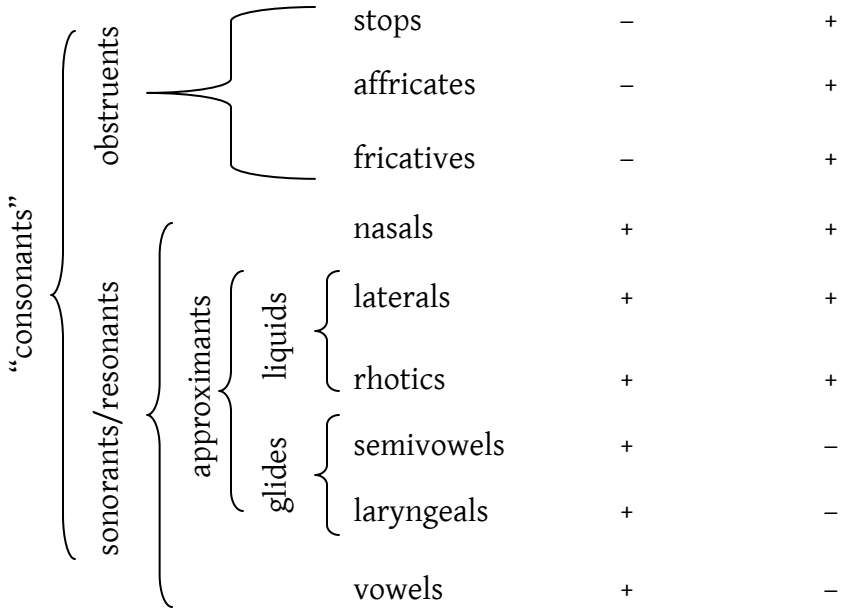
2.2.1.2.1. Introduction

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 1984:83). Segment types are grouped by both major class features in (20) on the next page.

(20) *Segments by major class features*



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

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, Blevins 2001), Totonac (MacKay 1994), St'at'imcets Salish (Van Eijk 1997), Dutch (Trommelen and Zonneveld 1983), and Oowekyala (Howe 2000). The treatment of laryngeals as [+sonorant] is consistent with Chomsky and Halle's (1968:303) conception of this feature (see also Halle and Clements 1983), but is contrary to Hyman's (1975a:45) suggestion that laryngeals are always [–sonorant] (Lass 1984:83, Lombardi 1997, Gussenhoven and Jacobs 1998, Ewen and 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)[30], Oromo (Lloret 1995), and Hawaiian (Pukui and Elbert 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

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

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 glottalization:

(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	
	Glottalized	p’	t’	t^{s}’	$t^{ɬ}$’	k’	k^w’	q’	q^w’	
[+sonorant]	Plain	m	n		l	j	w			h
	Glottalized	m̰	n̰		l̰	j̰	w̰			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 glottalization of root-initial sonorants (if any), as shown here:

(23) *Sonorant glottalization in Oowekyala plural forms*

	singular	*plural*	
a.	mam	mim̰am	‘blanket, bedding, bedcover’
b.	nusa	nin̰usa	‘to tell stories, legends, myths’
c.	lanca	lil̰anca	‘to go underwater’
d.	wi:k^w	wiw̰i:k^w	‘eagle’
e.	jəlχa	jij̰əlχa	‘to rub, smear (body part)’

The following examples illustrate that root-initial obstruents are unaffected by the process of glottalization, in spite of the fact that they are glottalizable segments in Oowekyala in general (see (22) above).

(24) *No glottalization 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 glottalization and changes to [ʔ] in the plural:

(25) *Laryngeal glottalization in Oowekyala plural forms*

	singular	*plural*	
a.	husa	hiʔusa	‘to count, to tally’
b.	həxtˢ’as	hiʔəxtˢ’as	‘singing for the dancers’
c.	həm̰gila	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/	[mãɲtʃatu]	‘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)’

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" (Clements and Hume 1995:276).[31] 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 characterized simply as a change to [–consonantal].

(29) *Hausa* (Clements and Hume 1995)

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

2.2.1.2.3. Russian labial fricatives

Modern Russian (Gussmann 2002) has a well-known restriction whereby obstruents (i.e., [–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

[31] A 'coda segment' is a segment in syllable-final position. The term 'coda' was apparently introduced by Hockett (1955). Many languages prefer [+sonorant] codas. For instance, Yidiɲ (Australian: Dixon 1977:47) permits only sonorants syllable-finally (m, n, ɲ, ŋ, l, r, ɽ, j).

/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 colors 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 syllable-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 and Maddieson 1996:185):

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

laminal dental		*apical alveolar*		*apical post-alveolar*		*laminal post-alveolar*	
l̪inp	'armpit'	lubiɹ	'thigh'	l̥aɻiŋk	'hit'	l̪ukuŋk	'to light'
al̪uŋ	'burrow'	aluŋk	'chase'	aɻat	'sacred board'	al̪ilk	'smooth'
albal̪	'smoke'	irmal	'fire saw'	aldimaɻ	'west'	kural̪	'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., Levin (1987), 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.[32] 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 and Maddieson 1996:190). Here are some examples from the Papuan language Mid-Waghi:

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

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

Lateral obstruents appear to be more highly *marked* (i.e., uncommon, unusual) than lateral sonorants (Maddieson 1984, Ladefoged and 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 /tɬ, tɬʰ, tɬʼ, ɬ/. Similarly, the phoneme inventory of Oowekyala (Wakashan: Howe 2000) has the lateral sonorants /l, l̃/ as well as the lateral obstruents /tɬ, dˡ, tɬʼ, ɬ/.[33] These laterals are illustrated in the following words:

(34)	*Voiceless lateral affricate*	tɬamu	'ocean perch, shiner'
	Voiced lateral affricate	dˡaː	'to wedge, to split with a wedge'
	Ejective lateral affricate	tɬʼaː	'black bear'
	Voiceless lateral fricative	ɬaɢis	'a tent'
	Voiced lateral sonorant	Lasa	'to plant'
	Glottalized lateral sonorant	l̃apa	'to spread apart with the thumbs'

[32] For arguments that the feature [±lateral] is independent of the Tongue Blade in feature geometry, see Sagey (1986b), Shaw (1991), Rice and Avery (1991), Kenstowicz (1994:156), Clements and Hume (1995:293), Hall (1997).

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

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

(35) *Lateral velar obstruents in Archi*

Voiceless prevelar fricative	ɻ̊ob	'sheath'
Labialized voiceless prevelar fricative	ɻ̊ʷalli	'large ravine'
Voiced prevelar fricative	naɻdor	'home'
Voiceless prevelar affricate	kᶴan	'hole'
Labialized voiceless prevelar affricate	kᶴʷijt'u	'seventeen'
Prevelar ejective affricate	kᶴ'al	'lamb'
Labialized prevelar ejective affricate	kᶴʷ'as	'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' (*el oso*)
b.	[el.θo]	[eɾ.θo]	'the zoo' (*el zoo*)
c.	[al.ba:.ka]	[aɾ.ba:.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'

The same pattern is found in Andalusian Spanish where, for instance, *alma* 'soul' is pronounced [arma], *espalda* '?' is pronounced [ehparda] (Mondéjar 1979:398-402, 1991). This change also extends to intervocalic contexts, e.g., *suelo* → *suero*, *claveles* → *claveres*, *sale* → *sare*, *me fui loca* → *me fui roca* (Becerra Hiraldo and Vargas Labella 1986:20, Moya Corral 1979:50-1).

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], *ʃatˢ'iɬa* 'persisting' is pronounced [ʃatˡ'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*	
puːtˡe̯qé	púːtaqɛ̆	's/he counts'
pa̯tˡa̯nan	pa̯tá̯n	's/he vomits'
tˡa̯ːwan	tanáːnán	's/he walks'
qa̯tˡa	qá̯t	'big'
tˡa̯ma̯nk	tá̯miŋ	'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] characterizes phonemes that are realized with high frequency frication, that is, high pitch white noise; [–strident] phonemes are realized 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 (1956) original system, wherein it was opposed to the cute feature [mellow].[34]

[34] Chomsky and Halle (1968:329): "Strident sounds are marked acoustically by greater noisiness

But it can also be defined articulatorily as "rough-edge articulation" (Hyman 1975b: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, dᵟ/.

Much more rarely, [±strident] is also used to distinguish *labiodental* obstruents from *bilabial* obstruents. The former are considered [+strident], the latter [–strident]. The West African language Ewe makes such a distinction among its fricatives (Ladefoged and Maddieson 1996:139).

(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. E.g., Venda (Tshivenda): *u fana* 'to resemble', *u fa* 'to die' vs. *u ɸa* 'to give'; *u vala* 'to close' vs. *u βala* 'to count, to read' (Ziervogel et al. 1981:7). 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,[35] [+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.[36]

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than their nonstrident counterparts. ... Stridency is a feature restricted to obstruent continuants and affricates."

[35] Languages without fricatives often have no [+strident] phonemes at all. For instance, Yidiɲ (Australian: Dixon 1977:31-2) has the inventory /b, d, ɟ, g, m, n, ɲ, ŋ, l, r, ɽ, j, w, a, i, u/, with no [+strident] phonemes.

[36] 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.

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

As another example of [+strident] being added to phonemes, consider the historical development in German of [+strident] affricates from [–strident] stops.[37] 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.[38]

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

[38] [–strident] affricates (e.g., p$^{\phi}$, t$^{\theta}$) 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 and Maddieson 1996:90).

Exercises

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

(43) *Disordered speech*

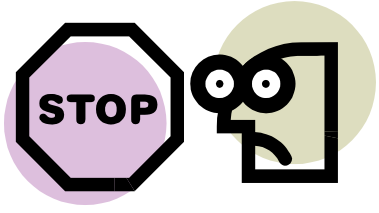
a.	bi	'bee'	m.	bɑ	'ball'
b.	us	'shoes'	n.	ɪŋks	'sink'
c.	ʌts	'shirt'	o.	ajf	'five'
d.	di	'tea'	p.	ops	'soap'
e.	ips	'sheep'	q.	kus	'school'
f.	go	'goat'	r.	gæ	'kite'
g.	ajnf	'fine'	s.	neks	'snake'
h.	du	'two'	t.	af	'fall'
i.	ɪŋgəs	'finger'	u.	dains	'shines'
j.	bə	'bus'	v.	bu	'boat, book'
k.	aks	'forks'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

B. Labialized consonants are illustrated below in the West African language Kutep. (In these data, [ɕ] is a dorsal-coronal fricative, [ʑ] its voiced counterpart, and [tᶝ], its affricate counterpart; accents on vowels are tones, which may be ignored.) What determines the phonetic form of the labialized element? (Roca and Johnson 2000)

(44)

bapʷa	'they grind'	baʑʸam	'they begged'
batʷap	'the picked up'	aɕᶠápaŋ	'groundnuts'
batˢᶠáp	'they chose'	baskʷáp	'they are foolish'
batᶝᶠák	'they sleep'	basᶠa	'they kneel'
nsázʸakkʷà	'the water is hot'	baŋʷáŋ	'they slip'
babʷa	'they deceived'	bamʷà	'they measured'
bambʷà	'they tasted'	baŋgʷà	'they drink'
bandʷap	'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."

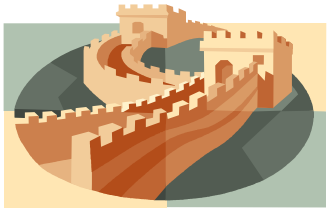
Since [±continuant] is defined on the basis of near-complete vs. complete blockage in the mouth, this feature is relevant only for [+consonantal] phonemes.

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* [timstɹ] ~ [timpstɹ], *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, e.g., Clements 1988, Van De Weijer 1995, Harris and Kaisse 1999, Kenstowicz 1994:34-8, 480-8).

Among obstruents, fricatives are [+continuant] and stops are [–continuant]. Fricatives appear to be more *marked* than stops (Chomsky and Halle 1968:406, Roca and Johnson 2000:585). 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. An example is Dinka (Nilotic: Andersen 1993, Telfer 2003): it has many stops (p, b, t̪, d̪, t, d, c, ɟ, k, g, etc.) but no corresponding fricatives (*f, *v, *θ, *ð, *s, *z, *ç, *ʝ, *x, *ɣ, etc.). Another example is Yidiɲ (Australian: Dixon 1977:32): its only obstruents are /b, d, ɟ, g/ —all stops. 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 and 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 and Maddieson 1996:150):

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

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



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

(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. qʷl̥qʷa to sprain, wrench
   χʷl̥qʷa to sharpen with a file

The status of affricates, such as /tˢ, dᶻ, tˢ', tɬ, dˡ, tɬ'/ 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 'fricative' is made — except perhaps in dˡ, where a homorganic[39] 'sonorant' [l] appears to be made (rather than a homorganic voiced fricative [ɮ]).[40] 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 nonglottalized) 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]
	tɬ	[t͡ɬʰ]	vs.	tɬ	[tʰɬ]

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

(48)	tˢ'	[t͡s']	vs.	ts	[t's]
	tɬ'	[t͡ɬ']	vs.	tɬ	[t'ɬ]

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 favor 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]

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

(51) Idealization of segmental duration (no overlap)

[tˢʰ]	[tˢ']	[tɬʰ]	[tɬ']
⊓	⊓	⊓	⊓
⊔ ⊔	⊔ ⊔	⊔ ⊔	⊔ ⊔
[tʰ s]	[t' s]	[tʰ ɬ]	[t' ɬ]

[39] Homorganic means 'at the same place of articulation'.

[40] 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 /tɬ/, the plain counterpart of phonologically aspirated /tɬʰ/ and glottalized /tɬ'/ (Krauss et al. 1981, Maddieson et al. 2001, Rice 1994, Blevins 1993).

yet been measured instrumentally, though.

The phonetic differences just described, combined with the relatively permissive phonotactics[41] 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[42]	to do what somebody else does or did
	tstsa	push repeatedly

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

w̃atˢ'	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 (p. 22ff.) 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 at the beginning 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.	t̲ˢit̲ˢaina	plural of: chinese
b.	t̲it̲sa	plural of: to push
c.	t̲ˢ'it̲ˢ'm:	plural of: index finger
d.	t̲it̲ɬa	plural of: to bait
e.	t̲'at̲'ɬa	plural of: to slice fish parallel to the backbone
f.	t̲ˡ'it̲ˡ'a:	plural of: black bear
g.	t̲'it̲'ɬa	plural of: to soak dried fish

[41] "Phonotactics" is the set of constraints on sequencing of phonemes in a language.

[42] A sequence like tˢtˢ is doubly released ([t͡sʰt͡sʰ]).

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

Crucially, the 'stop' and 'fricative' components of affricates such as /tˢ'/ do not get separated (*[tˈaːs...]) 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 1976a, 1976b) made possible a conception of affricates as "contoured segments": according to Leben (1980), Steriade (1982), Archangeli (1984), Sagey (1986a, 1986b) and others, each affricate is characterized 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 and Jacobs (1998:195-6), Zoll (1998:95), Elzinga (1999:46-7), Morelli (1999:108-10). 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 /d͡z/ but not /z/. Such a situation is not uncommon in the world's languages. Taba (Austronesian: Bowden and Hajek 1999:143) and Stoney Dakota (Siouan: Shaw 1980:21) have /t͡ʃ, d͡ʒ/ but not /ʃ, ʒ/; Hungarian has /c͡ç, ɟ͡ʝ/ but not /ç, ʝ/; Thai has /t͡ɕ, t͡ɕʰ/ but not /ɕ/; Arabic (Thelwall and Sa'adeddin 1999:51), Hausa (Schuh and Yalwa 1999:91), Hindi (Ohala

1999:100) and Igbo (Ikekeonwu 1999) all have /dʒ/ but no /ʒ/; etc. Such asymmetries illustrate 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 [tʲ], 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 characterize 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, n̪/, a series specified [+strident] /tˢ, dᶻ, tˢ', s/, and a series specified [+lateral] /tˡ, dˡ, tˡ', ɬ, l, l̪/. Crucially, affricates /tˢ, dᶻ, tˢ', tˡ, dˡ, tˡ'/ 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 1991, 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 *spirantization* —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.	còp	cof	'to overtake'
	kɛp	kɛ̀f	'to scoop (food) hastily'
b.	lo̪t̪	loθ	'to suck'
	jæ̪t̪	jæθ	'to wade'
c.	paːt	pàːɾ̪	'to sharpen'
	wɨt	wɨ̪ɾ̪	'to cut a point'
d.	jaːc	jaːç	'to hit'
	ɟ̪jèːc	ɟ̪jeːç	'to dismiss a person'
e.	ɟæk	ɟæh	'to throw away'
	jək	jəh	'to find'

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

It is worth noting here that *spirantization*, 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, affricates changed into fricatives after vowels, as the comparison with English in (59) reveals (Picard 1999:71). Here the feature involved is [±continuant].

(59)

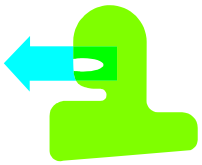
		[f]	[s]	[χ]
	German	*hoffen/auf*	*Wasser/es*	*Kuchen/Buch*
cf.	English	*hope/up*	*Water/it*	*cake/book*

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 (Halle 1988, Pulleyblank 1988, 1989, Halle 1992, Keyser and Stevens 1994, Clements and Hume 1995, Ladefoged and Maddieson 1996:44, 371, Halle et al. 2000, Halle 2003). 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 realize 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] characterizes phonemes which are articulated primarily with the lips. These include:

- labial stops /p, ᵐp, b, ᵐb, pʰ, p', bʱ, b̰, ɓ, ɓ̰, pʷ, ᵐpʷ, bʷ, ᵐbʷ, pʷʰ, pʷ', bʷʱ, b̰ʷ, ɓʷ, ɓ̰ʷ, pʲ, ᵐpʲ, bʲ, ᵐbʲ, pʲʰ, pʲ', bʲʱ, b̰ʲ, ɓʲ, ɓ̰ʲ, pˠ, ᵐpˠ, bˠ, ᵐbˠ, pˠ', bˠʱ, b̰ˠ, ɓˠ, ɓ̰ˠ, ᵐpˤ, bˤ, ᵐbˤ, pˤ', bˤʱ, b̰ˤ, ɓˤ, ɓ̰ˤ,, etc./,
- labial affricates /pᶠ, ᵐpᶠ, bᵛ, ᵐbᵛ, pᶠʰ, pᶠ', bᵛʱ, b̰ᵛ, 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, ʙ̰/,
- labial nasals /m, m̰, m̰, mʷ, m̰ʷ, m̰ʷ, mˠ, mʲ, mˠ, mˤ, etc./, and
- labial glides /ʊ, ʊ̃, ʊ̰, ʊ̰, 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, Ooowekyala consonants with [labial] as their major Place articulator feature are /p, b, p', m, m̰/, as illustrated in the following words:

(61) *Oowekyala*

a.	batˈa	'to fathom, measure by using the extended arms or fingers'
b.	patˈa	'to flatten'
c.	p'atˈ's	'sth. strung out on the ground'
d.	matˈa	'to shake hands, take by the hand'
e.	m̰itˈa	'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) $*\begin{bmatrix}\text{labial}\\ +\text{cont}\end{bmatrix}$ 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 (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).[43]

(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'

[43] 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.

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*

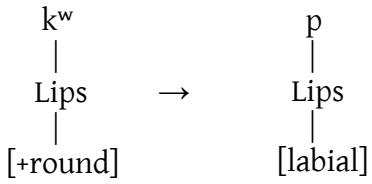
a.	qʷχʷ	Powder
b.	χʷtkʷ	(sth.) cut with a knife
c.	kʷxʷa	Hot
d.	kʷχʷbis	noiseless fart, cushion creeper
e.	kʷ'kʷ'χʷsjakʷ	sth. chopped up, kindling
f.	qʷ'iqʷxʷsm̩	powdery blueberry (Vaccinum ovalifolium)
g.	kʷ'qʷ'χʷdˡ̩a	incessantly urinating (said of a male)
h.	xʷm̩ɢʷatˢ'i	bee-hive
i.	ɢʷaχʷɢʷalaŋ̟usiwa	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 labialized segments (e.g., kʷ),[44] and that languages without labial continuants (*f, *v, etc.) may otherwise allow labialized 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]." 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 fea-

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

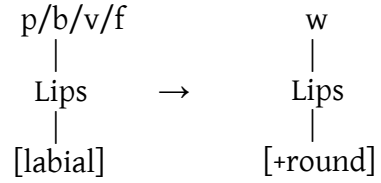
ture [labial].[45] But this replacement is mysterious unless [+round] and [labial] are related through a common organizing node —Lips— which remains constant during the change.

(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 labialized segments like [w] are related to labial consonants through the Lips node, which remains constant during the lenition process:[46]

(67)



Turning now to arguments for the autosegmental status of [+round], we first consider *stability*. Goldsmith (1976b) 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 (1994) observes that the [+round] feature of a deleted vowel is transferred to a preceding consonant, as illustrated in (68e).[47] 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	[isɔ̃tala: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'

[45] 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".

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

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

d.	i ã	[saːprãːsyk]	ça a pris en sucre	'it turned into sugar'
e.	o a	[ẽkutʷaːmastˢɪk]	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 labialized dorsals (k^w, g^w, x^w, ...) as well as labialized labials (b^w, m^w, f^w, ...), but no labialized coronals (*t^w, *d^w, *s^w, ...). Interestingly, the third masculine object in Chaha is indicated simply by labialization, i.e., [+round]. As shown in the data below (from McCarthy 1983:179), the floating [+round] appears to target the rightmost labializable consonant of the stem: the stem-final consonant, if labializable (69a), else the stem-medial consonant, if labializable (69b), else the stem-initial consonant, if labializable (69c). The third masculine object fails to surface if the stem has no labializable 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) *Labialization 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].

2.3.2.1. [coronal]

"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" (Chomsky

and Halle 1968:304). Phonemes specified [coronal][48] are relatively numerous in most languages; they include:

- dentals, e.g., t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪’, d̪ʱ, d̪̈, d̪̰, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪’, d̪ʱ, d̪̈, d̪̰, t̪ʷ, ⁿt̪ʷ, d̪ʷ, ⁿd̪ʷ, t̪ʷʰ, t̪ʷ’, d̪ʷʱ, d̪̈ʷ, d̪̰ʷ, t̪, ⁿt̪, d̪, ⁿd̪, t̪ʰ, t̪’, d̪ʱ, d̪̈, d̪̰, t̪ʷ, ⁿt̪ʷ, d̪ʷ, ⁿd̪ʷ, t̪ʷʰ, t̪ʷ’, d̪ʷʱ, d̪̈ʷ, t̪ʲ, ⁿt̪ʲ, d̪ʲ, ⁿd̪ʲ, t̪ʲʰ, t̪ʲ’, d̪ʲʱ, d̪̈ʲ, t̪ˠ, ⁿt̪ˠ, d̪ˠ, ⁿd̪ˠ, t̪ˠʰ, t̪ˠ’, d̪ˠʱ, d̪̈ˠ, tᶿ, ⁿtᶿ, dᵟ, ⁿdᵟ, tᶿ, tᶿ’, dᵟʱ, d̪ᵟ, θ̪, ð̪, ð̪̈, θ, ð, ð̰, θʰ, θ’, ðˢ, s̪, z̪, ž̪, s̪ʰ, s̪’, ɬ̪, ɮ̪, ɮ̪̌, ɬ̪ʰ, ɬ̪’, n̪, n̥̪, ñ̪, n̪̈, n̥̪̈, n̪̰, n̪ʷ, n̥̪ʷ, ñ̪ʷ, l̪ː, l̪̆ː, l̪̈ː, l̪̰ː, l̪ːʷ, l̪̆ːʷ, l̪̈ːʷ, l̪̰ːʷ, l̪ːˠ, etc.
- alveolars, e.g., t, ⁿt, d, ⁿd, tʰ, t’, dʱ, d̰, d̥, tʷ, ⁿtʷ, dʷ, ⁿdʷ, tʷʰ, tʷ’, dʷʱ, d̰ʷ, d̥ʷ, tʲ, ⁿtʲ, dʲ, ⁿdʲ, tʲʰ, tʲ’, dʲʱ, d̰ʲ, d̥ʲ, tˠ, ⁿtˠ, dˠ, ⁿdˠ, tˠ’, dˠʱ, d̰ˠ, d̥ˠ, tˢ, ⁿtˢ, dˢ, ⁿdˢ, tˢʰ, tˢ’, dˢʱ, d̰ˢ, d̥ˢ, ts, ⁿts, dz, ⁿdz, tsʰ, ts’, dzʱ, d̰z, t̥ɬ, ⁿt̥ɬ, dɮ, ⁿdɮ, t̥ɬʰ, t̥ɬ’, dɮʱ, d̰ɮ, s, ⁿs, z, ⁿz, z̃, sʰ, s’, sʷ, zʷ, sʲ, zʲ, sˢ, zˢ, ɬ, ɮ, ɮ̰, ɬʰ, ɬ’, ɬˢ, ɮˢ, ɮˢ’, n, n̥, n̰, nʷ, n̥ʷ, n̰ʷ, nʲ, nˠ, nˢ, l, l̥, l̰, lʷ, ɬʷ, l̥ʷ, l̰ʷ, lʲ, ɬʲ, l̥ʲ, l̰ʲ, lˢ, ɬ, ɬ̥, ɬ̰, ɬʷ, ɬ̥ʷ, ɬ̰ʷ, ɻ, ɻʷ, r, r̃, rʷ, rʲ, rˠ, rˢ, ɾ, ɾ̃, ɾʷ, ɾʲ, ɾˠ, ɾˢ, ɹ, ɹʷ, r̥, r̥ʷ, etc.
- retroflexes, ʈ, ⁿʈ, ɖ, ⁿɖ, ʈʰ, ʈ’, ɖʱ, ɖ̰, !, ʈʷ, ⁿʈʷ, ɖʷ, ⁿɖʷ, ʈʷʰ, ʈʷ’, ɖʷʱ, ɖ̰ʷ, ʂ, ʐ, ʐ̃, ʂʰ, ʂ’, ɳ, ɳ̊, ɳ̰, ɳʷ, ɳ̊ʷ, ɳ̰ʷ, ɭ, ɭ̊, ɭ̰, ɭʷ, ɭ̊ʷ, ɭ̰ʷ, ɽ, ɽ̊, ɽ̰, ɽʷ, ɽ̊ʷ, ɽ̰ʷ, etc.
- palatoalveolars, eg., tʃ, ⁿtʃ, dʒ, ⁿdʒ, tʃʰ, tʃ’, dʒʱ, d̰ʒ, cᶜ, ᶮcᶜ, dʲ, ⁿdʲ, cᶜʰ, dʲʱ, d̰ʲ, ʃ, ʒ, ʒ̃, ʃʰ, ʃ’, ʃʷ, ʒʷ, ʒ̃ʷ, ʃʷʰ, ʃʷ’, ʃˠ, ʒʲ, ʒ̃ʲ, ʃʲʰ, ʃˠ’, ʃˤ, ʒˤ, ʒ̃ˤ, ʃˤ’, etc.
- palatals, ɕ, ʑ, ʑ̃, ɕʰ, ɕ’, c, ᶮc, ɟ, ᶮɟ, cʰ, c’, ɟʱ, ɟ̰, ɟ̰̃, cᶜ, ᶮcᶜ, ɟʲ, ᶮɟʲ, cᶜʰ, ɟʲʱ, ɟ̰ʲ, cˤ, ᶮcˤ, ɟˤ, ᶮɟˤ, cˤʰ, ɟˤʱ, ɟ̰ˤ, tᶜ, ⁿtᶜ, dᶻ, ⁿdᶻ, tᶜʰ, tᶜ’, dᶻʱ, d̰ᶻ, tᶜʲ, ⁿtᶜʲ, dᶻʲ, ⁿdᶻʲ, tᶜʲʰ, tᶜʲ’, ç, ʝ, ʝ̃, çʰ, ç’, ɲ, ɲ̊, ɲ̰, ʎ, ʎ̝, ʎ̊, ʎ̰, j, j̃, j̊, j̰, jʷ, j̃ʷ, j̊ʷ, j̰ʷ, jˤ, ɥ, ɥ̃, ɥ̊, ɥ̰, etc.

That such diverse phonemes uniquely share a phonological feature is suggested by their class behavior 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... 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 generalization is captured if they share an articulator feature: [+consonantal, <u>coronal</u>] + [ju] is prohibited syllable-initially.[49]

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

[49] 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 and 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.			b.		
	ʔal-qamr	'the moon'		ʔaʃ-ʃams	'the sun'
	ʔal-faras	'the mare'		ʔad-da:r	'the house'
	ʔal-kita:b	'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'
xa:tam	'ring'	walad	'boy'
ba:b	'gate'	tiʒa:ra	'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-.[50] 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 > d͡b^{zv} (72h), and β > z͡v (72i).

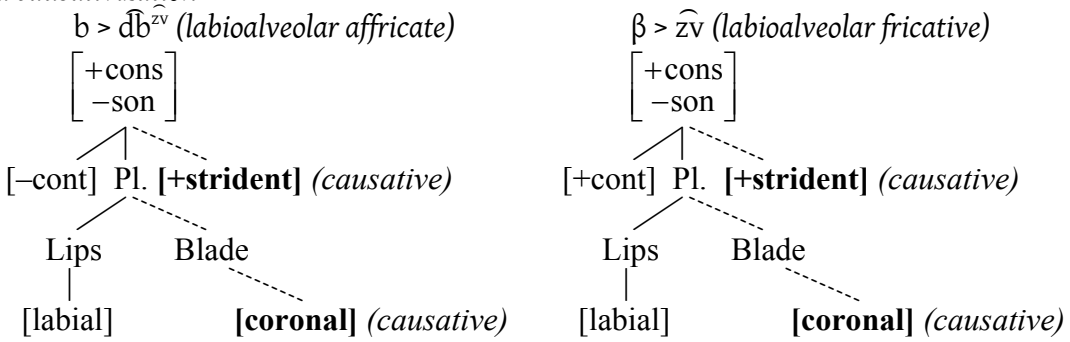
[50] See section 2.3.1.2 above regarding "stability effects."

(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'
			-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'	-reɗ͡ɗb͡^{zv}-a	'lengthen'
i.	-ɲóróβ-á	'be moist, soft'	-ɲóró͡zv-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).[51] 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 > d͡b$^{z͡v}$ and β > z͡v, both 'causative' features —[coronal] and [+strident]— are added to the stem-final labial consonants, resulting in *complex* segments,[52] as illustrated here:

(73) *Shona causativization*



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

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

[52] Such segments are rare. Only one language appears to have labial-coronal stops such as /t͡p, n͡m/ (Yeletnye, Papuan: Ladefoged and Maddieson 1996:344, cf. Maddieson 1983, who denies their existence).

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 (t̪ʰ/t̪, d̪ʱ/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[53] 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]#[54]

As Chomsky and Halle (1968:406, 407) observe, [–anterior] is generally more highly *marked* than [+anterior] (Morelli 1999:128-9, Roca and Johnson 2000:585, 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

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

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

[+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 and Maddieson 1996:237); the California language Karok contrasts [+anterior] /s̪/ with [–anterior] /s̺/, e.g., *s̪ú:f* 'creek' vs. *s̺ú:f* 'backbone'; similarly, in Luiseño: *s̪úkat* 'deer' vs. *s̺úkmal* 'fawn' (ibid., p. 146). Here are some (near) minimal pairs involving [±anterior] from the South Wakashan language Nuuchahnulth (Sapir and Swadesh 1939):

(75) *Nuuchahnulth*

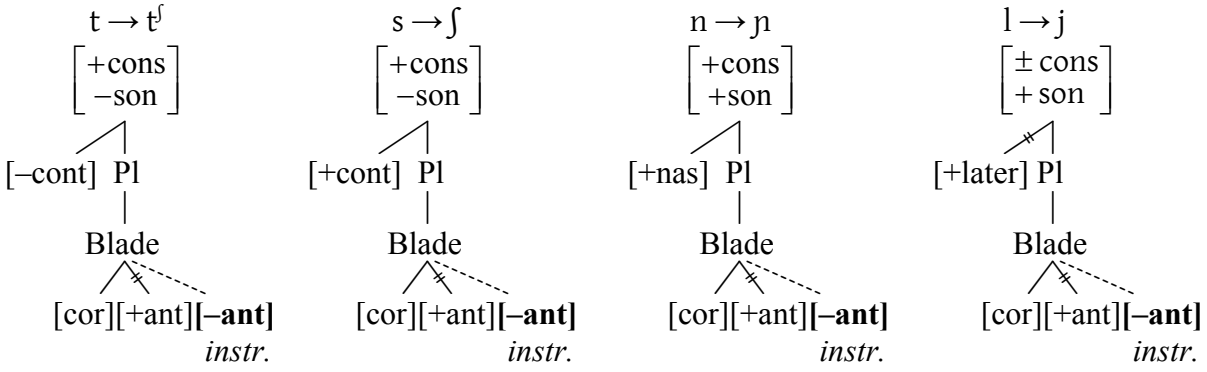
a.	su:p	'soap' or 'soup' < Eng	ʃu:wis	'shoes' < Eng
b.	tˢaka:	'to get spilled'	tʃaʔak	'island'
c.	tˢ'aʔak	'river'	tʃ'aʔak	'water'

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 (Leslau 1995, Zoll 2001):

(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 *palatalizations* can be represented as follows:



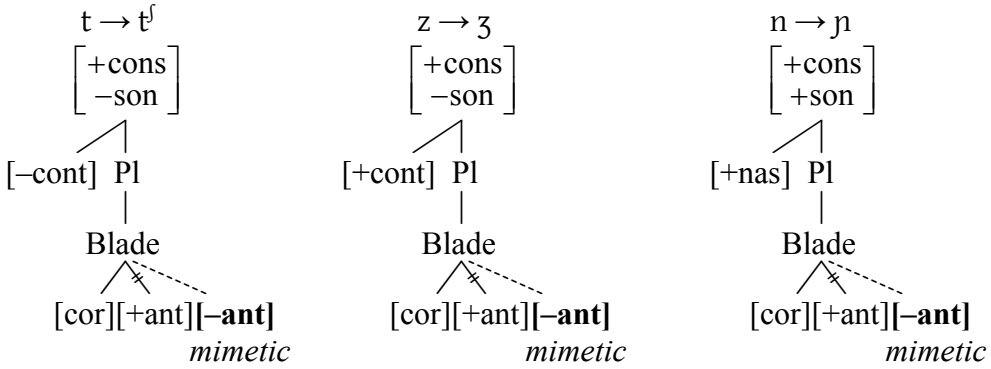
Another example of palatalization comes from Japanese mimetics. *Mimetics* are words that sound like what they mean ("onomatopoeia," e.g., English: *bow-wow, cock-a-doodle-doo*) or that have peculiar sound patterns ("ideophone," e.g., English: *helter-skelter, teeter-totter*). Interestingly, Japanese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

(77) *Japanese mimetics* (Archangeli and 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 palatalization*



A possible case of floating [+anterior] is found in Luiseño, a Uto-Aztecan language from the San Diego area of California. As Kroeber and Grace (1960:23) describe, "[ʃ] in a noun stem becomes [s] when the diminutive suffix, -mal is added, irrespective of whether the [ʃ] occurs one or two syllables before the suffix or of its position in the syllable." Arguably, this suffix carries a floating [+anterior] which docks onto a preceding [ʃ], converting it to [s].

(79) *Diminutive in Luiseño* (Kroeber and Grace 1960:23)

a.	ʃu:kat	'deer'	sukmal	'fawn'
b.	ʃoká:wot	'tree squirrel'	sokáwmal	'small tree squirrel'

c.	to:ʃexet	‘cottontail’	to:sexmal	‘young cottontail’
d.	maʃla	‘large brake fern’	masmal	‘small fern’
e.	qa:ʃil	‘white sage’	qa:simal	‘blue sage’
f.	ʃo:wut	‘black rattlesnake’	somal	‘small species’

2.3.2.3. [±distributed]

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

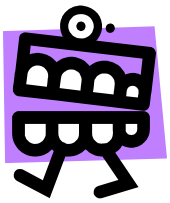
> *Distributed sounds are produced with a constriction that extends for a considerable distance along the direction of the air flow; nondistributed sounds are produced with a constriction that extends only for a short distance in this direction.*

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 and Maddieson 1996:58):

(80) *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 generalization (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):

(81) *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):

(82) *Chipewyan*

[+anterior, +distributed]		[+anterior, –distributed]		[–anterior]	
$t^{\theta}\hat{\varepsilon}\theta$	'hide'	$ts\hat{\varepsilon}ke$	'rubbers'	$t\int\acute{\imath}\varepsilon$	'berries'
$t^{\theta h}e$	'pipe'	$ts^{h}apa$	'money'	$t\int^{h}\varepsilon\theta$	'duck'
t^{θ}'áí	'dish'	ts'i	'canoe'	$t\int$'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 and Maddieson 1996:28):

(83) *Arrernte*

laminal dental		*apical alveolar*	
aṯ̪əmə	'grind'	atəmə	'burst'
aṉ̪əɻə	'sitting'	anəmə	'sitting'

apical palatoalvelar		*laminal palatoalveolar*	
kwəʈə	'smoke'	aṯ̪əməjə	'mother's father'
aɲə	'tree'	aləṉ̪ə	'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] characterizes 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).[55] That vowels involve a primary "dorsal articulation" has been recognized since Sievers (1881); see also Chomsky and Halle (1968:302).

(84) *[–consonantal, dorsal]*

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

b. Semivowels, e.g., ɯ̽, ɯ̃̽, ɯ̊̽, ɯ̪̽, ɯʷ̽, ɯ̃ʷ̽, ɯ̊ʷ̽, ɯ̪ʷ̽, etc.

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

(85) *[+consonantal, dorsal]*

a. **Velars**, e.g., k, ᵑk, g, ᵑg, kʰ, k', gʱ, g̊, ɠ, ɠ̊, kʷ, ᵑkʷ, gʷ, ᵑgʷ, kʷʰ, kʷ', gʷʱ, g̊ʷ, ɠʷ, ɠ̊ʷ, kˢ, ᵑkˢ, gˢ, ᵑgˢ, kˢʰ, gˢʱ, ɠˢ, ɠ̊ˢ, kˣ, gˠ, kˣʰ, kˣ', kʘˣ, kǂ, ᵑkǂ, gǂ, ᵑgǂ, kǂʰ, kǂ', gǂʱ, gǂ, kǂʷ, ᵑkǂʷ, gǂʷ, ᵑgǂʷ, kǂʷʰ, kǂʷ', gǂʷʱ, g̊ǂʷ, ɬ̠, ɮ̠, x, ɣ, ɣ̊, xʰ, x', xʷ, ɣʷ, ɣ̊ʷ, xʷʰ, xʷ', xʲ, ɣʲ, ɣ̊ʲ, xʲʰ, xʲ', ŋ, ŋ̊, ɲ, ɲ̊, ɴ, ɴ̊, ɴʷ, ɴ̊ʷ, ɴʲ, ɴˢ, ʟ, ʟ̃, ʟ̠, ʟ̠̃, ʟʷ, ʟ̃ʷ, ʟ̠ʷ, ʟ̠̃ʷ, etc.

b. **Uvulars**, e.g., q, ᶰq, ɢ, ᶰɢ, qʰ, q', ɢʱ, ɢ̊, ɠ, qʷ, ᶰqʷ, ɢʷ, ᶰɢʷ, qʷʰ, qʷ', ɢʷʱ, ɢ̊ʷ, ɠʷ, χ, ʁ, ʁ̃, χʰ, χ', χʷ, ʁʷ, ʁ̃ʷ, χʷʰ, χʷ', ɴ, ɴ̊, ɴ̠, ɴʷ, ɴ̊ʷ, ɴ̠ʷ, ʀ, ʀʷ, ʁ, ʁʷ, etc.

[55] Front semivowels (j, j̃, j̊, j̠, jʷ, j̃ʷ, j̊ʷ, j̠ʷ, jˢ, ɥ, ɥ̃, ɥ̊, ɥ̠) are specified [coronal, –anterior]. See, e.g., Amharic above. Also Halle et al. (2000:433).

[dorsal] also characterizes many complex segments and clicks, that is, segments specified not only [dorsal] but also [labial] or [coronal]. Complex segments which are both [dorsal] and [labial] are listed in (86a).[56] The glide /w/ in particular is commonplace and the stops /k͡p, g͡b, ŋ͡m/ occur in many (albeit mostly Niger-Kordofian) languages. Clicks are listed in (86b). They occur phonemically only in southern and eastern Africa,[57] and are generally [dorsal]-[coronal], as Ladefoged and Maddieson (1996:247) describe: "every click has both a tip or blade (or lip[58]) action determining the type of click, and also an accompanying velar or uvular articulation." They are velaric ingressive sounds: the [dorsal] closure is released to form a "sucking" sound with the other closure, i.e. [coronal] or [labial]. For instance, the Khoisan clicks /k!, g!, n!/ are both [dorsal] and [coronal].[59]

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

a. **Complex segments**, e.g., w, w̃, ʍ, w̰, wˤ, w̆, k͡p, ᵑ͡ᵐk͡p, ᵑk͡p, g͡b, ᵑ͡ᵐg͡b, ᵑg͡b, k͡pʰ, k͡pˀ, g͡bʱ, g͡b̰, k͡pˣ, g͡bˣ, q͡p, q͡b, etc.
b. **Clicks**, e.g., kʘ, gʘ, kʘʰ, kʘˀ, kʘ', kǀ, gǀ, kǀʰ, kǀ', kǀˀ, k!, g!, k!ʰ, k!', k!ˀ, kǁ, gǁ, kǁʰ, kǁ', kǁˀ, kǂ, gǂ, kǂʰ, kǂ', kǂˀ, klˣ, k!ˣ, kǁˣ, kǂˣ, 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, ŋʘ, ɲ̊ʘ, ˀŋʘ, ɲ̊ʘʰ, ŋl, ɲ̊l, ˀŋl, ɲ̊lʰ, ŋ!, ɲ̊!, ˀŋ!, ɲ̊!ʰ, ŋǁ, ɲ̊ǁ, ˀŋǁ, ɲ̊ǁʰ, ŋǂ, ɲ̊ǂ, ˀŋǂ, ɲ̊ǂʰ, etc.

As an example of a process in which [dorsal] is specifically targeted, consider the Gurage language Muher, where the glottalized velar /k'/ weakens to glottal stop [ʔ] after vowels (Rose 2000a). 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.)

(87)	*Perfect*	*Imperfect*	*Jussive*	*Imperative*	
a.	k'əffəməm	jɨʔəffu	jəʔfif	k'ɨfif	'cut, nick'
b.	k'ɨnəbbam	jɨʔnabbu	jəʔəmba	k'əmba	'chatter, talk nonsense'
c.	ləkk'əməm	jɨləʔmu	jəlk'im	lɨʔim	'pick'
d.	nəkk'ələm	jɨnəʔlu	jənɨʔil	nɨʔil	'uproot, pull out'

[56] No language has been found with coronal-dorsals such as /t͡k, d͡g, nˆŋ/ (Maddieson 1990, Chitoran 1998, Ladefoged and Maddieson 1996:345, 348). What happens, then, when a stop is phonologically specified both [coronal] and [dorsal]? The answer is a click; read on. (Cf. Kinyarwanda exercise on p. 57.)

[57] Hale (1992) reports the use of clicks in Damin, an artificial language used by initiated Lardil men on Mornington Island in Australia. Clicks are also found in some disordered languages (Heselwood 1997).

[58] All languages with clicks have coronal ones (typically dental, but also alveolar, palatal, or lateral) but Southern Khoisan languages additionally have labial clicks, which are labial-dorsals. Engstrand (1997) suggests that (labial) clicks developed historically as phonetic variants of labial-dorsals (k(p, g(b, ŋ͡m).

[59] The Tongue Blade gesture was lost in the Khoe language, exposing the [dorsal] gesture. For instance, Khoisan [!kae] 'tie', [!go] 'antbear' and [!nu] 'country' became [kae], [go] and [ŋu], respectively (Traill and Vossen 1997:29).

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

Note that labialization ([+round]) does not interfere with this lenition process, such that a labialized [kʷʼ] is realized as [ʔʷ] after vowels. In (88a,b) labialization is an underlying property of the verbal root, whereas in (88c,d) labialization is added to non-labialized roots to indicate the impersonal mood. As Rose (2000a:110) explains, "a glottal stop reduced from a /kʼ/ is still labialized. For example, the 3 ms object of the imperative *niɬʔɨl* 'uproot' is *niʔʷɨɬ*." (Recall that the 3 masculine singular object morpheme is just a "floating" feature in some Gurage languages; see Chaha data in (69) on p. 44.)

(88)	*Root*	*Perfect*	*Imperfect*	*Jussive*	
a.	/kʷʼm/	kʷʼəməm	jɨʔʷəmu	jəʔʷɨm	'stand'
b.	/kʼwr/	kʷʼəkkʷʼərəm	jɨʔʷəkkʷʼɨru	jəʔʷəʔʷɨr	'squeeze, wring'
c.	/lakʼ/	laʔʷim	jɨləʔʷit	jəlaʔʷi	'surpass'
d.	/nkʼ-nkʼ/	nɨʔənnəʔʷim	jɨnkʼənnɨʔʷit	jənəʔnəʔʷi	'shake'

An instance of a "floating" [dorsal] feature is found in Dakota (Boas and Deloria 1932, 1941, Shaw 1980, 1989), a Siouan language spoken on the Canadian prairies and American mid-northwest plains. In this language, the first-person dual-inclusive prefix appears to be *ʔũ-*, as the following data illustrate.

(89) *Dakota* (Shaw 1989:12, 27)

a.	ʔũ- + ʃi	→	ʔũʃi	'we order'
	1incl + order			
b.	ʔũ- + hi	→	ʔũhi	'we arrive'
	1incl + arrive			
c.	ʔũ- + xa	→	ʔũxa	'we bury'
	1incl + bury			
d.	ʔũ- + tʰi	→	ʔũtʰi	'we live'
	1incl + live			
e.	ʔũ- + jatʰã	→	ʔũjatʰã	'we praise'
	1incl + praise			
f.	ʔũ- + kʃiʒa	→	ʔũkʃiʒa	'we are doubled up'
	1incl + bend			

However, this prefix has the shape [ʔũk] when used before a stem which begins in a vowel, e.g., (90), or in a glottal stop, e.g., (91). (A glottalized [kʼ] surfaces in the latter case.)

(90) *Dakota* (Shaw 1989:10, 27)

a.	ʔũ + u	→	ʔũku	'we come'
	1incl + come			
cf.	wa + u	→	wau	'I come'
	1sg + come			

b.	ʔũ + i	→	ʔũki	'we go'
	1incl + go			
c.	ʔũ + ũspe	→	ʔũkũspe	'we know'
	1incl + know			

(91) *Dakota* (Shaw 1989:11, 28)

a.	ʔũ- + ʔũ	→	ʔũkˀũ	'we are/use'
	1incl + be/use			
cf.	wa- + ʔũ	→	waʔũ	'I am/use'
	1sg + be/use			
b.	ʔũ- + ʔĩ	→	ʔũkˀĩ	'we wear'
	1incl + wear			
c.	ʔũ- + ʔo	→	ʔũkˀo	'we shoot'
	1incl + shoot			

Still, there are good reasons for *not* treating this prefix as *ʔũk-* underlyingly. First, we would be unable to explain the absence of the prefix's /k/ in (89), since "normal" /k/ freely occurs in consonant clusters in Dakota, even in syllable-initial clusters, e.g., (92). Compare especially (89a) and (89f).

(92) *Syllable-initial clusters in Dakota* (Shaw 1989:7, 27)

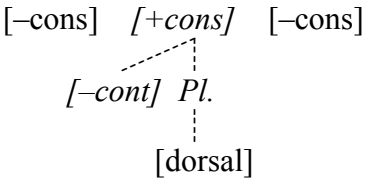
kʃu	'to bead'	ksapa	'be wise'
kpa	'to swell'	kte	'kill'
k͡ʃa	'loose'	tke	'be heavy'

Second, we would be unable to explain the merger of the prefix's /k/ with a following glottal stop, which results in glottalized [kˀ] (91). Crucially, "normal" /k/ does not merge in this manner with a following glottal stop in Dakota; compare (91c) with /ʃũk-ʔo-pi/ (dog-shoot-pl.) → [ʃũkʔopi] 'they are shooting dogs' (Shaw 1989:11).

Third, treating *ʔũk-* as /k/-final would make it the only prefix that ends in a consonant; all other prefixes in Dakota end in vowels (Shaw 1989:27).

Building on Shaw (1989), Zoll (1998:149) proposes that the first-person dual-inclusive prefix *ʔũ-* carries a [dorsal] feature which "is 'floating' and will be realized only when required to fill an otherwise empty [syllable] onset" (Shaw 1989:27). That is, when *ʔũ-* is added to a vowel-initial stem such as *u* 'to come', the potential vowel hiatus[60] is avoided by adding unmarked features ([+cons], [–cont], ...) to [dorsal], resulting in intervocalic [k].

(93)



[60] See fn. 28 on p. 19, and the surrounding discussion of "*h*-aspiré" in French.

Exercises:

A.
Rhotics have changed from [r] to [ʀ] in dialects of many languages, including French (Straka 1965), German (Howell 1987) and several Scandinavian languages (Swedish, Danish, Norwegian: Torp 2001).[61] Describe this change featurally.

B.
Explain alternations in the following data from Canadian French (Walker 1982:76, my transcriptions)

a. *Onset position*		b. *Word-finally*		c. *Preconsonantally*	
gɑɲe	'won'	gɑŋ	'win!'	gɑŋpɛ̃	'job' (win-bread)
ãseɲe	'taught'	ãsɛŋ	'teach!'	ãsɛŋmã	'teaching'
peɲe	'combed'	pɛŋ	'comb!'	pɛŋwaʀ	'peignoir'
liɲe	'lined'	lɪŋ	'line'	ãlɪŋmã	'alignment'

C.
Explain changes in the final consonants in the development from Middle Chinese (MC) to Fuzhou Chinese (FC), as illustrated in the following data (Chen 1973, Norman 1988:228-39).

	MC	FC			MC	FC	
a.	śjəm	> tsʰiŋ	'deep'	b.	diep	> tʰak	'stack up'
	duân	> touŋ	'break off'		ngjwɐt	> ŋuok	'moon'
	dung	> tøiŋ	'copper'		ńźjiuk	> nyk	'meat'

D.
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 nativization of German loan words, which suggest that consonant clusters are not permitted. Try to resolve this contradiction.

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

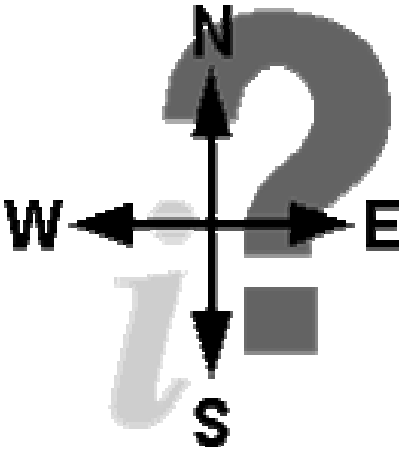
[61] Other examples include:

Portuguese (Noll 1997), Italian (Ladefoged and Maddieson 1996:225), Spanish (Puerto Rican: Navarro Tomás 1966, Granda 1966), English (Northumbrian and Sierra Leonean: Rydland 1995, Ladefoged and Maddieson 1996:236), Dutch (Gussenhoven 1999), Yiddish (Eastern: King and Beach 1998:284-6), Russian (Ladefoged and Maddieson 1996:225), and several Central Sulawesi languages (Lauje, Dampelas and Tolitoli: Himmelmann 1991).

2.3.3.2. Other Tongue Body features

The other Tongue Body features are [±high], [±low], and [±back]. Chomsky and Halle (1968:304-5) 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 (94).

(94) *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,[62] but the features [±high] and [±back] are important in classifying various types of consonants. [±high] characterizes the difference between velars and uvulars: they are [+high] and [–high], respectively (see (85) above).[63] This distinction is illustrated in the following Oowekyala minimal pairs:[64]

(95) *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'

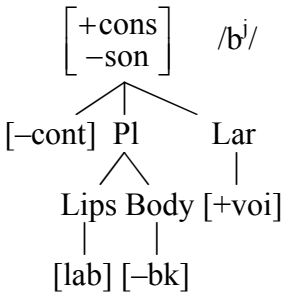
[62] The reason for this should be obvious to you; think about the definition of [+consonantal].

[63] On [high] in velars vs. uvulars, see Chomsky and Halle (1968:304-5), Zetterstrand (1998), Vaux (1999), and Halle et al. (2000:426-7).

[64] Closely-related Heiltsuk provides a nice minimal pair: [kʲ̓át] 'poor' vs. [qʲ̓át] 'rich' (Rath 1981).

b. kiχa ‘to use a saw’
qiχa ‘to fade (color)’
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 Dˈəwə̃χa Dances’
d. kʼɬa ‘to move (brush, sweep, shake) particles from a surface’
qʼɬa ‘to lift, pick up, hold, carry a person (esp. a baby)’

The feature [–back] is used in consonants to characterize palatalization. For example, Japanese has a series of palatalized 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 palatalized 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 palatalization feature, which is assumed to be [–back], can also act as a “floating” feature. For instance, in Zoque, spoken in Chiapas, Mexico, [–back] represents the third person possessive (Akinlabi 1996). It targets word-initial consonants, as illustrated in (96):

(96) *Zoque* (Wonderly 1965)

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’
kama	‘cornfield’	kʲama	‘his cornfield’
gaju	‘rooster’	gʲaju	‘his rooster’
hajah	‘husband’	hʲajah	‘his husband’
ʔatˢi	‘older brother’	ʔʲatˢi	‘his older brother’

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

(97) -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)
-ʲba ?, /sud-/ ‘judge’ vs. /sudʲ-ba/ ‘fate’

More examples of floating [–back] features come from German (Wiese 1996, Roca and Johnson 2000). The adjectival suffix *-lich* and the adverbial suffix -ig, both translatable as '-ly' in English, each appear to carry a floating [–back]. To see this, first consider the changes in (98): when *-lich* or *-ig* are added to a root, its back vowels (e.g., /o, u, ɔ/) become fronted (/ø, y, œ/, respectively).

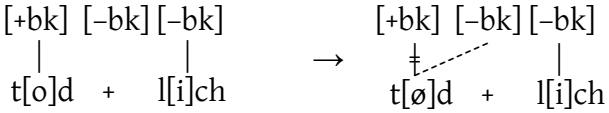
(98)				
	T[o]d	'death'	t[ø]d+lich	'deadly'
	Br[u]der	'brother'	br[y]der+lich	'brotherly'
	v[ɔ]ll	'full'	v[œ]ll+ig	'fully'

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

(99)				
	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 (2000:161-3) suggest that what is special about the suffixes *-lich* and *-ig* in (98) is that they carry a floating [–back] feature which replaces the [+back] specification of the root vowels, as represented here for *tödlich* 'deadly':

(100)

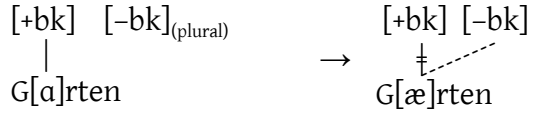


Vowel fronting is also used to indicate the plural form of many nouns in German, e.g. (101). The umlaut diacritic (¨) indicates fronting ([–back]) in a vowel in German orthography.

(101)	*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 and Johnson 2000).

(102)



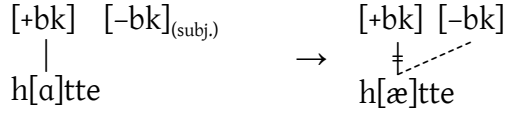
Finally, vowel fronting is also used to indicate the subjunctive form of many verbs, e.g.:

(103)

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:

(104)



Roca and Johnson (2000:164-5) 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].)

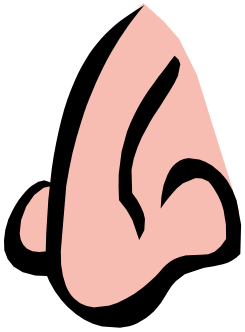
Turning now to [±high], it, too, can occur autonomously from segments. For instance, in Latvian the accusative singular marker appears to be just the feature [+high]. Latvian has two [–high] vowels /e, a/ and two [+high] vowels /i, u/. At the end of singular accusative forms, a nonhigh vowel is raised 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. (105a). Naturally, when the stem-final vowel is already high *i* or *u*, no raising is observed in the singular accusative, e.g. (105b).

(105) *Latvian* (Archangeli 1984)

	sg. loc.	*sg. dat.*	*sg. acc.*	
a.	ma:te:	ma:te-j	ma:ti	'mother' (fem.)
	ma:sa:	ma:sa-j	ma:su	'sister' (fem.)
	zirga:	zirga-m	zirgu	'horse' (masc.)
b.	zivi:	zivi-j	zivi	'fish' (fem.)
	gulbi:	gulbi-m	gulbi	'swan' (masc.)
	tirgu:	tirgu-m	tirgu	'market' (masc.)

Exercise:
English has a regular [l] syllable-initially (*lip*, *slip*, *kindling*, *silo*, etc.) but a so-called 'dark' [ɬ] syllable-finally (*pill*, *silt*, *mildew*, *mile*, etc.). Suggest a possible account of this pattern.

2.4. Soft Palate



A single feature is realized by the Soft Palate: [±nasal].[65] 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."[66] 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).[67]

The unmarked value for [nasal] is orality, i.e., [–nasal] (Chomsky and Halle 1968:405).[68] For instance, the substitution of [–nasal] phonemes for [+nasal] phonemes is common in child language, e.g.:

(106) *Child English: Sally* (Bernhardt and Stemberger 1998:320)

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

(Berhardt and 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.).)

---

[65] Halle et al. (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.)

[66] This definition of [±nasal] is simplistic phonetically. If you're interested:

> *During the production of oral phonemes, the velum moves in a superior and posterior direction with a type of "knee action" to achieve closure against the posterior pharyngeal wall. ... The posterior pharyngeal wall often moves anteriorly to assist in achieving contact. The lateral pharyngeal walls move medially to close against the velum, or in some cases, to meet in midline behind the velum. There are three basic patterns of normal velopharyngeal closure. Some normal speakers demonstrate closure primarily through the action of the velum and posterior pharyngeal wall (coronal pattern), while with other normal speakers, closure is achieved primarily from the medial movement of the lateral pharyngeal walls, which meet in midline (sagittal pattern). In some speakers, all structures move equally to achieve closure (circular pattern). Regardless of the basic closure pattern, velopharyngeal closure occurs as a valve or sphincter through coordinated action of these structures. The velopharyngeal valve closes for the production of oral sounds and opens with the production of nasal sounds.* (Kummer and Marsh 1998:614)

[67] The raised ^{e} stands for 'error'.

[68] Velopharyngeal closure is the norm only during speech. The velum is at rest during normal breathing (thank goodness; cf. fn. 66 on p. 62).

There are also languages in which the feature [+nasal] is banned entirely, such as South Wakashan Ditidaht and Makah (Klokeid 1977).[69] So for example, the root *naq-* 'to drink' in North Wakashan Oowekyala has the cognate *daq-* in these other languages.

Pawnee, a Caddoan language now spoken in Oklahoma, is another language without nasals. As Parks (1976:19, n. 1) describes: "Besides having so few consonants [it has just eight: p t t^s k s w r h], Pawnee is also unusual in that it has no nasal consonants —neither phonetically nor phonemically." Hidatsa and Crow are two Siouan languages which also lack overt nasals (Matthews 1958).

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] favors [+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 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 1987).

Nasal glides are common in some varieties of Spanish, where they occur before nonstops or word-finally (D'Introno and Sosa 1984:2-3). The following words are from a variety of Spanish spoken in northern Dominican Republic (Pineros 2002).[70] The nasal glide here sounds like "a very weak and reduced" velar nasal (ŋ) (Jimenez Sabater 1975:117).

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

a.	oj̪teNsja	'proper name'
	eNfejmo	'sick'
	saNha	'ditch'
	oNra̪do	'honest'
	eNlase	'link'
b.	ra̪toN	'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 nasalized h's which are written <nh>, e.g. *nhonho* [ɦoɦo] 'devil's horn'.

[69] This feature is also shared by Twana and Lushootseed, two unrelated languages spoken in the same area.

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

(108) *Kwangali* (Ladefoged and 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):

(109)

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 (110a-f) make clear, the first vowel deletes before the second one, which is lengthened. Crucially, data such as (110f,g) reveal that while the first vowel deletes in coalescence, its feature [+nasal] survives on the remaining vowel. As Dumas (1994:114) states: "the feature of nasality ... is absolutely immune to any reduction and is systematically transferred to the vowel that remains" (my translation).

(110) *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'
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* [kpĩ́ olú] *'divide mushrooms', vowel deletion optionally applies to delete the nasalized 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:* [kpṍlú].

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, see also: Gomez-Imbert and Kenstowicz 2000:422):

(111) *Southern Barasano*

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

As Pulleyblank (1998) argues, this generalization —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:

(112)

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 1960).

(113)

Underlying representations	a r i d e	a r i d e [+nas]
Link & spread nasality	n/a	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 characterizes phonemes produced primarily with the root of the tongue, such as the pharyngeal glides[71] /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 (Convery 1997:47):

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

It is fairly common for dorsal consonants to shift to pharyngeals. In terms of features, the shift in question is from [dorsal] to [radical]. For instance, the Stoney pharyngeals [ħ, ʕ] just illustrated developed historically from the velar fricatives /x, ɣ/, respectively (Shaw 1980:21). In South Wakashan languages (Jacobsen 1969), the glottalized uvulars /q', qʷ'/ have changed to a voiced glottalized pharyngeal /ʕ'/ in both Ditidaht and Nootka-Nuuchahnulth,[72] and uvular fricatives /χ, χʷ/ have changed to a voiceless pharyngeal /ħ/ in Nootka-Nuuchahnulth but not in Ditidaht.

(115) *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'itʃaːk	ʕ'itʃaːk	ʕ'itʃaːk	qʷ'itʃaːk	'rotten'
c.	miq'aːt	miʕ'aːt	biʕ'aːt	biq'aːt	'sockeye salmon'
d.	q'iχak	ʕ'iħak	ʕ'aχak	q'iχak	'to cry, howl'

[71] Most phonologists treat pharyngeals as glides, i.e. [–consonantal, +sonorant] (e.g., Laufer 1996, Halle et al. 2000). But it should be noted that many treat pharyngeals as fricatives, i.e. [+consonantal, -sonorant] (e.g., Ladefoged and Maddieson 1996).

[72] Plain uvular stops /q, qʷ/ have remained intact. Compare, e.g., North Wakashan Oowekyala *naq-* 'drink' and South Wakashan Nootka-Nuuchahnulth *naq-* 'ibid.'

e.	χamup	ħamup	χabup	χabup	'knowing'
f.	χupt-	ħupta:	χu:bit'ad	χu:bit'ad	'snoring'
g.	tˢ'iχʷat-	tˢ'iħata	tˢ'iχʷatʃtˡ	tˢ'iχʷatʃitˡ	'to be scared'

Exercise
Santerre (1979) reports the following pronunciations in Montreal French: *arracher* [aʕaʃe] 'to tear off' (cf. standard Canadian French [aʀaʃe]), *carabine* [kaʕabɪn] 'rifle' (cf. standard Canadian French [kaʀabɪn]). He (1982) also reports that in Havre St-Pierre, Quebec, young people pronounce *Henri Richard* [ãʕi ʕiʃɑʀ] (cf. Standard Canadian French [ãʀi ʀiʃɑʀ]). What (featural) change is involved in these pronunciations?

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.

The feature [±ATR] is useful in distinguishing between so-called "tense" versus "lax" vowels in (Canadian) English as in many other languages:[73]

(116)

[+ATR]	i, e, æ, u, o *beat, bait, bat, boot, boat*	also: y, ø, etc.
[–ATR]	ɪ, ɛ, ɑ, ʊ, ɔ[74] *bit, bet, bought, foot, boy/bore*	also: ʏ, œ, etc.

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 underlined in the left column of (117) are noticeably long (cf. short vowels in right column). By contrast, [–ATR] [ɪ, ɛ, ʊ, ɔ] are never long in English.

(117)

[e:]	Canadian	cf.	Canada
	Arabia		Arab
	Jordanian		Jordan
	regalia		regal
	courageous		courage

[73] Some vowels, such as [a] and [ʌ], are ambiguous in terms of their [±ATR] specification. Each is treated as [+ATR] in some languages, but [–ATR] in other languages.

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

[oː]	Mongolia	Mongol
	Babylonian	Babylon
	felonious	felon
	colonial	colony
	Gregorian	Gregory
[iː]	collegiate	college
	comedian	comedy

Exercises

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

(118)

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'
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* (Davenport and Hannahs 1998)

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.)

(119)

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?

(120)

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 neighboring vowels in stems (this is *vowel harmony*; we return to this topic later). For example, the prefix is [+ATR] *o-* in (121a), as it is next to a [+ATR] vowel in the stem *bi̱sa*. But the same prefix is [–ATR] *ɔ-* in (121b), as it is next to a [–ATR] vowel in the stem, *kɑ̱ri*. Conversely, the suffix is [–ATR] *-ɪ* in (121a), as it is next to a [–ATR] vowel in the stem *bisɑ̱*, while it is [+ATR] *-i* in (121b), as it is next to a [+ATR] vowel in the stem, *kari̱*.

(121) *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’

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 (122c,d), these roots systematically induce [+ATR] prefixes.

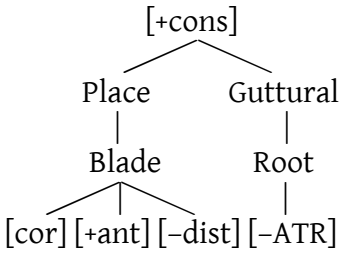
(122) *Akan*

a.	o-bisɑ-ɪ	‘he asked’	c.	o-dʒʷɑnɪ-ɪ	‘he fled’
b.	ɔ-kɑri-i	‘he weighed’	d.	o-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 labialization on the preceding consonant ([dʒʷ]) in the first root, while [–back] of historical [i] survived as palatalization 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 to consonants, the feature [–ATR] has been used to characterize *pharyngealization* on certain consonants, known as "emphatics" (/tˤ, sˤ, etc./), which are found in some Salishan, Athapaskan, Wakashan and Semitic languages, e.g., Qatari Arabic *sad* 'to prevail' vs. *sˤad* (name of the letter) (Ladefoged and Maddieson 1996:365, Eijk 1997, Bessell 1998, see also McCarthy 1994 on [pharyngeal]).[75]



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 and Idsardi (2001); Tone is introduced separately in section 2.5.3, p. 87ff. below)

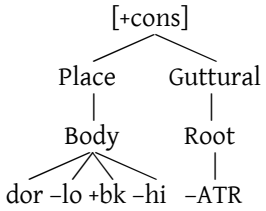
2.5.2.1. [glottal]

This feature characterizes 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 labialized (hʷ, ʔʷ), palatalized (hʲ, ʔʲ), or pharyngealized (hˤ, ʔˤ) ([+round], [–back], and [–ATR], respectively).

Considering first labialized laryngeals, you might recall that in the Gurage language Muher, a labialized [kʷ'] is realized as [ʔʷ] after vowels, as illustrated in the following data (repeated from (88) above):

(123)	*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'

[75] It is sometimes claimed that uvulars (q, ɢ, χ, ʁ, ʀ, ɴ, etc.) 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 et al. 2000:409). The Tongue Root-specification of uvulars is advocated by Cole (1987), Elorrieta Puente (1991), Pulleyblank (1995:12), Shahin (1997), and Howe (2000), among others.



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

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

Exercise

As part of the well-known lenition alternation in Irish, the voiceless plain coronals [t] and [s] and their palatalized counterparts [tʲ] and [sʲ] reduce to [h] and [hʲ], respectively. How can this process be formulated?

(124)	talə	'land'	mə halə	'my land'
	soləs	'light'	mə holəs	'my light'
	tʲo:xt	'temperature'	mə hʲo:xt	'my temperature'
	sʲo:l	'sail'	mə hʲo:l	'my sail'

Pharyngealized laryngeals, which may be written /hˤ, ʔˤ/, are found in Arabic dialects and Interior Salish languages (Shahin 1997). They are also found in North Wakashan languages (see Lincoln and Rath (1980:15-6) and Rath (1981:9-11) on Heiltsuk, and Lincoln and Rath (1986:20-1) on Haisla and Kwakwala). The following examples are from Oowekyala.

(125) *Pharyngealized laryngeals in Oowekyala* (Howe 2000)

a. hˤiɬ 'to set right, to heal'
b. hˤuma 'to obtain information (by watching, listening)'
c. ʔˤixp'a 'good or sweet taste, to have a good or sweet taste'
d. ʔˤukʷ 'to pity, to have mercy'

Turning now to the relation between [glottal] and [radical], their dependence on a shared Guttural node is motivated not just by anatomy but by phonological patterns. For instance, Shahin (1995) reports that laryngeals [h, ʔ] (variably) replace pharyngeals [ħ, ʕ] in Child (Palestinian) Arabic, e.g.:

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

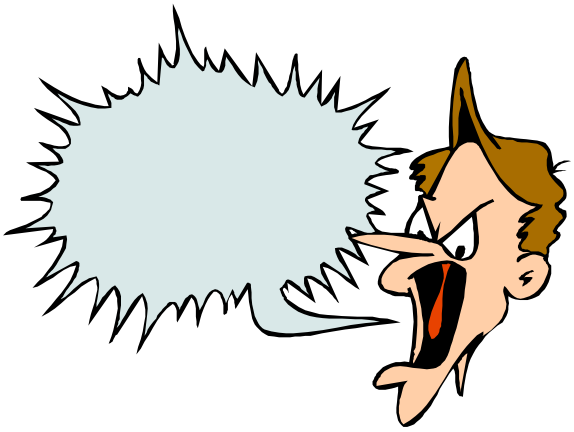
a.	/ħæ:mi/	[hæmi]	'difficult'	2;2
b.	/rˤu:ħ/	[lʊh]	'to go'	2;4
c.	/ʕʊsˤsˤ/	[ʔɑs]	'to press, squeeze'	1;11

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 behavior. 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):

(127)	*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.[76]

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*).[77] 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:

(128) *Voicing markedness*

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

"Obstruents must be voiceless."

[76] 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 and 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 1988).

[77] By the way, loudness, or vocal intensity, is achieved by increasing the amplitude of vocal fold vibrations, which is achieved by increasing subglottal air pressure.

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 (128).[78]

(129) *Voicing contrasts in obstruents*

[–voice]	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
[–voice]	ɸ	f	θ	s	ɬ	ʃ	ʂ	ç	x	χ
[+voice]	β	v	ð	z	ɮ	ʒ	ʐ	ʝ	ɣ	ʁ

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

(130) *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 (131), repeated from (111) from section 2.4. A complication is now revealed in the third column of (131): voiced stops are prenasalized.

(131) *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 (1998:97) remarks, the prenasalized voiced stops of Southern Barasano, as exemplified in the third column of (131), raise several questions:

(i) If prenasalization involves specification for the feature [+nasal], why don't prenasalized stops initiate nasal harmony?
(ii) Why do prenasalized stops appear in otherwise fully oral words?

[78] 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.

(iii) If prenasalization involves the assignment of [+nasal] to a segment, then why don't the targeted segments become fully nasal(ized)?

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 realization 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 prenasalized 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."

Prenasalization 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:

(132) *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))

(133) *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:

(134) *Syllable-final voicing markedness*

$*\begin{bmatrix} -\text{sonorant} \\ +\text{voice} \end{bmatrix}.$ "Voiced obstruents are not permitted syllable-finally."

This constraint results in *positional neutralization*: lexical distinctions in [±voice] are neutralized 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 and 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 text. 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:

(135)		*noun stem*	*possessed form*	*UR (stem)*
a.	'rope'	ip	ipi	
b.	'louse'	bit	biti	
c.	'reason'	sebep	sebebi	
d.	'wing'	kanat	kanadɨ	
e.	'honor'	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.	'color'	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.)

(136)	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 favored in certain positions in many languages. This state of affairs can be illustrated with an exercise on Plains Cree (Algonquian) (Davenport and Hannahs 1998:112-3):

C. In the following data from Plains Cree (Algonquian: Davenport and Hannahs 1998), 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.

(137) *Plains Cree* (Davenport and Hannahs 1998)

a.	pahki	'partly'	l.	tahki	'all the time'
b.	ni:sosa:p	'twelve'	m.	miht͡ʃe:t	'many'
c.	ta:nispi:	'when'	n.	nisto	'three'
d.	paskua:u	'prairie'	o.	tagosin	'he arrives'
e.	asaba:p	'thread'	p.	mi:bit	'tooth'
f.	si:si:p	'duck'	q.	nisida	'my feet'
g.	wa:bame:u	'he sees him'	r.	me:daue:u	'he plays'
h.	na:be:u	'man'	s.	kodak	'another'
i.	a:bihta:u	'half'	t.	nisit	'my foot'
j.	nibimohta:n	'I walk'	u.	nisi:si:bim	'my duck'
k.	si:si:bak	'ducks'	v.	iskode:u	'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:

(138) *Rendaku in Japanese*

a.	ju	+	to:ɸu	→	judo:ɸu
	'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
	'color'		'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 and Mester 1995, Avery and Idsardi 2001).

Another example of floating [+voice] comes from Aka, a Bantu C language spoken in the Central African Republic (Kosseke and Sitamon 1993, Roberts 1994, Akinlabi 1996). In this language, the so-called "noun class 5" is marked by voicing the first con-

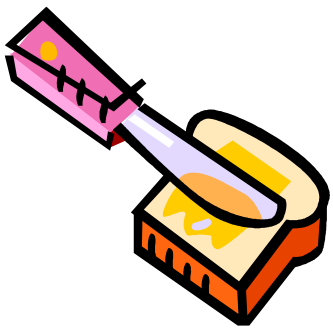
sonant of the root, as shown in (139a). As Akinlabi (1996:286) explains, "the featural prefix is simply [voice]."

(139)

	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.	dʒ́ú	mà-su	'cheek'
	dʒ́èlé	mà-sèlé	'lizard' (sp.)
c.	gɔ̀àlà	mà-gɔ̀àlà	'game of imitation'
	bèlèlè	mà-bèlèlè	'sound of a waterfall'
	dʒ́ámbà	mà-dʒ́ámbà	'mud'

The examples in (139b) illustrate what happens with stems that begin with /s/. As Akinlabi (1996:286) explains, Aka does not have [z], though it does have [dʒ́], so when [+voice] is added to /s/, the result is not [z], which Aka happens to lack, but [dʒ́], its closest consonant. (In other words, when [+voice] is added to /s/, so are [–continuant], [–anterior] and [+distributed].) The examples in (139c) 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 ("glottal abduction"), such as [h] and aspirated consonants, are [+spread glottis]; other segments are [–spread glottis] (Halle and Stevens 1971).[79]

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

[79] FYI, vocal folds may become paralyzed in spread position ("bilateral adductor vocal fold paralysis"), which may result in aphonia.

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

a.	pʰa	'flower'	d.	ʈʂʰa	'to stick in'
	pa	'eight'		ʈʂa	'to pierce'
b.	tʰa	'it, he/she'	e.	tɕʰa	'to dig fingernail into'
	ta	'to put up, build'		tɕa	'to add'
c.	tsʰa	'to wipe'	f.	kʰa	'to scrape with knife'
	tsa	'take food with tongue'		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 and Maddieson 1996:179).

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

(141) *Burmese* (Ladefoged and Maddieson 1996:111)

	Bilabial	*Alveolar*	*Palatal*	*Velar*	*Labialized-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 and Hannahs 1998:110):

(142) *Scottish English: aspirated [ʍ] vs. unaspirated [w]*

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-distinctive, role in English phonology: roughly, in absolute word-initial position, voice-

less stops (and immediately following consonants, if any) are [+spread glottis]. By contrast, consonants after /s/ are [–spread glottis].

(143) *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 behavior comes from a common form of reduction whereby laryngeal distinctions are suppressed in syllable-final position. For example, many languages oppose aspirated, voiced and plain stops [pʰ, b, p] in syllable-initial position but limit the syllable-final position to just [p]. One such language is Thai.

(144) *Laryngeal contrasts in Thai*

pʰaː ‘cloth’	baː ‘crazy’	panja ‘brains’	riːp ‘hurry’
pʰjaː ‘title’	bil ‘Bill’	pen ‘alive’	sip ‘ten’
pʰrɛː ‘silk’	bruː ‘fast’	plaː ‘fish’	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 (1998a), 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.

(145)

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

Here is Vaux (1998a: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.

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.[80]

(146)	*Sanskrit*	*English*
a.	bʰrá:tar	brother
	bʰára-	bear
b.	dʰa:-	do, did, deed
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. (Ladefoged and Maddieson 1996:83):

təru 'bottom' vs. *dəru* 'door' vs. *dʰəru* (district name) vs. *tʰəru* 'trunk of body'

Exercises

A. Vaux (1998a:497) claims 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).

(147) *Northern Rustic Dominican Spanish*[81]

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[80] The change PIE **bʱ, *dʱ, *gʱ* > 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

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

a.	/peskaă̤o/	→	pehkaðo	‘fish’
b.	/abispa/	→	aβihpa	‘whasp’
c.	/aros/	→	aroh	‘rice’
d.	/moska/	→	mohka	‘fly’
e.	/d̪if̪̆teria/	→	d̪ihṯerja	‘diphtheria’
f.	/afganis̪tán/	→	ahganihṯáN	‘Afghanistan’
g.	/relox/	→	reloh	‘watch’

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

(148) *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)’

2.5.2.4. [±constricted glottis]

The feature [+constricted glottis] (“glottal adduction”)[82] is widely assumed to be the phonological feature shared by ejectives, implosives, glottalized or laryngealized (“creaky”) sonorants, and glottal stop.[83] 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 (149a), as *ejection* (postglottalization) in alveolar fricatives and velar stops (149b), and as *preglottalization* in glides (149c):

(149) *Hausa* (Ladefoged and Maddieson 1996:86)

	Glottalized		*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’
	k^{w}’a:rà:	‘shea nut’	k^{w}a:rà:	‘pour’
c.	ʔja:	‘daughter’	ja:	‘he’ [comp.]

[82] FYI, vocal folds can also become paralyzed in this position; this is a life-threatening condition (“bilateral abductor paralysis”) which requires immediate tracheostomy! (cf. fn. 79 on p. 78.)

[83] 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 glottalized, 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).

Like the other laryngeal features, [+constricted glottis] can be very restricted in distribution in some languages. In the Wakashan language Nuu-chah-nulth (Sapir and Swadesh 1939, Howe and 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/prevocalic ejectives. Crucially, there are no examples of either word-final or preconsonantal ejectives in Nuu-chah-nulth.

(150) *Surface distribution of ejectives*

a.	*Word-initial*	p'uːʔi	*halibut*	tˡ'aʔak	*water*
		t'uħtˢ'iti	*head*	k'aʃkʷaʔjap	*put things away*
		tˢ'aʔak	*river*	kʷ'isaː	*snowing*
		tɬ'upaː	*sunny*		
b.	*Intervocalic*	tup'aɬ	*sea, ocean*	kʷ'atɬaq	*sea otter belt*
		ʔat'a	*thick*	wik'atɬ	*not*
		qʷajatˢ'iːk	*wolf*	t'akʷ'as	*gills*
		ʔitˡ'aʔap	*to lift*		
c.	*Postconsonantal*	ɬapħsp'at'u	*bird wing*	hitaːq'as	*woods, forest*
		tˢ'imt'uː	*squirrel*	tɬ'ask'asʔiʃ	*the surface is smooth*
		tɬuɬtˢ'uːʔiʃ	*it is clean*	ʔinkʷ'aħs	*lamp, ceiling light*
		ʔimtˡ'aːp	*to play*		

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

(151) *Contrasts between glottalized obstruents and clusters with [ʔ]*

VC'V	t'aʔjatˢ'u	*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 *VC'ʔV*) and glottal stops cannot occur except syllable-initially/prevocalically (explaining the absence of *VʔCV* and *VʔC'V*).

The distribution of ejectives is faithfully repeated by the glottalized sonorants in Nuu-chah-nulth. As with ejectives, glottalized sonorants occur only in prevocalic/syllable-initial position. Examples are given in (152) of word-initial, intervocalic and postconsonantal but prevocalic glottalized sonorants. As with ejectives, there are no examples of either word-final or preconsonantal glottalized sonorants in Nuu-chah-nulth.

(152) *Surface distribution of glottalized sonorants*

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

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

(153) *Contrasts between glottalized sonorants and clusters with [ʔ]*

VR'V	qinħaːˀma	*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.

(154) *Surface distribution of glottal stop*

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

As with both ejectives and glottalized sonorants, a glottal stop may not occur either word-finally or before a consonant. To account for the parallel behavior of ejection in obstruents, creak in sonorants (glottalization is realized as creakiness in the initial portion of glottalized 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 glottalization in syllable-final position:

(155) *Syllable-final glottalization markedness*
*[+constricted glottis] . "Glottalization is not permitted syllable-finally."

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

(156) *Tlingit*

	Alveolar	*Velar*	*Labialized Velar*	*Uvular*	*Labialized Uvular*
Plain	sa:	xa:t	xʷa:s	χe:t	χʷa:l
	'be narrow'	'protrude'	'hang'	'multiply'	'shake, tremble'
Ejective	s'a:	x'a:t	xʷ'a:s'k	χ'e:t'	χʷ'a:s'
	'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 glottalization of some neighboring consonant", and which Blevins (1993:266) interprets as "a floating [constricted glottis] feature". This feature, which accompanies the diminutive /-ʔa:k'/ for example, affects stops (157a) and affricates (157b) as well as sonorants (157c,d). Note, too, that with vowel-final stems (157e) glottalization is realized as [ʔ]. With a single feature, [+constricted glottis], a pattern such as this is straightforwardly accounted for.

(157) *Klamath diminutive*

a.	/Red + n̰epʰ + ʔa:k'/	→	n̰enp'a:k	'distributive little hands'
b.	/Red + pʰetʃʰ + ʔa:k'/	→	peptʃ'a:k	'distributive little feet'
c.	/Red + qtʃʰu:l + ʔa:k'/	→	qtʃʰuqtʃʰu:l̰ a:k	'distributive little star'
d.	/Red + ʔankʰu+ ʔa:k'/	→	ʔaʔankw̰a:k	'distributive little buffalos'
e.	/Red + kʰow̰e + ʔa:k'/	→	kʰokw̰eʔa:k	'distributive little frogs'

Similarly, Buckley (1990:84) 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 glottalizing feature.

(158) *Kashaya*

a.	jahmot + ʔ	→	jahmotʼ	‘it’s a cougar’
b.	tˢʼiʃkan + ʔ	→	tˢʼiʃkaɲ̃	‘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):

(159) *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’)	pʼ (gopʼa ‘look’)
alveolars	t (geta ‘hold on’)	d (goda ‘wash’)	tʰ (gotʰa ‘pick’	tʼ (jõʃtʼa ‘Shawnee’)
alveolar affricates	tˢ (ditˢa ‘I sleep’)	dᶻ (ʔadidᶻa ‘I say’)	tˢʰ (tˢʰja ‘dry’)	tˢʼ (tˢʼa ‘I cry’)
alveolopalatal affricates	tʃ (tʃu ‘boat’)	dʒ (gokʰadʒu ‘armpit’)	tʃʰ (tʃʰu ‘bed’)	tʃʼ (setʃʼa ‘she drowns’)
velars	k (jaka ‘white’)	g (sjoga ‘she rests’)	kʰ (dᶻokʰa ‘flour’)	kʼ (dokʼa ‘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.:[84]

(160) *Uduk* (Ladefoged and Maddieson 1996:82)

		Bilabial		*Alveolar*	
[–voice, –constr. gl.]	*voiceless*	pàl	‘to try’	tèr	‘to collect’
[+voice, –constr. gl.]	*voiced*	baʔ	‘to be something’	dèɗ	‘to shiver’
[–voice, +constr. gl.]	*ejective*	pʼàcʰàɗ	‘fermented’	tʼèɗ	‘to lick’
[+voice, +constr. gl.]	*implosive*	ɓàʔ	‘back of neck’	ɗek’	‘to lift’

[84] Uduk additionally has contrastively aspirated consonants, e.g.:

[–voice, +spread gl., –constr. gl.] pʰàlal ‘centipede’ tʰèr ‘to pour off’

2.5.3. Tone

As discussed in section 2.5.2.2 above, the feature [+voice] characterizes segments produced with vocal fold vibration. As it happens, the *rate* of this vibration is also linguistically significant: segments produced with relatively many vibrations of the vocal folds are perceived as high in pitch, while segments produced with relatively few vibrations of the vocal folds are perceived as low in pitch. In this section we look at languages that use pitch levels to distinguish words from each other. More than half of the world's languages are *tonal* in this sense, including such major languages as Standard Chinese (0.9 billion speakers), Yoruba (20 million) and Swedish (9 million) (Yip 2003:1). Two tonal features are introduced below: [±upper] and [±raised] (Yip 2003, Hyman 2003:264-5).[85]

2.5.3.1. [±upper register]

The feature [±upper register] characterizes the distinction between high and low tone, indicated with the IPA diacritics ˊ and ˋ respectively (Yip 1980, 2003, Pulleyblank 1986, Fox 2000). In current practice, most phonologists use H for [+upper register] and L for [-upper register]. As a first example of this contrast, consider Heiltsuk (Kortlandt 1975, Rath 1981), a Wakashan language spoken in Waglisla (Bella Bella) and Klemtu, British Columbia. Each syllable peak in Heiltsuk words is either H or L, as shown in (161-163). Phonetically, according to Lincoln and Rath (1980:11-2) "[t]he actual difference of pitch between high and low tone varies, but in slow speech it can be as much as the musical interval of a fourth." Note that syllable peaks in Heiltsuk may be vowels (161a-c, 162a-b, 163) as well as sonorant consonants (161d-f, 162c-d).

(161) *Some monosyllabic words in Heiltsuk*

a.	kʲʷás	'mussel(s)'	d.	sm̓s	'mouth'
	kʲʷàs	'to sit outside'		dᶻm̓s	'buried in the ground'
b.	ɢíχs	'in the canoe for long'	e.	ɬn̓χ	'wild crabapple'
	lìχ	'red cedar'		pn̓ɬ	'to have a blister'
c.	kʲús	'not'	f.	qʲʷl̓kʷ	'fish stew'
	qʲùs	'lake'		wl̓kʷ	'(s. o.) arrested'

(162) *Some disyllabic words in Heiltsuk*

a.	ʔéxstù	'clear, bright'	c.	kʲl̓xsm̓	'Hudson's Bay blanket'
	ʔèxstús	'generous'		kʲl̓xsm̓t	'to tie up a bundle'
b.	qʲúsʔìt	'to start paddling'	d.	sn̓dn̓	'louse eggs, nits'
	qʲùsʔít	'to become a lake'		ɢn̓χsn̓	'one's left hand'

[85] These two features were first proposed by Gruber (1964) as [±High] and [±High2]. They were relabeled [±upper] and [±raised] respectively by Yip (1980) and Pulleyblank (1986) respectively. For recent discussions of tone features, see especially Yip (2003:39-64) and Fox (2000:200-212).

(163) *Some trisyllabic words in Heiltsuk*

HHH	láxʷíwá	'kerchief'	HHL	lákásù	'to be approached by'
LHH	làxsíwá	'to go through'	HLH	lájˀàxɬˢí	'to go away'
LLH	làxstàʔítˢ	'to go to bed'	LHL	làʔésʔìt	'to start to set'
HLL	láχàmàs	'to let sth. down'	LLL	lànùgʷà	'me (perf.)'

Many Athabaskan languages of North America are also tonal. The examples in (164) illustrate the contrast between H and L in Tanacross, an Athabaskan language of Alaska (Holton 2000).

(164) *Tanacross* (Holton 2000:76)

a.			b.		
	tɬ́é:s	'charcoal'		tɬ̂ù:ɬ	'rope'
	t͡sʰáʔ	'beaver'		sà:	'sun'
	kʰónʔ	'fire'		tʰù:	'water'
	t͡θɬ́é:x	'sinew'		sè:kʰ	'saliva'
	tɬ́éjʔ	'fly'		tʰɬ̂ej	'trail'

Interestingly, Tanacross tones are the opposite of those found in the neighboring Athabaskan language Upper Tanana (Tuttle 1998), as illustrated here:

	Tanacross	*Tanana*		*Tanacross*	*Tanana*	
(165)	tʰé:ʒàh	tʰè:ʒáh	'he left'	ká:nʔ	kànæ̀ʔ	'arm'
	ɣ̀ihhà:ɬ	íhhá:ɬ	'I am going'	-gótʰ	-gòtʰ	'knee'
	t͡sʰáʔ	t͡sʰàʔ	'beaver'	-ðɛ́tʰ	-ðətʰ	'liver'
	kʰéʔ	kʰæʔ	'foot'	kʰónʔ	kʰòn̥ʔ	'fire'
	tʰáʔ	tʰàʔ	'father'	ðɬ̂ihɬ̂t͡sɬ̂ìn	ðíɬɬ̂t͡sín̥	'you made it'

Similarly, opposite tones are found in the Athabaskan languages Hare and Sekani spoken in British Columbia (Rice 1999, Yip 2003:241):[86]

	Hare	*Sekani*	
(166)	jáʔ	jàʔ	'louse'
	tɛ́ʔ	tèl	'cane'
	wɬ́áʔ	t͡sɬ̂àʔ	'dish'
	tù	tú	'water'

[86] See also Kingston (2002) on Chipewyan vs. Gwich'in Athabaskan. Opposite tones also occur in two dialects of Japanese, Narada and Tokyo, as shown in the following data (Kim 1999:286, Chang 2002:33).

Narada	*Tokyo*	
kágàmì-gá	kàgámí-gà	'mirror'
kàbútò-ga	kábùto-ga	'helmet'
kókòró-ga	kòkórò-ga	'heart'

In comparison to other features, tone is peculiar in that segments are permitted to carry more than one tonal feature in some languages. Each of the tones illustrated so far has been a *level* tone:

> "one in which, within the limits of perception, the pitch of a syllable does not rise or fall during its production." (Pike 1948:5)[87]

But there is another type of tone, known as *contour*:[88]

> "one in which during the pronunciation of the syllable on which it occurs there is a perceptible rise or fall, or some combination of rise and fall, such as rising-falling or falling-rising." (ibid.)[89]

Special contour features such as [±falling] and [±rising] were employed in early studies of tone (e.g., Gruber 1964, Wang 1967), but contours have since been identified with sequences of levels (Woo 1972, Goldsmith 1976a, 1976b, Anderson 1978, et seq.), an understanding that is reflected in IPA diacritics:

falling ◌̂ = ◌́ + ◌̀ *rising* ◌̌ = ◌̀ + ◌́ *falling-rising* ◌᷄ = ◌́ + ◌̀ + ◌́ *rising-falling* ◌᷅ = ◌̀ + ◌́ + ◌̀

For example, in Tanacross the tone of a vowel can be level high or level low, as seen above in (164), but any given vowel may also have a falling tone (IPA ◌̂) or rising tone (IPA ◌̌), as shown in (167). These contour tones are assumed to be H + L and L + H, respectively.

(167) *Contour tones in Tanacross* (Holton 2000:79)

Falling		*Rising*	
tə̂j	'spring'	xə̌ːθ	'raft'
mâːɣ	'shore'	t͡sə̌tʔ	'blanket'
t͡ʃə̂k	'berries'	t͡ʃʰə̌ɣʔ	'his quill'
nûːn	'animal'	mlə̌ːkʔ	'his fish'

In support of this interpretation, Holton (2000:78) suggests that Tanacross words with contours derive historically from longer words with level tones, i.e., *CV́CV̀ > CV̂, *CV̀CV́ > CV̌.[90]

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[87] In practice, a level tone may involve a small phonetic (but phonologically insignificant) change in pitch. Maddieson (1978) as well as Yip (2003:22-3) define a level tone as 'one for which a pitch level is an acceptable variant'.

[88] It has been claimed that a language will only have contour tones if it also has level tones, but not vice versa (Maddieson 1978, contra Pike 1948). If correct, this suggests that levels are necessary for contours.

[89] Pike called contours *gliding* tones.

[90] Synchronic evidence for the compositional nature of Tanacross contours is described below, in (175).

This diachronic scenario is confirmed by synchronic alternations in other languages.[91] For instance, in the Bantoid language Tiv (Nigeria: Pulleyblank 1986) root-final vowels regularly delete when not followed by a suffix (such as infinitival *-n*). The tone of the deleted vowel survives (*tonal stability*) and a contour is created when this tone links to a preceding vowel with a different tone, e.g.:

(168) *Tiv* (Pulleyblank 1986:219)

a. L H → L H — [bĕr] — 'pond'
bere → ber

b. H L → H L — [kêr] — 'seek!'
kere → ker

c. L H L → L H L — [ŋgòhôr] — 'accepted (recently)'
ŋgohoro → ŋgohor

Similarly, in the Cross River language Efik (Nigeria: Westermann and Ward 1933:149-50) when two vowels are brought together, the first one deletes and leaves behind its tone. The H tone of the deleted vowel reattaches to the remaining vowel, notwithstanding that this vowel already has a L tone. Thus the remaining vowel begins with H but ends with L, yielding a falling tone.

(169) *Efik* (Westermann and Ward 1933:149-50, Fox 2000:217-8)

a. H L H → H L H
ké + ùbóm → kûbóm — 'in the canoe'

b. H L L → H L L
ké + ùruà → kûruà — 'in the market'

In the Chadic language Hausa (Nigeria: Newman 1995, Jagger 2001), too, some two-syllable words with level tones have contracted, one-syllable variants with contours. Several examples illustrate this correspondence between levels and contours in (170).

[91] On 'diachronic' *vs.* 'synchronic', see fn. 13 on p. 1.

(170) *Hausa* (Newman 1995, Jagger 2001)

a. H L ~ H L
   | | ╲╱ [zá:nì] ~ [zân] 'I will'
   za:ni zan

b. H L ~ H L
   | | ╲╱ [mínì] ~ [mîn] 'to me'
   mini min

c. H L ~ H L
   | | ╲╱ [másà] ~ [mâz] 'to him'
   masa maz

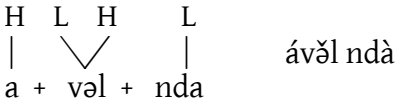
Another compelling argument that contours are compositional comes from so-called 'polarity' items. These are morphemes whose tone is always contrary to that of an adjacent root. For example, many clitics and affixes in the Chadic language Marghi are 'polar' in this sense, as described in Pulleyblank (1998:68-9, cf. 1986:203ff.):

> "When certain subject clitics follow a nominal or verbal predicate, their surface tone is variable. If the predicate bears a low tone, then the clitic itself is high; if the clitic bears a high tone, then the clitic is low. That is, the clitic bears bears the *opposite* tone to the root to the root, hence the label of polarity. Examples follow:
>
> (171) *Polarising subject clitics*
> a. hàgʲì gʊ́ 'you are a Higi'
> b. màrgʲí gʊ̀ 'you are a Marghi'
>
> In an entirely analogous fashion, certain prefixes exhibit tonal polarity. For example, the prefix *a*, a marker of the present tense, surfaces as H before a low tone verb and as L before high tone verb.
>
> (172) *Polarising tense prefixes*
> a. á-wì ⁿdá 'they run'
> b. à-sá ⁿdà 'they err'
>
> The examples in [(172)] also serve to demonstrate the polarity of the subject clitic *nda*, third person plural, which patterns like *gʊ* in being high after a low tone predicate and low after a high tone predicate.
>
> With the above discussion of polarity as background, consider now the tonal effect observed when a polarising prefix and a polarising clitic are added to a root belonging to the rising tone class. In such a case, the prefix surfaces as H and the clitic as L:

(173) *Polarising morphemes with a rising tone root*
á-vǎl ndà 'they fly'

Until this case, a tense prefix and subject clitic always exhibited the same tone, both morphemes H in [(172a)] and both morphemes L in [(172b)]. It might therefore seem surprising that in this case the tones of prefix and clitic differ. In particular, if a contour was not decomposed into a sequence of level tones, one would expect its behaviour to be uniform, like the behaviour of simple high and simple low tones. If the analysis of this chapter is adopted, however, then the properties of polarity are exactly as expected. As seen in the structure of [(174)], the prefix is H because it is adjacent to a L (the first component of the rising contour); the postverbal clitic, however, is L because it is adjacent to a H (the second component of the rising contour)."

(174) *Polarising morphemes with a rising tone root: the structural configuration*



Focusing now on floating tone features, Holton (2000:79ff.) argues that the possessive suffix *-ʔ* in Tanacross carries a floating H which produces a rising contour when added to a root vowel that is already L, e.g. (175a). Likewise, Holton claims that the nominative morpheme consists of two floating features: [+voice] and L. Crucially, a falling contour results from the floating L linking to a H-tone root, e.g. (175b).

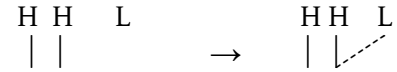
(175) *Contour tone formation in Tanacross* (Holton 2000:79ff.)

a. L H → L H
t͡ʃʰox -ʔ tʃʰoɣʔ [t͡ʃʰǒɣʔ] 'his quill'
quill his

b. H L → H L
me:tˢ [+voi] me:dᶻ [mêːdᶻ] 'the fish'
fish NOM

Likewise, the definite article 'the' in Hausa is a suffix with a L-tone which causes a preceding H to become falling, e.g.:

(176) *Contour tone formation in Hausa* (Newman 1995, Yip 2003:48)



[gídân] 'the house'

Limburgian Dutch provides another example: Hermans (1991) argues that the feminine morpheme in this dialect is a floating L which produces a falling contour when added to a high tone stem, e.g.:

(177) *Limburgian Dutch* (Hermans 1991, Alderete 2001:275-6)

		FEM.	
a.	wí:s	wî:s	'wise'
b.	stí:f	stî:f	'stiff'
c.	ká:l	kâ:l	'bald'
d.	lá:m	lâ:m	'paralyzed'
e.	brú:n	brû:n	'brown'
f.	fí:n	fî:n	'refined'
g.	tá:m	tâ:m	'tame'

Interestingly, in some cases floating low tones are prevented from linking to a nearby vowel, resulting in a phenomenon known as *downstep* (Ford and Clements 1978, Clements and Ford 1979, Clements and Goldsmith 1980, Pulleyblank 1986).[92] For instance, in Dschang (Nicole 1980, Stewart 1981, Pulleyblank 1986:38ff.) the preposition *è* 'of' deletes in rapid speech:

(178) a.

[sáŋ è sáŋ] 'bird of bird'

b.

[sáŋ ꜜ sáŋ] 'bird of bird'

c.

[sáŋ ꜜ sáŋ ꜜ sáŋ ꜜ sáŋ ...] 'bird of bird of bird of bird ...'

As represented in (178b,c) the tone of deleted *è* (encircled L) does not reattach, yet it seems to linger phonologically: the H-tone of the second *sáŋ* 'bird' in (178b) is realized at a phonetically lower pitch than the H-tone of the first *sáŋ*; likewise, the H-tone of *sáŋ*

[92] For an alternative approach to downstep, see Odden (1982) and Clark (1990).

has a progressively lower pitch after each deleted *è* in (178c). Such phonetic lowering is called downstep and is represented in writing by a raised exclamation mark (ꜜ).

Another example of downstep is provided by Tiv (Pulleyblank 1986:34). Recall that this language has contour tones, e.g. (168). In fact, its contours are permitted only at the ends of phrases. Phrase-medially, contours are lost, as illustrated in (179-181). Crucially, when L is delinked from a contour, it triggers a downstep (ꜜ) in a following H, as Pulleyblank (1986:28-30) discusses:

> There is a floating L-tone in the phonological representation ... Such a floating tone appears on the tonal tier but is not linked to any vowel; as a consequence, it is not itself pronounced although it does trigger downstep. ... [A] downstepped H-tone is realized on a slightly lower pitch than a preceding H-tone; the pitch-drop in a HꜜH sequence is considerably less than the drop in a HL sequence.

(179) a. H H H L — íwá ŋgî — dogs be — 'there are dogs'

b. H H H (L) H L L — íwá ŋgí ꜜ jévèsè — dogs be fleeing — 'the dogs are fleeing'

(180) a. L L H L — kásév ᵐbâ — women be — 'there are women'

b. L L H (L) H — kásév ᵐbá ꜜ gá — women be not — 'there aren't women'

(181) a. H L — ùnʲìnʲà ᵐbâ — horses be — 'there are horses'

b. H (L) H L — ᵐbá ꜜ vân — be coming — 'they are coming'

One last curiosity worth mentioning is that tonal features exhibit mobility in some languages (Yip 2003:66ff.): a tone can move far from its original, lexical location. For example, in the Bantu language Chizigula (Kenstowicz and Kisseberth 1990), the H tone of a verb root moves rightward to the before-last[93] vowel in a word, as illustrated in (182a). The examples in (182b) show that no H tone appears on the before-last vowel if the verb root has no H.[94]

(182) *H mobility in Chizigula* (Kenstowicz and Kisseberth 1990:166)

a.	/ku-lómbez-a/	→	[kùlòmbézà] 'to request'
	/ku-lómbez-ez-a/	→	[kùlòmbèzézà] 'to request for'
	/ku-lómbez-ez-an-a/	→	[kùlòmbèzèzánà] 'to request for each other'

[93] Phonologists often refer to the before-last vowel or syllable as *penult* (or *penultimate*).

[94] Note that tonal mobility in somewhat easier to comprehend if only H tones are specified, that is, if L tones are lexically unspecified in Chizigula. Indeed, this is what most Bantu phonologists assume.

b.	/ku-damanj-a/	→	[kùdàmànjà]	'to do'
	/ku-damanj-iz-a/	→	[kùdàmànjìzà]	'to do for'
	/ku-damanj-iz-an-a/	→	[kùdàmànjìzànà]	'to do for each other'

In the same vein, according to Kenstowicz and Kisseberth (1990:166-7),

> The third person subject prefixes *a-* 'he, she' and *wa-* 'they' consistently impose a High tone on the verb ... The High contributed by the third person does not surface on the prefix itself, but rather appears on the penult[95] syllable. In [(183)] we see this prefixal High tone realized at greater and greater distances from the prefix where it originates, but always on the penult syllable of the word.

(183) *H mobility in Chizigula* (Kenstowicz and Kisseberth 1990:167)

a.	/ku-gulus-a/	→	[kùgùlùsà]	'to chase'
	/á-a-gulus-a/	→	[àgùlúsà]	'he/she is chasing'
	/wá-a-gulus-a/	→	[wàgùlúsà]	'they are chasing'
b.	/ku-songoloz-a/	→	[kùsòngòlòzà]	'to avoid'
	/á-a-songoloz-a/	→	[àsòngòlózà]	'he/she is chasing'
	/wá-a-songoloz-a/	→	[wàsòngòlósà]	'they are chasing'
c.	/ku-hugusahugus-a/	→	[kùhùgùsàhùgùsà]	'to shell repeatedly'
	/á-a-hugusahugus-a/	→	[àhùgùsàhùgúsà]	'he/she is chasing'

Another example of tonal mobility is provided by so-called 'accent-shifting' morphemes in Japanese. These are affixes which attract the H tone of stems they attach to.[96] For instance, when the agentive suffix *-te* or the particle *nagaɾa* 'though, in spite of' are added to a stem with H, this tone migrates onto them, as shown in (184a) and (185a). (The (b) examples show that these morphemes only trigger mobility if they attach to a stem with H.)

(184) *-te* '*-er*' (Poser 1984:337, Alderete 2001:287)

a.	/káki-te/	→	[kàkìté]	'writer'
	/jómi-te/	→	[jòmìté]	'reader'
b.	/kataɾi-te/	→	[kàtàɾìtè]	'narrator'
	/kiki-te/	→	[kìkìtè]	'hearer'

(185) *nagaɾa* '*though, in spite of*' (McCawley 1968:166-7, Alderete 2001:287)

a.	/ínoti-nagaɾa/	→	[ìnòtìnágàɾà]	'in spite of life'
b.	/mijako-nagaɾa/	→	[mìjàkònàgàɾà]	'in spite of the city'

[95] See fn. 93.

[96] It is standardly assumed that only H is lexically specified in Japanese, as in Bantu; see fn. 94.

Similarly, when added to stems with H, the suffixes *-ja* 'keeper/seller' and *-mono* 'thing' attract this H to the vowel that precedes them, as shown in (186a) and (187a). (Again, the (b) examples illustrate that these suffixes only trigger an effect when they attach to a stem with H.)

(186) *-ja 'keeper, seller of/house of X'* (Poser 1984, Alderete 2001:286)

a.	/kúzu-ja/	→	[kùzújà]	'junk man'
	/sóba-ja/	→	[sòbájà]	'noodle house'
	/koná-ja/	→	[kònájà]	'flour seller'
	/nomí-ja/	→	[nòmíjà]	'bar, saloon'
b.	/kabu-ja/	→	[kàbùjà]	'stockbroker'
	/toma-ja/	→	[tòmàjà]	'mat seller'

(187) *-mono 'thing'* (Poser 1984, Alderete 2001:286)

a.	/káki-mono/	→	[kàkímònò]	'scroll'
	/jómi-mono/	→	[jòmímònò]	'reading matter'
b.	/noɾi-mono/	→	[nòɾìmònò]	'vehicle'
	/wasuɾe-mono/	→	[wàsùɾèmònò]	'forgotten item'

Exercises:

A. Consonants and vowels get deleted when individual words are combined into phrases in Lomongo (Bantu: Congo):

a.	bàlóngó bǎkáé	→	bàlóngə̃́káé	'his book'
b.	bɔ̌mɔ̌ bòmtámbá	→	bɔ̌mɔ̃̌támbá	'another tree'

Name and describe the property exhibited by tone in these cases of deletion. What is the significance of this phenomenon?

B. Try to explain tonal alternations in the interrogative suffix of Mahou (a.k.a. Mau), a Manding language spoken in the Ivory Coast (Bamba 1984, 1991). (N.B.: Mahou has no contour tones.)

(188) *Mahou* (Prunet 1992:12)

a.	sí	'seed'	b.	sí-á	'a seed?'
	sí	'fly'		sí-à	'a fly?'
b.	bá	'river'		bá-á	'a river?'
	bá	'mother'		bá-à	'a mother?'

C. The following sentences are from Mono-Bili (Merrifield et al. 1967:31, Jensen 1990:74). Figure out how tenses (past, future) are conjugated in this language of the Congo.

a.	àbá dá mɨ̀	'Father spanked me'
	àbá dà mɨ̀	'Father will spank me'
b.	kòmbá zɨ́ g͡bàgà	'The bird ate the peanut'
	kòmbá zɨ̀ g͡bàgà	'The bird will eat the peanut'
c.	múrú wó ʃè	'The leopard killed him'
	múrú wò ʃè	'The leopard will kill him'
d.	àbá dá ʃè	'Father spanked him'
	àbá dà ʃè	'Father will spank him'

2.5.3.2. [±raised pitch]

The feature [±upper register] suffices to characterize most tonal systems. For instance, the famous four tones of Standard Chinese can be understood in terms of just H ([+upper register]) and L ([–upper register]), e.g.:[97]

(189) *Standard Chinese* (Duanmu 2000:220)

H	má	'mother'	H	tᶜiáo	'teach'
L	mà	'horse'	L	tᶜiào	'mix'
HL	mâ	'scold'	HL	tᶜiâo	'call'
LH	mă	'hemp'	LH	tᶜiăo	'chew'

But [±upper register] differentiates at most two levels of tone, whereas some languages make out as many as four distinct levels of pitch.[98] Such is the case, for instance, in Grebo, a Kru language spoken in Liberia (Newman 1986, Yip 2003:145), e.g., (190), in Cantonese (Yip 1980, 2003:175), e.g., (191), and in Chiquihuitlán Mazatec, a Popolocan language of Mexico (Jamieson 1977, Yip 2003:216), e.g., (192). The new IPA diacritics ˝ and ˉ in (191-190) designate 'extra-high' and 'mid' level tones, respectively.

---

[97] In the *phonetics* of Standard Chinese, LH is realized as a rise in pitch from mid to high, rather than from low to high, while L is implemented as a low dip, often followed by a small rise in pitch phrase-finally. Duanmu (2000:212) observes:

> One may suspect that [mid-to-high] and [low-to-high] probably contrast in other Chinese dialects, but in fact they never do (Bao 1990b:123). Similarly, to my knowledge, [low dip] and [low level] never contrast.

In other words, there is no *phonological* difference between mid-to-high and low-to-high contour tones, nor between low dip and low level tones.

[98] We assume a maximum of four levels, in agreement with noted tonologists such as Yip and Hyman (2003:263): "The few languages that have been claimed to have five contrastive tone heights may be subject to reanalysis."

(190) *Grebo*

tő	'store'
ná	'fire'
mɔ̄	'you (sg.)'
fɛ̃̀	'herring'

(191) *Cantonese*

sǐː	'poem'
síː	'to try, taste'
sīː	'affair, undertaking'
sìː	'time'

(192) *Chiquihuitlán Mazatec*

tʃʰɛ̃́	'I talk'
tʃʰá	'difficult'
tʃʰā	'his hand'
tʃʰà	'he talks'

The feature [±raised pitch] (Gruber 1964, Yip 1980, Pulleyblank 1986)[99] is used to divide each of [+upper register] and [–upper register] into two halves, totaling four pitch levels, as represented in (193). Note that most phonologists use lower case h and l for [+raised pitch] and [–raised pitch], respectively. (Cf. upper case H/L for [±upper register].)

(193) *Features for languages with four levels*

+upper register (H)	+raised pitch (h)	'extra-high'
	–raised pitch (l)	'high'
–upper register (L)	+raised pitch (h)	'mid'
	–raised pitch (l)	'low'

The four tones of Grebo illustrated in (190) are represented with H/L and h/l in (194a-d). In addition to these level tones, Grebo has two rising contours which both combine l and h: one within H ('high-rising'), the other within L ('low-rising'). Two examples are presented in (194e,f), from Yip (2003:145, Newman 1986).

(194)

a.	b.	c.	d.	e.	f.
H h	H l	L h	L l	H l h	L l h
to	na	mɔ	fɛ̃	ni	g͡be
'store'	'fire'	'you (sg.)'	'herring'	'water'	'dog'

Cantonese has a comparable inventory of tones, as illustrated in the following paradigm (Yip 1980, 2003:2):

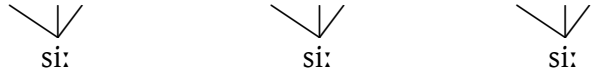
(195)

a.	b.	c.	d.	e.	f.
H h	H l	L h	L l	H l h	L l h
jaw	jaw	jaw	jaw	jaw	jaw
'worry'	'thin'	'again'	'oil'	'paint'	'have'

In fact, Cantonese allows three contours: l + h within H ('high-rising'), h + l within H ('high-falling'), and l + h within L ('low-rising'). Thus the words *sǐː* 'to cause, make', *sīː* 'silk' and *sìː* 'market, city' (Yip 1980, 2003:175) can be added to the paradigm from (191):

[99] We will adopt Pulleyblank's term [±raised] instead of Yip's (1980, 2003) [±high] (cf. Gruber's [±high2]) to avoid confusion with the Tongue Body feature (see also Hyman 2003:264-5). Pulleyblank (1986:125) credits Morris Halle (p.c.) for this suggestion.

(196) a. H l h b. H h l c. L l h



'to cause, make' 'silk' 'market, city'

Many tonal languages differentiate only three levels of pitch: high, mid and low. Examples include Tsúùt'ínà (Sarcee), a language spoken in Calgary, Alberta (Athabaskan: Cook 1971:168), Thai, the official language of Thailand (Austro-Tai: Gandour 1974, Yip 2003:202), and Nupe, a language of Nigeria (Nupoid: George 1970, Yip 2003:144).

(197) *Tsúùt'ínà*

míɬ	'moth'
mīɬ	'snare'
mìɬ	'sleep'

(198) *Thai*

kʰáː	'to engage in trade'
kʰāː	'be stuck'
kʰàː	'a kind of spice'

(199) *Nupe*

bá	'to be sour'
bā	'to cut'
bà	'to pray'

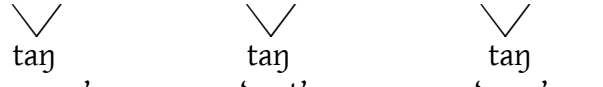
Languages which make a three-way distinction among level tones do not differentiate between [–upper, +raised] ([L, h]) and [+upper, –raised] ([H, l]); both are realized phonetically as 'mid' as shown in (200).[100]

(200) *Features for languages with three levels*

+upper register (H)	+raised pitch (h)	'high'
	–raised pitch (l)	'mid'
–upper register (L)	+raised pitch (h)	
	–raised pitch (l)	'low'

Of the two possible specifications for mid tone, [–upper, +raised] is preferred, because [–upper] is less marked than [+upper] (for extensive discussion, see Pulleyblank 1986, Yip 2003). So for instance, the Min dialect Chaoyang (Zhang 1979, 1981, 1982, Yip 1994:2) has three level tones: high (201a), mid (201b) and low (201d). Here, the mid tone is assumed to be [L, h] rather than [H, l].

(201) a. H h b. L h c. L l



'bronze' 'east' 'cave'

[100] To explain this, Yip (2001:310) suggests that tone is guided by the following principles of phonetic interpretation:

(i) The pitch space is exhaustively and equally partitioned into registers.
(ii) Within a register, a [h] is realized at the upper limit of that register, and a [l] is realized at the lower limit of that register, *unless...*
(iii) contrast preservation requires that two tones be kept distinct.

Chaoyang additionally has three contour tones: high-falling (202a), low-rising (202b) and mid-falling (202c). Crucially, [H, l] and [L, h] are both considered mid-tone, so the end point of the first contour ('high-to-mid'; IPA ˧˥) corresponds phonetically to the end point of the second contour ('low-to-mid'; IPA ˨˧), and also to the beginning pitch of the third contour ('mid-to-low'; IPA ˧˨).

(202)

a.	b.	c.
H h l	L l h	L h l
taŋ	taŋ	taŋ
'political party'	'heavy'	'jelly meat'

Wuming Zhuang, a Tai language of China (Snyder and Lu 1997, Yip 2003:204-5) likewise has high (203a), mid (203b) and low (203c) level tones as well as high-rising (203d), low-rising (203e) and mid-falling (203f) contour tones. Here, too, the beginning pitch of the first contour ('mid-to-high'; IPA ˧˦) corresponds phonetically to the end pitch of the second contour ('low-to-mid' ˨˧), and also to beginning pitch of the third contour ('mid-to-low'; IPA ˧˨).

(203)

a.	b.	c.
H h	L h	L l
ha	taɯ	mɯŋ
'five'	'chopsticks'	'you'

d.	e.	f.
H l h	L l h	L h l
sɯi	pai	ɣam
'to wash'	'to go'	'water'

The phonetic equivalence of [L, h] and [H, l] in a three-level language can also be illustrated with Tsúùt'ínà (e.g., (197)). The second person singular morpheme in this Athabaskan language is simply H, which raises the tone of the vowel preceding the verb root. If that vowel is mid-tone [L, h], it changes to high-tone [H, h] in the second person singular, as shown in (204a) and (205b). (Cf. (204b,c), (205b,c).)

(204) *Mid-to-high raising in second person singular* (Cook 1971:171-5, 1984:141)

a.	L h	H	L l			
	ni-		tʰàh	→	[nítʰàh]	'you'll lie down'
	FUT	2s	'lie'			
b.	nī-	s-	tʰàh	→	[nīstʰàh]	'I'll lie down'
	FUT	1s	'lie'			
c.	nī-	Ø	tʰàh	→	[nītʰàh]	'he'll lie down'
	FUT	3s	'lie'			

(205) *Mid-to-high raising in second person singular* (Cook 1971:171-5, 1984:141)

a.	L l	L h	H	H h			
	na-	si-		tʰin	→	[nàsítʰín]	‘you dreamt’
	MOD	PERF	2s	‘dream’			
b.	nà-	sī-	s-	tʰín	→	[nàsīstʰín]	‘I dreamt’
	MOD	PERF	1s	‘dream’			
c.	nà-	sī-	Ø	tʰín	→	[nàsītʰín]	‘he dreamt’
	MOD	PERF	3s	‘dream’			

If the vowel preceding the verb root is low-lone [L, l], it is raised to mid-tone [H, l] in the second person, as shown in (206a) and (207a); cf. (206b), (207b). Crucially, the mid-tone resulting from [L, l] → [H, l] corresponds phonetically to the other mid-tone [L, h] which is found more generally, e.g., (204b,c), (205b,c), (207).

(206) *Low-to-mid raising in second person* (Cook 1971:171, 174-5)

a.	L l	L l	H	L l			
	i-	ti-		ʔiʃ	→	[ìtīʔìʃ]	‘you are kicking’
	EPEN	PERF	2s	‘kick’			
b.	ì-	tì-	Ø	ʔìʃ	→	[ìtìʔìʃ]	‘he is kicking’
	EPEN	PERF	3s	‘kick’			

(207) *Low-to-mid raising in second person* (Cook 1971:171, 174-5)

a.	L l	H	L h				
	ku-		na		→	[kūnā]	‘you are talking’
	IMP	2s	‘talk’				
b.	kù-	Ø	nā		→	[kùnā]	‘he is talking’
	FUT	3s	‘lie’				

Finally, if the vowel preceding the verb root is already high-tone, it undergoes no change in the second person singular, e.g. (208a); cf. (208b).

(208) *No raising in second person* (Cook 1971:171-5, 1984:217)

a.	tí-	H	t͡sʰàɬ	→	[tít͡sʰàɬ]	‘you’ll throw (a stone)’
	INCEP	2s	‘throw’			
b.	tí-	s-	t͡sʰàɬ	→	[tíst͡sʰàɬ]	‘I’ll throw (a stone)’
	INCEP	1s	‘throw’			

> *'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.

2.6. Intrasegmental phonology: conclusion

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 realized without aspiration by French speakers. The feature [+nasal] is licit in the grammars of both French and English,[101] 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 recognized. For instance, Pericliev and Valdés-Pérez (2002) report that in the vast majority of languages with multiple idiosyncratic phonemes (approximately 92%), the idiosyncracy is *shared* in terms of features. To illustrate: Akan has the unusual segments /ç^{w}, c$^{ç w}$, ɟ$^{j w}$, ɲ^{w}/; 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.

In classical generative phonology (Chomsky and Halle 1968), certain intrasegmental combinations of features were banned in any given language by 'linking' rules. For example, the combination of features for a labial fricative could be banned by (209).

(209) A 'linking' rule à la Chomsky and Halle (1968)

$$[-\text{sonorant}] \rightarrow [-\text{continuant}] / \begin{bmatrix} \text{labial} \\ \text{\_\_\_\_} \end{bmatrix}$$

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

As Chomsky and Halle recognized, linking rules such as the one just given cannot be wholly language-specific since they normally reflect universal tendencies, i.e. *markedness* (see Trubetzkoy 1939, Jakobson 1941 on Markedness Theory). For example, compare the rule in (209) with Sherzer's (1976:258) implicational statement (63) on p. 41. Since only languages without (209) 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 and 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 (209) is thus a good candidate for grammaticalization because it results in a relatively less marked phonological system (Sherzer 1976:258). In contrast, an equally logical rule such as (210) is less likely to become grammaticalized because it would result in an increase of relative markedness (a system with labial fricatives but no labial stops).

(210) A logically possible but implausible linking rule

$$[-\text{sonorant}] \rightarrow [+\text{continuant}] / \begin{bmatrix} \text{labial} \\ \text{\_\_\_\_} \end{bmatrix}$$

Suppose, then, that the grammar of a language includes a markedness-motivated language-particular rule like (209) 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 and 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.[102]

[102] This contradiction persists even in modern theories where rules like (209) are reinterpreted as 'persistent' feature-changing rules (Mohanan 1991, Myers 1991, Halle et al. 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 (see esp. Kiparsky 1982b, 1982a, 1985, Pulleyblank 1986). 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 (i) (cf. (209)) 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

This problem stems from the fact that markedness is not incorporated directly into the grammatical analysis. A popular recent theory in phonology, Optimality Theory (OT: Prince and Smolensky 1993) avoids this problem by recognizing the grammatical status of markedness constraints. OT assumes that all languages share a universal set of *markedness* constraints on features and/or their combinations, such as *[labial, +continuant], *[+spread glottis], *[+nasal, –consonantal], and *[+round, –anterior]. Each such constraint ranks high in many grammars, so that potential words with labial fricatives, or aspirated segments, or nasalized vowels, or labialized 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 [f], [h], or [õ], or [ɲʷ], are indeed attested.

Interestingly, OT 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. Moreover, in OT 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. For more information on this approach to segment inventories, see Pulleyblank (1997), Archangeli and Langendoen (1997), Kager (1999), McCarthy (2001), and de Lacy (2002).

A final point: the number and diversity of attested segments among languages is also predicted by our conception of phonological features as articulatory, rather than acoustic.[103] Consider the fact that many languages have gigantic consonantal invento-

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be part of Universal Grammar. Consequently, redundancy rules simplify segment inventories without necessarily adding to the complexity of the language-specific portion of grammars.

(i) *An underspecification-theoretic redundancy rule*

$$[\ ] \rightarrow [-\text{continuant}] / \begin{bmatrix} -\text{sonorant} \\ \text{labial} \\ \_\_\_\_\_ \end{bmatrix}$$

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 (i) do not simply replace rules like (209). To see this, consider again the alleged adaptation of English labial fricatives into Oowekyala, e.g. (64). The redundancy rule (i) 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 > bankʷuba in Oowekyala, one needs to posit the independent existence in Oowekyala grammar of some structure changing rule like (209) (see Mohanan 1991, Myers 1991).

[103] Incidentally, the use of articulatory features in segmental phonology does not reduce the latter to articulatory phonetics, as Halle (2002a:8) describes:

> [F]eatures serve not only as instructions to articulatory actions; they also make up the representations of words and morphemes in speakers' memories and all intermediate representation that arise in the course of the computation of the surface representation. The fact that features serve as instructions for articulatory actions is relevant only

ries: for instance, Hmong (Miao-Yao: Haudricourt 1970:224) has 60 consonants, Ubykh (Northwest Caucasian: Colarusso 1988:438) has 81, Marghi (Chadic: Ladefoged 1964) has 87, and Changana (Bantu: Janson 2001) has 125! Colarusso's (1988:xxii-xxiiv) reflection on this fact is instructive:

> [S]uch large consonantal inventories appear somehow improbable or strange only if one adheres to an account of phonology based upon a Jakobsonian feature system (Jakobson et al. 1952, Lieberman 1974). For such a theory of phonology languages with large consonant inventories present two problems. First, they may be uncharacterizable in crucial ways and phonological behavior exhibited between members of these inventories may remain inexplicable. ... Second, such phonological theories predict that large consonantal inventories will make a language difficult to perceive since the acoustic cues involved in distinguishing segments are often very subtle. In fact, it appears to take a child quite a bit of time to learn all the segments of a complex Circassian language such as Bzhedukh,[104] but once learned this language appears to work as well as some of its simpler cousins. Bzedukh speakers claim that all the contrasts may be perceived, for example, while riding the New York City subway. This is understandable if one adopts a motor theory of speech perception (Liberman et al. 1963) with distinctive features based upon articulatory gestures (Chomsky and Halle 1968). In such a framework each gesture is distinct even though related to other gestures through a shared set of features. Acoustic distinctions, therefore, are not all of equal significance, i.e., there is no uniform metric throughout an acoustic space. Certain cues are crucial in that they represent distinct articulatory gestures[105] whereas others, even though acoustically diverse in a purely physical sense, are nonetheless insignificant. ... Chomsky-Halle's system, with some modifications [which have been incorporated into

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> to the outcome of these computations, to the surface representations figuring in the bottom line of a computation. In all other stages of the computation and in the representations of words and morphemes in memory the features serve as purely diacritic markers.

[104] Bzedukh Circassian has 66 consonants (ibid., p. xvii).

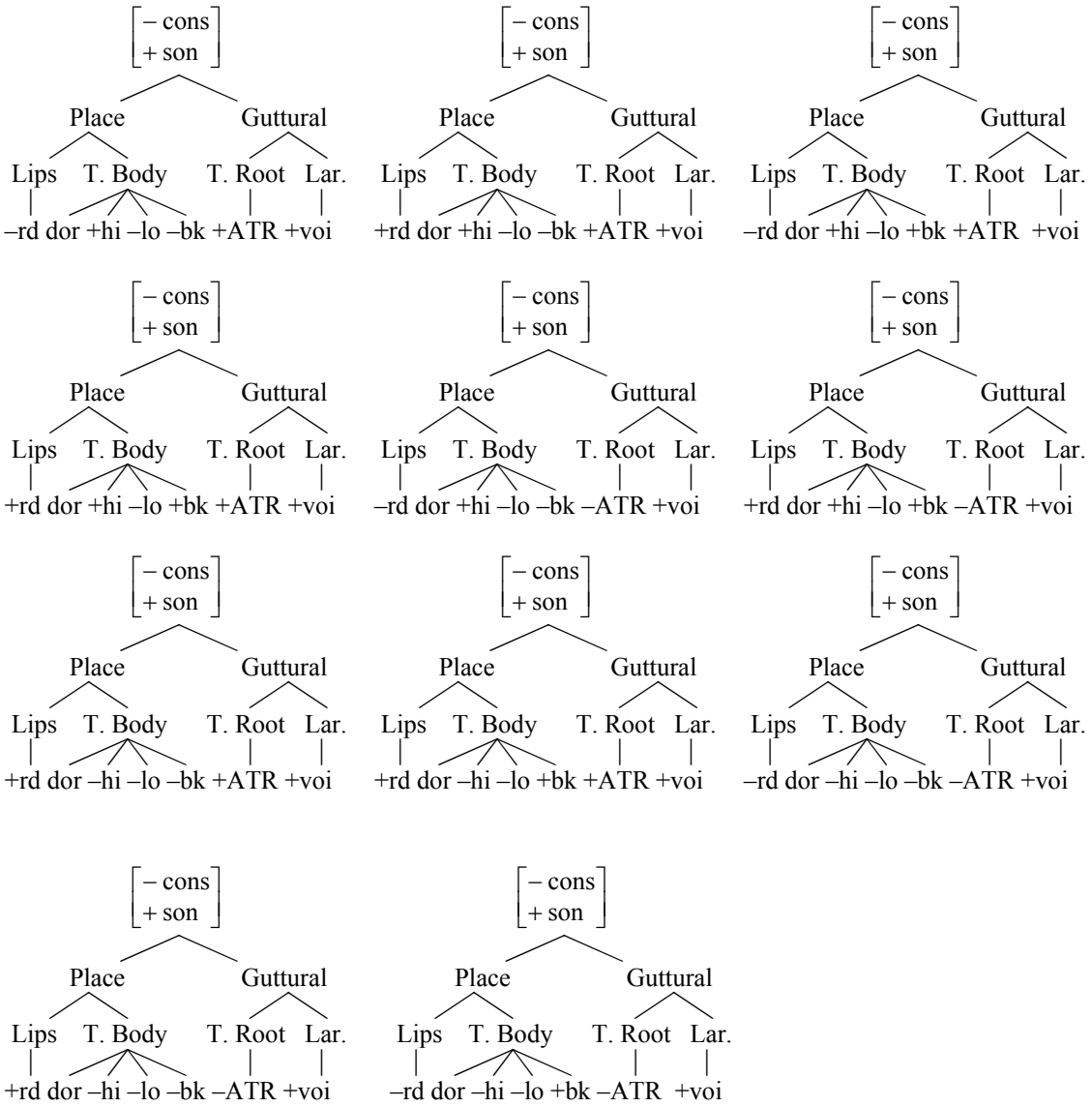
[105] Recent studies in neurophysiology lend fresh support to this view that the perception of speech may well be articulation-based. As Halle (2002a:8) reports, "it has been observed by L. Fadiga et al. (2002) that the same motor centers in the brain are activated both in the production of speech and in speech perception, where the perceiver engages in no overt motor activity. These findings imply, in Fadiga's words, that

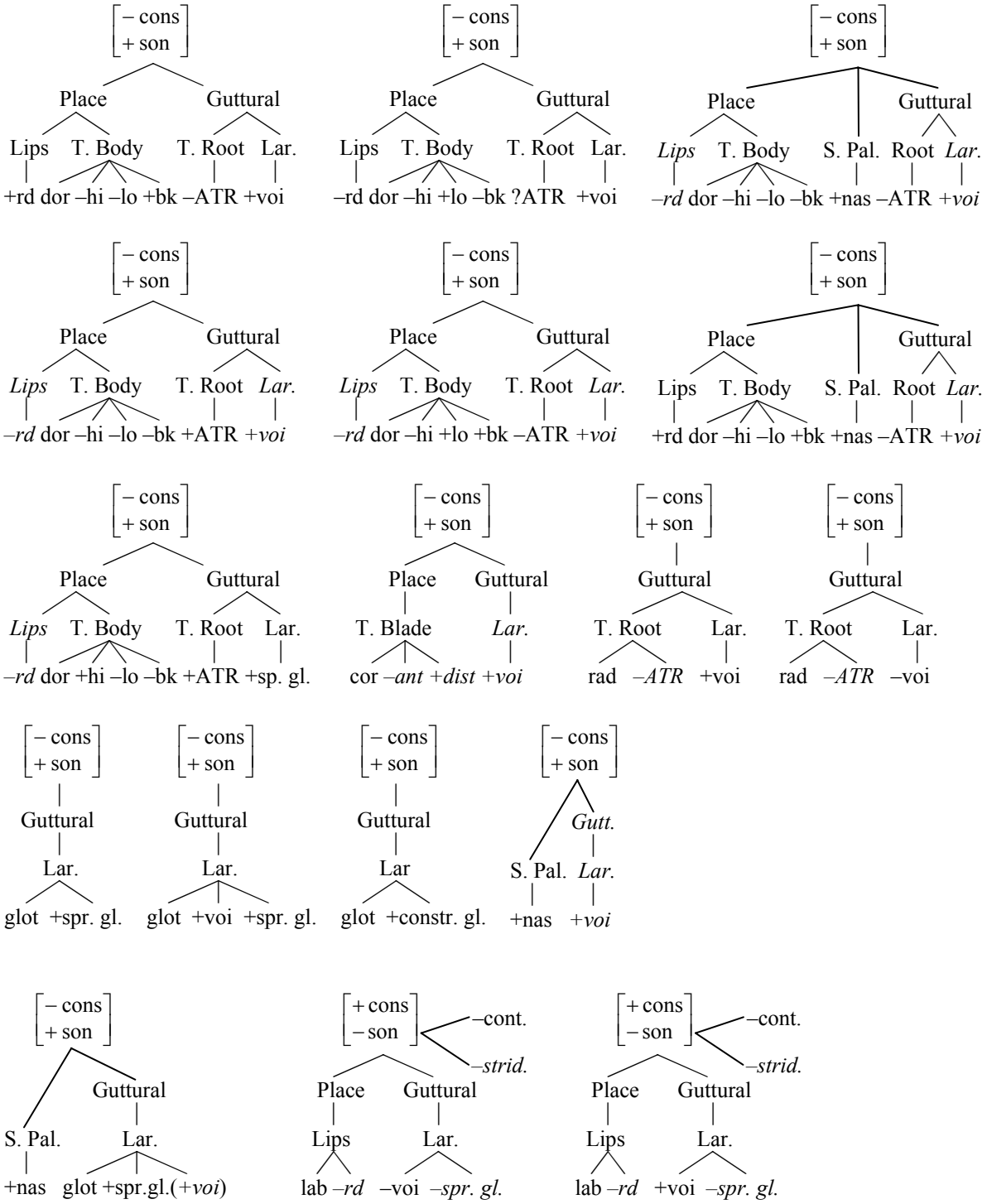
> speech perception and speech production processes use a common repertoire of motor primitives that during speech production are at the basis of articulatory gesture generation, while during speech perception are activated in the listener as the result of an acoustically evoked motor 'resonance'.

this text], predicts that large consonantal (and vocalic) inventories should be possible and that they may be part of efficient media for communication. These predictions are confirmed. The Caucasian languages and others with large consonantal inventories may be impressive and exciting for the phonologist, but they are not, in any scientific sense, bizarre or odd.

2.7. Practice

In the next few pages, write the appropriate symbol for each tree:

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+rd dor –hi –lo +bk –ATR +voi
[– cons, + son]
Place Guttural
Lips T. Body T. Root Lar.
–rd dor –hi +lo –bk ?ATR +voi
[– cons, + son]
Place Guttural
Lips T. Body S. Pal. Root Lar.
–rd dor –hi –lo –bk +nas –ATR +voi
[– cons, + son]
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Lips T. Body T. Root Lar.
–rd dor –hi –lo –bk +ATR +voi
[– cons, + son]
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Lips T. Body T. Root Lar.
–rd dor –hi +lo +bk –ATR +voi
[– cons, + son]
Place Guttural
Lips T. Body S. Pal. Root Lar.
+rd dor –hi –lo +bk +nas –ATR +voi
[– cons, + son]
Place Guttural
Lips T. Body T. Root Lar.
–rd dor +hi –lo –bk +ATR +sp. gl.
[– cons, + son]
Place Guttural
T. Blade Lar.
cor –ant +dist +voi
[– cons, + son]
Guttural
T. Root Lar.
rad –ATR +voi
[– cons, + son]
Guttural
T. Root Lar.
rad –ATR –voi
[– cons, + son]
Guttural
Lar.
glot +spr. gl.
[– cons, + son]
Guttural
Lar.
glot +voi +spr. gl.
[– cons, + son]
Guttural
Lar
glot +constr. gl.
[– cons, + son]
Gutt.
S. Pal. Lar.
+nas +voi
[– cons, + son]
Guttural
S. Pal. Lar.
+nas glot +spr.gl.(+voi)
[+ cons, – son] –cont. –strid.
Place Guttural
Lips Lar.
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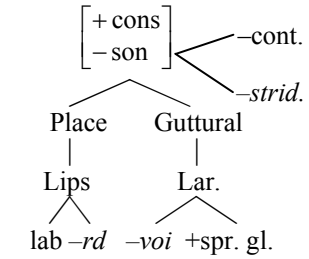
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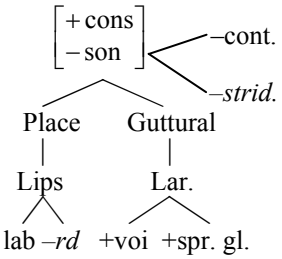
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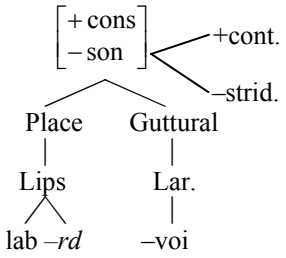
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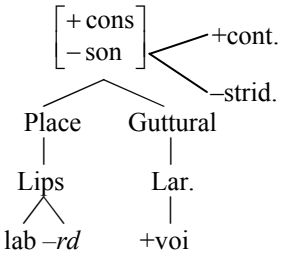
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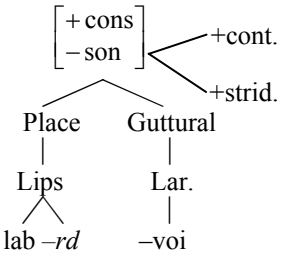
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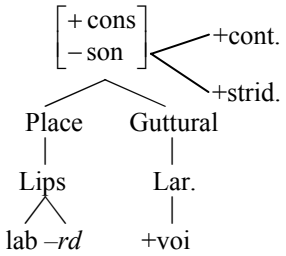
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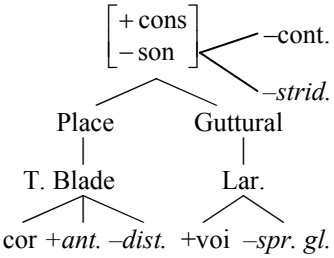
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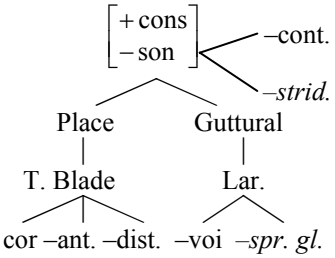
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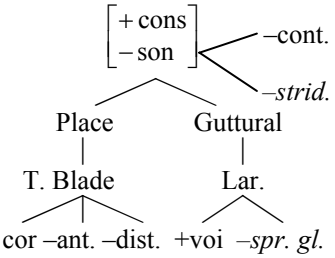
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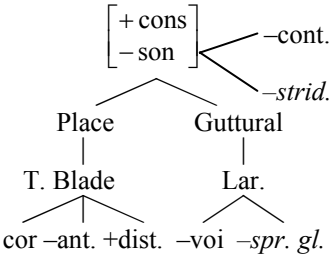
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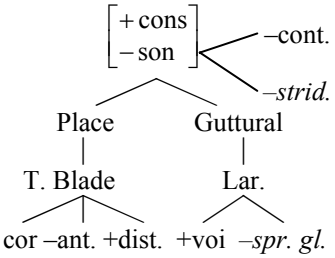
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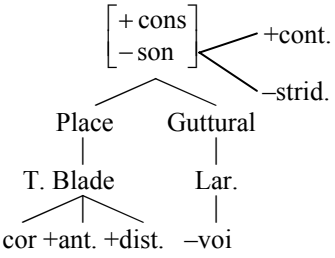
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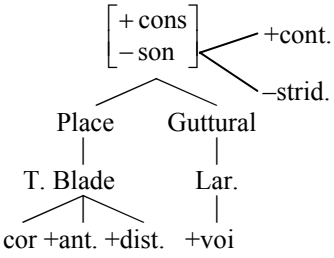
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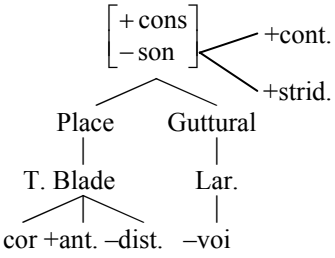
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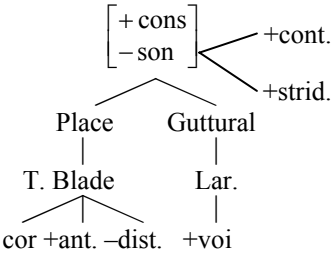
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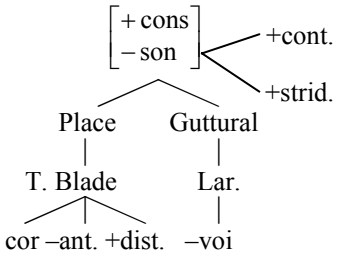
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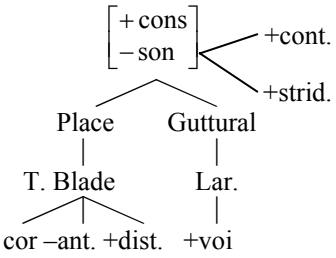
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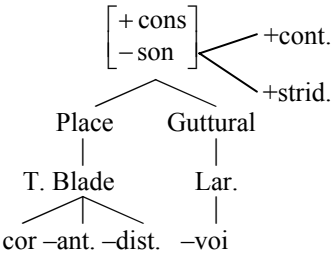
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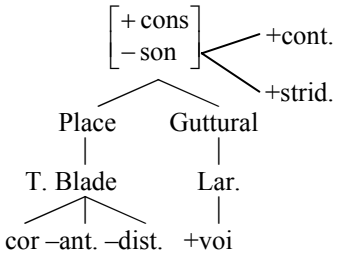
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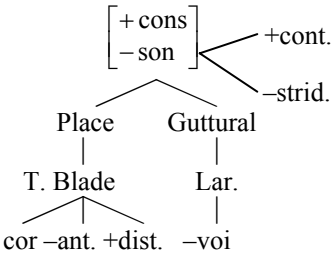
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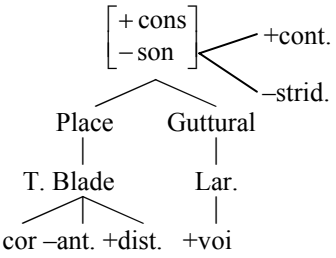
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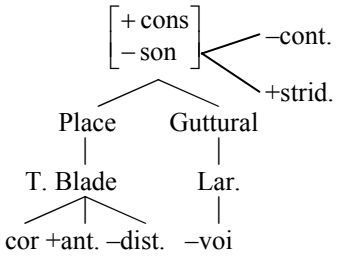
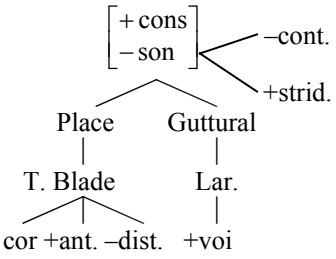
cor –ant. +dist.
+voi


[+cons −son]
–cont.
+strid.
Place
Guttural
T. Blade
Lar.
cor +ant. –dist.
–voi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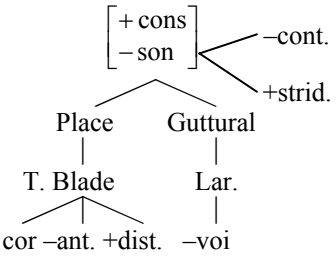
+strid.
Place
Guttural
T. Blade
Lar.
cor +ant. –dist.
+voi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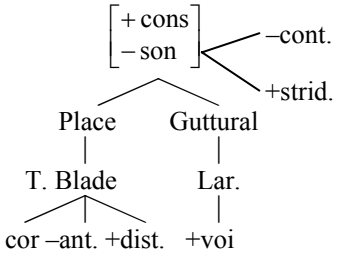
–cont.
+strid.
Place
Guttural
T. Blade
Lar.
cor –ant. +dist.
–voi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+strid.
Place
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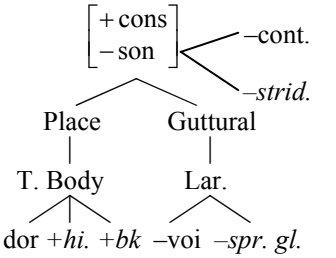
T. Blade
Lar.
cor –ant. +dist.
+voi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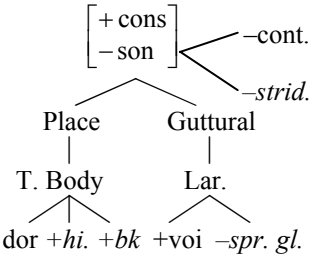
–cont.
–strid.
Place
Guttural
T. Body
Lar.
dor +hi. +bk
–voi
–spr. gl.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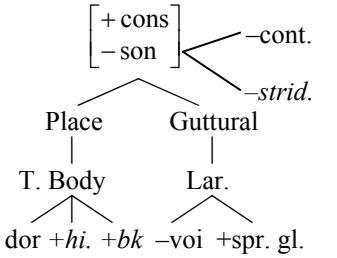
–cont.
–strid.
Place
Guttural
T. Body
Lar.
dor +hi. +bk
+voi
–spr. gl.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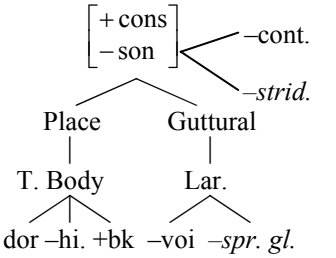
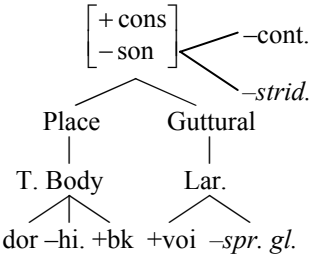
–cont.
–strid.
Place
Guttural
T. Body
Lar.
dor +hi. +bk
–voi
+spr. gl.


[+cons −son]
–cont.
–strid.
Place
Guttural
T. Body
Lar.
dor –hi. +bk
–voi
–spr. gl.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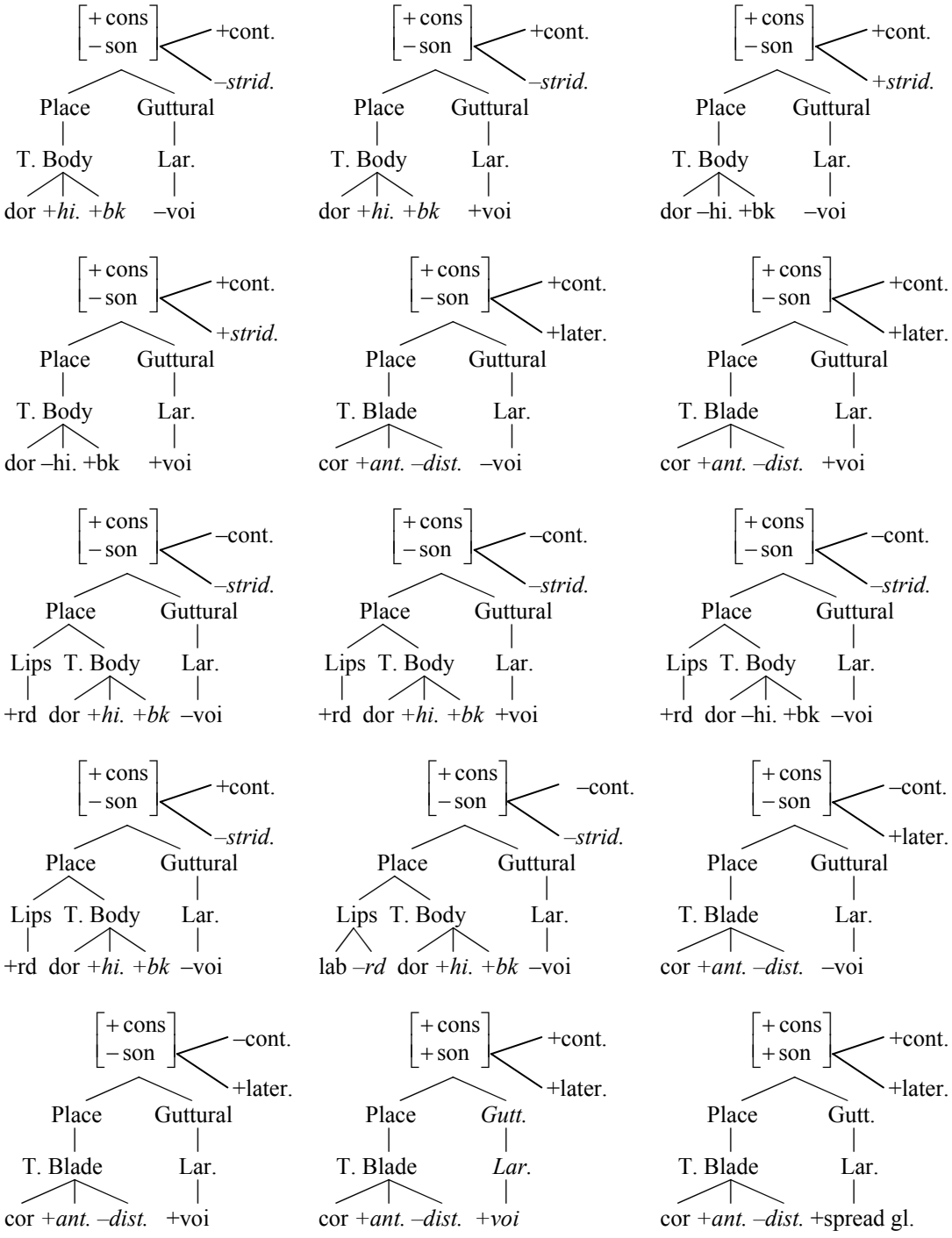
–cont.
–strid.
Place
Guttural
T. Body
Lar.
dor –hi. +bk
+voi
–spr. gl.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[+cons −son] +cont. +strid. Place Guttural T. Body Lar. dor –hi. +bk –voi
[+cons −son] +cont. +strid. Place Guttural T. Body Lar. dor –hi. +bk +voi
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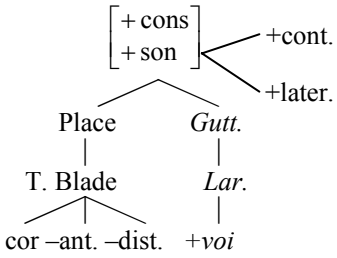
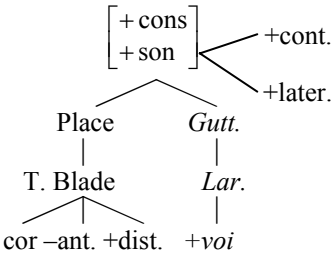
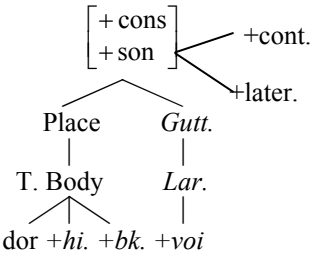
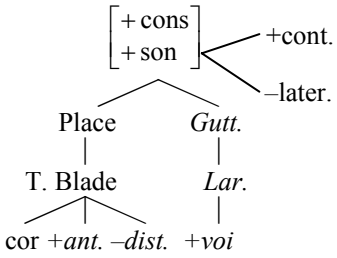
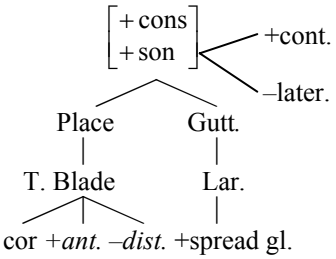
[+cons −son] +cont. +later. Place Guttural T. Blade Lar. cor +ant. –dist. +voi
[+cons −son] –cont. –strid. Place Guttural Lips T. Body Lar. +rd dor +hi. +bk –voi
[+cons −son] –cont. –strid. Place Guttural Lips T. Body Lar. +rd dor +hi. +bk +voi
[+cons −son] –cont. –strid. Place Guttural Lips T. Body Lar. +rd dor –hi. +bk –voi
[+cons −son] +cont. –strid. Place Guttural Lips T. Body Lar. +rd dor +hi. +bk –voi
[+cons −son] –cont. –strid. Place Guttural Lips T. Body Lar. lab –rd dor +hi. +bk –voi
[+cons −son] –cont. +later. Place Guttural T. Blade Lar. cor +ant. –dist. –voi
[+cons −son] –cont. +later. Place Guttural T. Blade Lar. cor +ant. –dist. +voi
[+cons +son] +cont. +later. Place Gutt. T. Blade Lar. cor +ant. –dist. +voi
[+cons +son] +cont. +later. Place Gutt. T. Blade Lar. cor +ant. –dist. +spread gl.

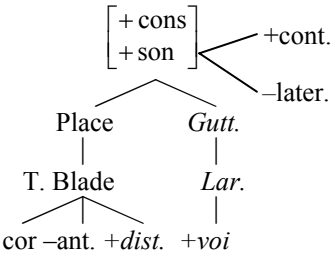

+cons
+son
+cont.
+later.
Place
Gutt.
T. Blade
Lar.
cor –ant. –dist.
+voi

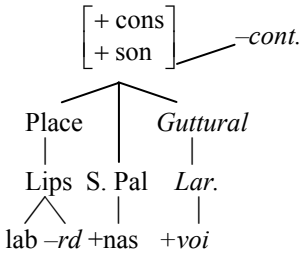

+cons
+son
+cont.
+later.
Place
Gutt.
T. Blade
Lar.
cor –ant. +dist.
+voi

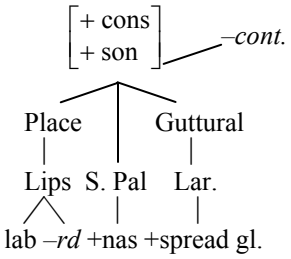

+cons
+son
+cont.
+later.
Place
Gutt.
T. Body
Lar.
dor +hi. +bk.
+voi

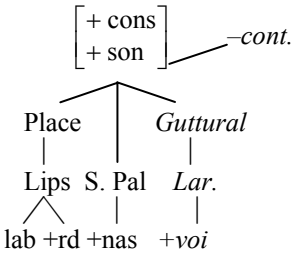

+cons
+son
+cont.
–later.
Place
Gutt.
T. Blade
Lar.
cor +ant. –dist.
+voi

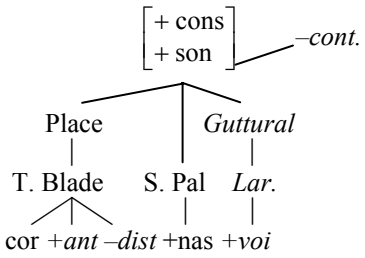

+cons
+son
+cont.
–later.
Place
Gutt.
T. Blade
Lar.
cor +ant. –dist.
+spread gl.

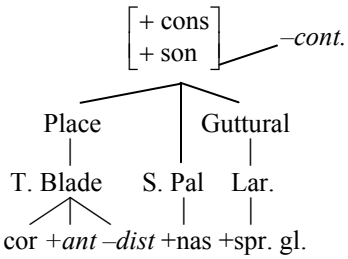

+cons
+son
+cont.
–later.
Place
Gutt.
T. Blade
Lar.
cor –ant. +dist.
+voi

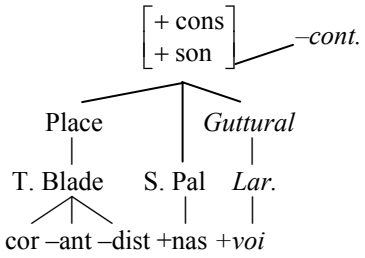

+cons
+son
–cont.
Place
Guttural
Lips
S. Pal
Lar.
lab –rd +nas
+voi


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


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


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


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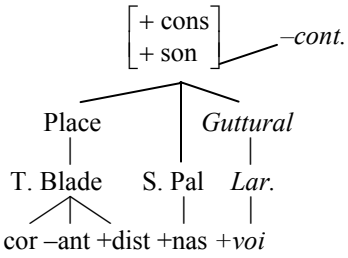
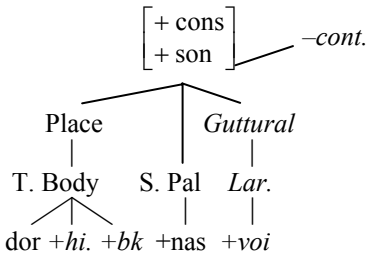
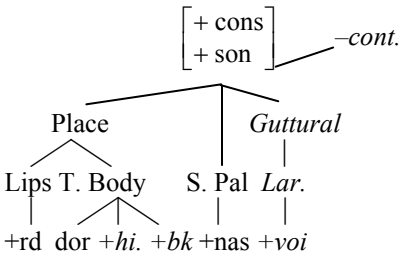
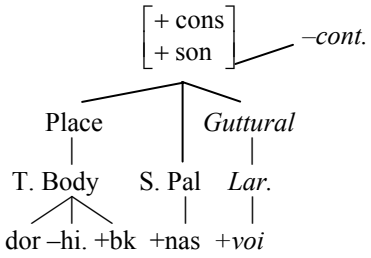
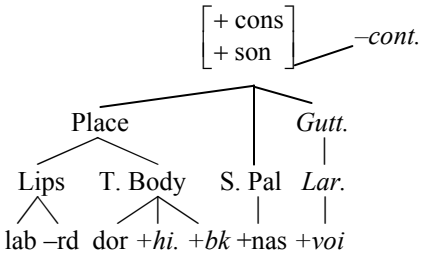
+son
–cont.
Place
Guttural
T. Blade
S. Pal
Lar.
cor –ant –dist +nas
+voi

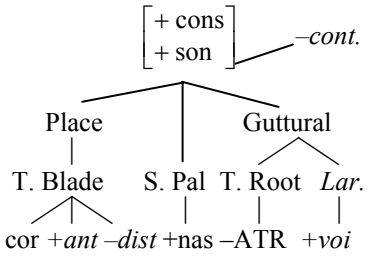

+cons
+son
–cont.
Place
Guttural
T. Blade
S. Pal
Lar.
cor –ant +dist +nas
+voi


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


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


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


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


+ cons
+ son
–cont.
Place
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 neighboring 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 neighboring 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 establizhed 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

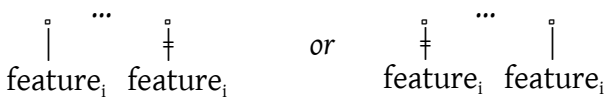
b. *regressive*

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 neighboring segment (Alderete 2003). In nonlinear phonology, dissimilation is viewed as the *delinking* of a feature (or set of features) from a segment in the neighborhood 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.

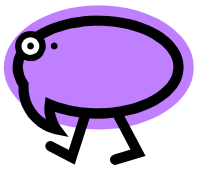
(2) *Dissimilation as delinking*



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

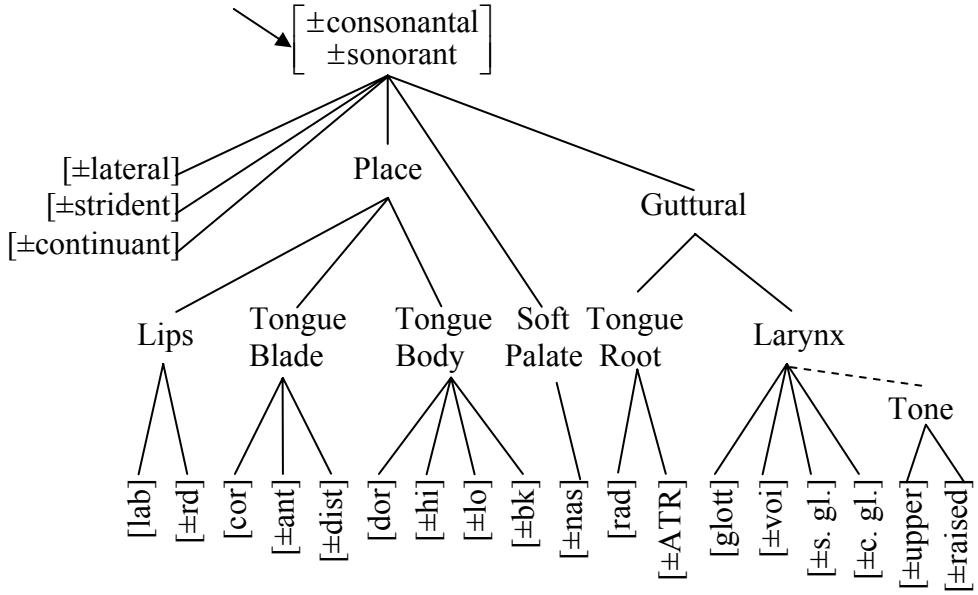
In this section we consider the syntagmatic behaviors of the articulator-free features: [±consonantal], [±sonorant], [±lateral], [±strident], and [±continuant]. We begin with the major class features.



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 et al. 2000, Halle 2003): they *constitute* the segmental root node, onto which the other features link, as shown in (3) (cf. (7) on p. 11).

(3) *Major class nodes inside root 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.[106]

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[106] 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 Rätо-Romansh dialect of Switzerland), the glides /j, w/ strengthen to the voiced velar stop [g] before any consonant, e.g. (ia-c). The voiced velar then devoices before voiceless consonants, including those which have themselves undergone word-final devoicing, e.g. (id-f).

(i) *Preconsonantal fortition in Bergüner Romansh*

a.	/lavowra/		ləvogrə	'works'
b.	/skrejvər/		skregvər̥	'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. (ii). Such adaptations have not occurred in adjacent and closely related dialects, e.g., nearby dialects have *powr* 'farmer', *dejt* 'finger', and *vejr* 'true'.

(ii) *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', *dʷej* '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*.

3.2.2. The other articulator-free features

Unlike the major class features [±consonantal] and [±sonorant] which are claimed by many never to 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 (4a-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 (4c-g) show (< > indicates infixation). Interestingly, when the root-initial conso-

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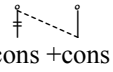
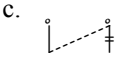
(iii) *Consonantal assimilation?*



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

(iv) *Morgan* (Bernhardt and 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’	
	/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 (1994, 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).

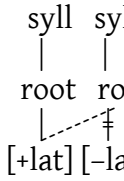
nant is /l/, the infix is realized as [al], as shown in (4h-i).

(4) *Sundanese lateral assimilation*

a.	/ar-anɟin/ PL-you	aranɟin
b.	/ar-ajim/ PL-patient	arajim
c.	/ar-poho/ PL-forget	p<ar>oho
d.	/ar-damaŋ/ PL-well (adj)	d<ar>amaŋ
e.	/ar-kusut/ PL-messy	k<ar>usut
f.	/ar-riwat/ PL-startled	k<ar>usut
g.	/di-ar-visualisasi-kin/ PASS-PL-visualize-VSUFFIX	div<ar>isualisasikin
h.	/ar-litik/ PL-little	l<al>itik
i.	/ar-ləga/ PL-wide	l<al>əga

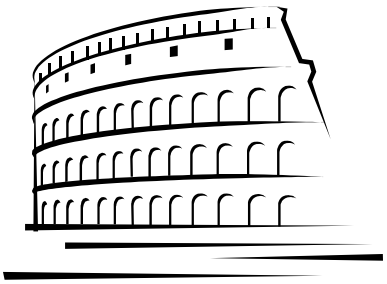
Cohn (1992:207) gives the following rule: "When the /r/ of the infix is preceded by an /l/ in the previous syllable, the [+lateral] specification of the /l/ spreads to the right, with concomitant delinking of [–lateral]."

(5)



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 (6a), 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 (6b). The data in (6c) show that when an *r* intervenes between the two *l*'s, no dissimilation occurs.

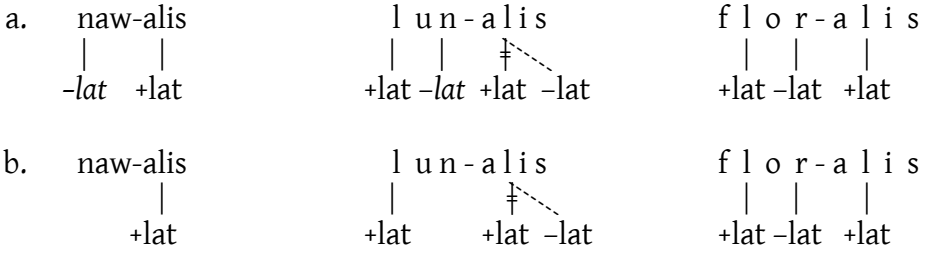


(6) *Latin lateral dissimilation*

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 et al. 2000), this pattern indicates simply that [+lateral] dissimilation in Latin is sensitive only to contrastive values of [±lateral]; noncontrastive [±lateral] is shown in italics in (7a). 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 (7b).

(7) *Latin lateral dissimilation*



Exercises:

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

(8)	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)

(9)

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).

(10)

sing.	pl.	
kusut	k-ar-usut	'messy'
visualisasi	v-ar-isualisasi	'visualize'
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'
bɨŋhar	b-al-ɨŋhar	'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'. Also explain the following changes in Romanian: *suspirare* > *suspinare* 'to breathe out', *lurecare* > *lunecare* 'to slip' (Rosetti 1965:27).

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.*

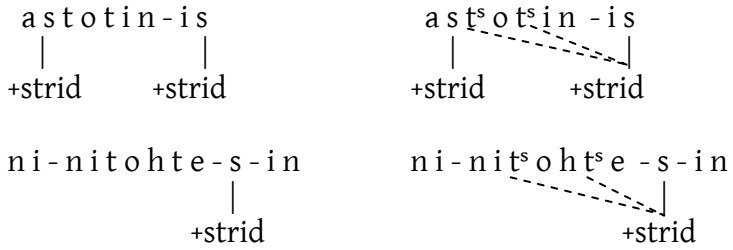
Still, a possible case of [±strident] assimilation is found in Plains Cree (Hirose 1997). Recall from section 2.2.2.2 that in this Algonquian language "plain" /t/'s become [+strident] affricates [t^{s}] when they occur with a diminutive affix, -(i)s or -(i)sis:

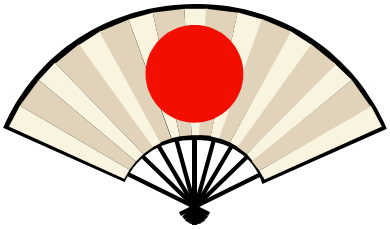
(11) *Diminutives in Plains Cree*

	Non-diminutives		*Diminutives*	
a.	astotin hat	'a/the hat'	ast^{s}ot^{s}in-is hat-DIM	'a little hat'
b.	ni-nitohte-n 1-listen-1	'I listen'	ni-nit^{s}oht^{s}e-s-in 1-listen- DIM-1	'I listen a little'
c.	atim dog	'dog'	at^{s}imo-sis dog-DIM	'a/the little dog'
d.	ni-tem 1-horse	'my horse'	ni-t^{s}em-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 (12).

(12) *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. (13a). Assibilation fails before other vowels, e.g. (13b).

(13) *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, a language spoken in Cameroon and Equatorial Guinea (Kim 2001:91): the stops /b d t g k/ of Proto-Bantu became affricated in Mvumbo, to /dʒ tʃ/ before /i/, as in (14a), and to /bᵛ pᶠ/ before /u/, as in (14b). Stops before nonhigh vocoids in Proto-Bantu were not affricated historically, e.g. (14c). In other words, [–sonorant, -continuant] became [+strident] before [–consonantal, +high].

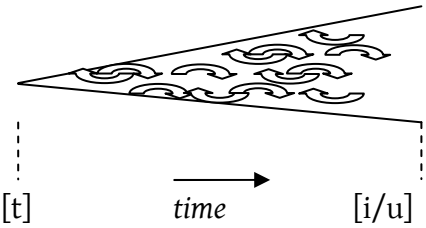
(14)

	ProtoBantu	*Mvumbo*	
a.	*-tiːtʊ	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-bᵛuː	'hippopotamus'
	*-kuba	pᶠuwo	'chicken'
c.	*-bod	-buo	'become rotten'
	*-dɪ	-di	'eat'
	*-toːg	-tuog	'boil up'
	*-gada	-kala	'mat'
	*-konde	-kwande	'banana'

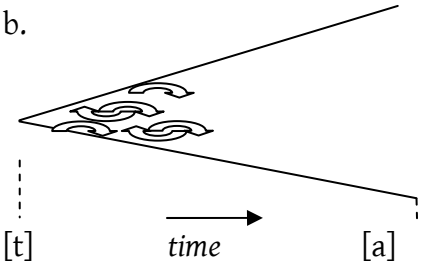
Assibilation appears to be a kind of "acoustic assimilation". (Again, this is not too surprising, given the acoustic basis of the feature [+strident].) As Kim (2001) explains, the narrow channel which is created in the transition between a stop and a following high vowel (or glide) generates an especially 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 schematized in (15a) *vs.* (15b).

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

a.



b.



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.

(16) *Modern Korean*

a.	/mat-i/ -i Nomin.	[ma.dʑi]	'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. (17), and Asháninca (Campa), an Arawakan language of Peru (Spring 1992), e.g. (18), and Kpándo, a Gbe language of Ghana (Capo 1991), e.g.

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

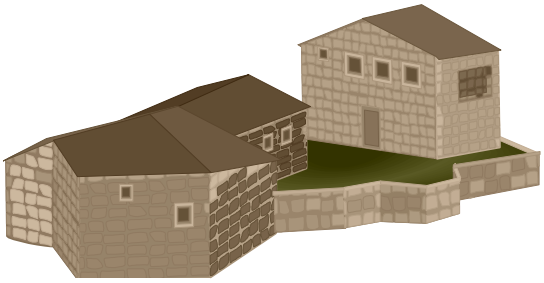
(18) *Asháninca*

a.	/no-kant-i/ I-say-NF (nonfuture)	[nokantˢi]	‘I said’
b.	/no-ant-i/ I-do-NF	[nantˢi]	‘I did’
c.	/no-misi-i/ I-dream-NF	[nomisitˢi][107]	‘I dreamed’

(19)

	Gbe	*Gen*	*Kpándo*	
a.	*atí	atí	atˢí	‘tree’
b.	*ti	ti	tˢi	‘be fed up’
c.	*didi	didi	dᶻidᶻi	‘to be far’
d.	*dí	(dᶾí)	dᶻí	‘to look for’

Turning now to dissimilation of [+strident], an example is reported in the isolate Basque. LaCharité (1995:164) gives the rule in (20) for this language. As she explains: “When the morphology juxtaposes two [+strident] specifications, the rightmost is deleted, leaving a homorganic stop” (ibid.), e.g. (21).



(20) *Strident dissimilation in Basque*

$$\begin{array}{ccc} X & X & \\ | & | & \rightarrow \\ *[+stri] & [+stri] & \end{array} \qquad \begin{array}{cc} X & X \\ | & \ddagger \\ [+stri] & [+stri] \end{array}$$

(21) *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.:

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

(22) *Disallowed root shapes in Yucatec Maya*

*sVtˢ	*tˢVs	*ʃVs	*tʲVs
*sVʃ	*tˢVʃ	*ʃVtˢ	*tʲVtˢ
*sVtʃ	*tˢVtʃ	*ʃVtʃ	*tʲVʃ, etc.

Blust (2002) also reports sibilant dissimilation in the development of Kiput, a North Sarawak Austronesian language.

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 and Hannahs 1998).

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* > paburik:u.)

	Japanese	*Original*	
a.	tˢu:pi:su	tu:pi:s	English: 'two piece(s)'
b.	tˢu:ru:zu	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 1993).

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][108]	'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

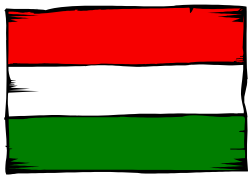
E. Try to explain the distribution of the [əz] allomorph of the English plural suffix:

(23) *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 and 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.:

(24) *Hungarian*

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

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

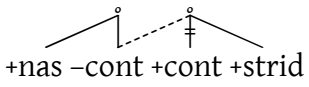
In Venda (Padgett 1995), [–continuant] spreads from a nasal to a following fricative, yielding an affricate, e.g. /N+vulɛdᶻa/ [mbᵛulɛdᶻɔ] 'finishing' (cf. /N+bᵛuda/ [mbᵛudɔ] 'a leak'). Similarly, in Zulu (ib.) and Kikongo (Hyman 2001):

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

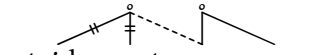
a.	izimpᶠudu	'tortoises'	cf.	u:fudu	'tortoise'
b.	izintˢizi	'sorrows'		u:sizi	'sorrow'
c.	izindᶻime	'walking staffs'		u:zime	'walking staff'

(26) *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'



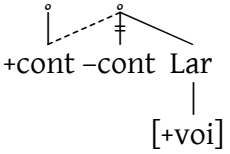
In some dialects of American English, [–continuant] spreads in the opposite direction, from a nasal to a preceding fricative, e.g. [bɪdnɪs] 'business', [ɪdnɪt] 'isn't it?', [wʌdnɪt] 'wasn't it?' (McCarthy 1988). ([+strident] is lost simultaneously, presumably to avoid [dᶻ], which English lacks.)



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. (27a-c), after [r], e.g. (27d-f), and after [l], e.g. (27g-h) (/b, g/ only).[109] As Morris (1998:189) states, "most studies concur that continuancy assimilation is achieved by the rightward spreading of a feature [continuant]."

(27) *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]

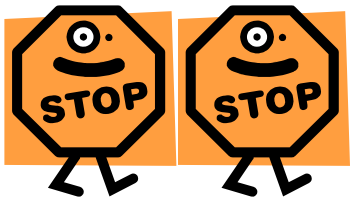


Spanish also shows a tendency to lenite stops to fricatives in syllable-final position, e.g., *adquirir* [aðkirir], *étnico* [eθniko]. As Morris (1998:202) affirms: "Coda obstruents may not be [–cont]."[110] Interestingly, this process of lenition "feeds" continuancy assimilation, i.e., fricatives resulting from lenition cause a following voiced stop to become [+continuant], e.g., *abdica* [aβðika].

[109] 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.

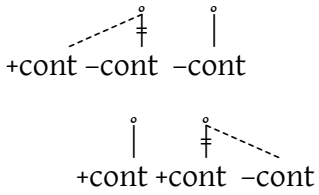
[110] Cf. fn. 31 on p. 26.

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. (28a-b). On the other hand, the second fricative in a sequence of two fricatives changed to a stop, e.g. (28c-d).[111]



(28) *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. (29a), except after fricatives, where it is realized as *-tik*, e.g. (29b). This alternation results from the dissimilation of [+continuant] among obstruents ([–sonorant]), as in (28c-d).

(29) *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 realized as *-tˢm* after [ɬ], e.g. (30a-b); cf. (30c-e).

[111] 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.

(30) *-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)'
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)'

Similarly, the suffix *-sista* 'around' is realized as *-tˢista* after [ɬ], e.g. (31a-b); cf. (31c-e).

(31) *-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.	tɬ'iχ-sista	'to spawn all over the area (said of herring)'
e.	nawalaxʷ-sista	"power is around"

And the suffix *-su* '2sg.' is realized as *-tˢu* after [ɬ], e.g. (32a-c); cf. (32d-f).

(32) *-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. Explain why *diphthong* is pronounced [dɪpθɑŋ] by some, [dɪftɑŋ] by others.

B. Try to explain the following changes from Old English to later Old English:[112] *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)

C. 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

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

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?

D. 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.

(33) *Proto-Bantu* (Halle and 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'

E. Chaha is a Semitic language spoken in Ethiopia (Banksira 2000). Use the data in (34) and (35) 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.: [β̪] is a bilabial glide.)

(34)

a.	jə-xtɨβ̪	'Let him vaccinate!'
b.	jə-tɨks	'Let him burn sth.!'
c.	jə-xətɨt	'Let him surround sth.!'
d.	jə-kʃəʃ	'Let it be prickly!'
e.	j-a-xətɨr	'Let him precede!'
f.	jə-kzəβ̪	'Let it become inferior!'
g.	jə-xdɨm	'Let him look after!'
h.	jə-kɨft	'Let him open sth.!'
i.	j-a-xdɨr	'Let him dress someone!'
j.	jə-kəʃ	'Let him crush sth.!'
k.	jə-xβ̪ɨβ̪	'Let him encircle!'
l.	jə-ksər	'Let him strain!'
m.	j-a-ŋkɨs	'Let him light the fire!'
n.	jə-kfɨr	'Let him separate!'
o.	j-a-xɨβ̪d	'Let him respect someone!'
p.	j-a-kjəs	'Let him joke!'

q.	jə-xrəm	‘Let him spend a year!’
r.	jə-ŋkɨf	‘Let him provoke a quarrel!’
s.	jə-xi	‘Let him dig!’
t.	jə-ŋkɨs	‘Let him bite/let a plant root!’
u.	jə-xərtɨm	‘Let him cut sth. off!’
v.	j-a-β̪əŋkɨs	‘Let him assign as a pretext!’
w.	j-a-xmac	‘Let him strain people!’
x.	j-əkɨs	‘Let him wait!’
y.	j-a-xəmbɨr	‘Let him invert cooked food!’
z.	jə-kjaf	‘Let it drizzle!’

(35)

	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-β̪tɨx	jɨ-β̪ət(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.

(36)

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:

(37)

a.	kətəf	‘has hashed’
b.	kɨβ̪əsəs	‘has unraveled fiber’
c.	a-kβ̪abəs	‘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 (1988, 1989), 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.

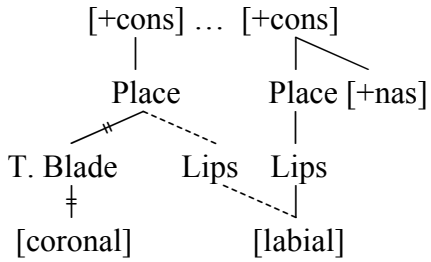
3.3.1.1. [labial]

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 (38a) from Dylan (4;6–5;0) illustrate [labial] spread from a nasal [m] to a preceding coronal, as represented in (38b).

(38) *Dylan* (Bernhardt and Stemberger 1998)

a.	/taɪm/	[paĩm]	‘time’
	/θʌm/	[bɛ̃m]	‘thumb’
	/sʌmtaɪmz/	[bɛmpaɪm]	‘sometimes’
	/nʌmbɹz/	[bʌ̃mbə][113]	‘numbers’

b.



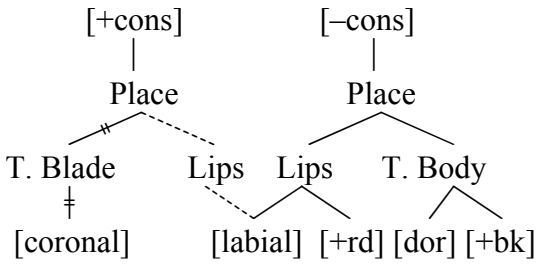
[113] The loss of [+nasal] in the initial consonant of this form is unexpected, since “there were no obvious constraints against co-occurrence of [Labial] and [+nasal]” (Bernhardt and Stemberger 1998:625, n. a). Perhaps there was dissimilation of [+nasal], *[mVm]?

The data in (39a) are also from Dylan. They illustrate another type of [labial] assimilation: from /w/ to an immediately preceding [coronal] consonant, as represented in (39b). (There is also independent stopping and voicing of word-initial consonants.)

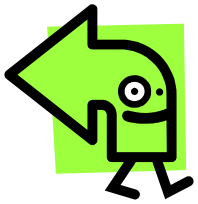
(39) *Dylan* (Bernhardt and Stemberger 1998)

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

b.



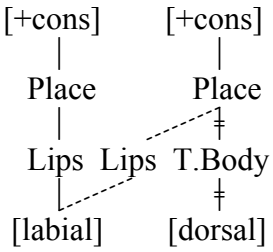
The data in (40) are from Charles (5;10–6;0). They illustrate [labial] spread from /w/ to an immediately preceding consonant, whether [coronal] or [dorsal]. (These data also reveal that Charles requires all word-initial obstruents to be [+continuant].)



(40) *Charles* (Bernhardt and Stemberger 1998)

a.	/bɹɛd/	[vwʌdᵊ]	'bread'
b.	/dɹɛst/	[vwʌθ̪t̪]	'dressed'
c.	/twɛnti/	[fwɛntiˈ]	'twenty'
d.	/glʌv/	[vwʌbᵊ]	'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]." A comparable case is found in the Roermondsch dialect of Dutch, e.g. /kom-t/ → [komp] 'come' (imp. pl.) (Clements 2001:137, n. 11).

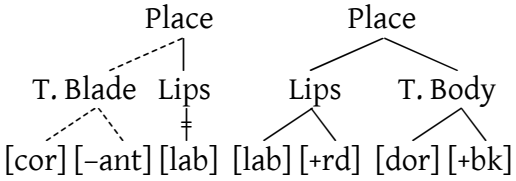


As an example of [labial] dissimilation, consider what happens when the passive suffix *-w-* is added to stem-final [labial] consonants in the Bantu language SiSwati:

(41) *Dissimilatory palatalization in SiSwati* (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".

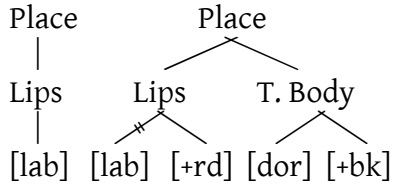
(42) *Dissimilatory palatalization in SiSwati* (Herman 1996)

	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	kúsetʃéntis-w-a	'to use' / pass

In another Bantu language, Venda, labial dissimilation causes the [labial] feature of the passive *-w-* itself to delink. Without [labial], /w/ converts to a labialized velar: [ɣʷ] after voiced obstruents (43a-c), [ŋʷ] after nasals (43d), [xʷ] after voiceless obstruents (43e), [xʷʰ] after voiceless aspirated obstruents (43f), and [xʷʾ] after glottalized obstruents (43g). The variety of resulting labialized velars is due to independent nasal and laryngeal assimilation processes (see sections 3.4 and 3.5.2 below). (Note, too, that fricatives delete before the labialized velars, e.g., (43c,e), apparently due to [+continuant] dissimilation; see section 3.2.2.3 above.)

(43) *Labial dissimilation in Venda* (Ziervogel et al. 1981, Clements 1993:128)

	Infinitive	*Passive* /-w-/	
a.	-goba	-gobɣʷa	'to weed'
b.	-βumba	-βumbɣʷa	'to mold'
c.	-ðiβa	-ðiɣʷa	'to know'
d.	-luma	-lumŋʷa	'to buy'
e.	-βoφa	-βoxʷa	'to tie'
f.	-pʰapʰa	-pʰapʰxʷʰa	'stick to'
g.	-ťaʔa	-ťapxʷʔa	'push back'



A different form of [labial] dissimilation occurs in Modern Georgian (Butskhrikidze and Van de Weijer 2001, Weijer and Butskhrikidze 2001). This language has a general process of metathesis[114] that affects /v/ when following the sonorant consonants /r, l, n/ in infinitival verb forms:

(44)	*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.	dᶻer	dᶻr-av-s	dᶻvr-a	'to move'

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

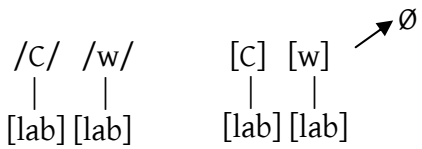
(45)	*root*	*pres. 3sg.*	*infinitives*	
a.	ber	ber-av-s	berv-a (*bvr-a)	'to blow up'
b.	par	par-av-s	da-parv-a (*da-pvr-a)	'string'

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

(46)	*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 labiovelar [w] often deletes in ordinary speech, especially after bilabial consonants, e.g., *pwa* → *pa* 'look!', *mweari* → *meari* 'echo', *pwe* → *pe* 'hemp cloth', *pʰwita* → *pʰita* 'blossom'. Kang (1996) attributes the loss of [w] to dissimilation of labiality:

(47) *Labial dissimilation in Korean*



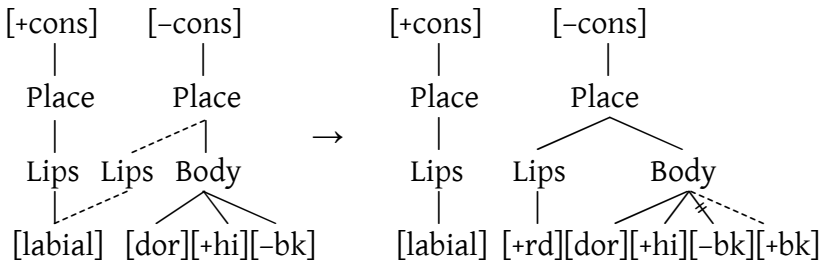
[114] *Metathesis* is the phenomenon whereby two sounds that appear in a particular order in one form of a word occur in the reverse order in a related form of the word. For more information, visit Elizabeth Hume's website on metathesis: http://www.ling.ohio-state.edu/~ehume/metathesis/.

Before turning to [+round], we describe a peculiar effect of the feature [labial]: when it spreads to a vowel, the latter becomes [+round]. To account for this, Halle et al. (2000) suggest that vowels cannot surface as [labial][115] and as a result "a vocalic [labial] segment ... becomes [+round]" (p. 416). To illustrate, consider the adaptation of English loans in the Southern Bantu language Shona (Uffmann 1999), e.g., (48). Consonant clusters and word-final consonants are avoided by adding [i] (48a), but [u] is used instead after labials (48b).[116] This can be understood as [labial] assimilation, with [labial] replaced by [+round] in the vowel, as represented in (49).[117] (Note that [–back] is also changed to [+back] to avoid [y], which Shona lacks.)

(48) *Loanword adaptations in Shona* (Uffmann 1999)

a.			b.		
	girini	'green'		purasita	'plaster'
	he^{n}dib^{h}egi	'handbag'		mepu	'map'
	sitiret͡ʃa	'stretcher'		d^{h}uropu	'gonorrhea discharge' < drop
	b^{h}azi	'bus'		temu	'term'
	s͡vuti	'suit'		gav^{h}ume^{n}de	'government'
	begi	'bag'		b^{h}afu	'bath'

(49)



Exercises

A. Explain the colloquial pronunciation of *seven* as [sɛbm̩]. What does this pronunciation tells us about the distinction "bilabial" vs. "labiodental"? (Davenport and Hannahs 1998)

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[115] The primary articulation of vowels is assumed to be [dorsal], following Sievers (1881:93ff.), Chomsky and Halle (1968:302), Sagey (1986) et seq., Halle (1988) et seq., Shaw (1991:139), etc.; see section 2.3.3.1, p. 53ff.

[116] The same pattern is reported in other African languages. Compare Yoruba *gírámà* 'grammar' vs. *búrẹ́dì* 'bread' (Salami 1972, Pulleyblank 1988, Akinlabi 1993) and SeTswana *kirisimasi* 'Christmas' vs. *hafu* 'half' (Batibo 1995). In Chengdu Chinese, [ɤ] becomes [o] after [p, p^{h}, m, f, w] (Duanmu 2000:74).

[117] A competing school of feature organization called Vowel-Place Theory argues that vowels have a separate Vowel-Place node which can carry [labial]. Crucially, Vowel-Place [labial] is realized as rounding, such that no adjustment is required when [labial] spreads from a consonant as in (48b) (cf. (49)). For more information on Vowel-Place Theory, see Clements (1989), Herzallah (1990), Lahiri and Evers (1991), Ní Chiosáin and Padgett (1993), Prince and Smolensky (1993:179ff.), Hume (1994), Odden (1994), Ní Chiosáin (1994), Levelt (1994), Clements and Hume (1995), Rice (1995b) et seq., Newman (1997), Bernardt and Stemberger (1998), Archibald (1998), Zoll (1998), Pater and Werle (2001), Fallon (2002), etc.

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

(50) *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:

(51) *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.

(52) *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'

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

am-las	'shear'	an-r̩mi	'be tired'
am-krz	'plow'	an-b̩ur	'remain celibate'
am-agur	'remain'	an-d̩fur	'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.

(54) *Tagalog*

a.	sulat	sumulat	'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.

F. Explain the possible pronunciation of *sandwich* as [sæmwɪʧ].

3.3.1.2. [±round]

As you may recall from section 2.3.1.2 (p. 42ff.) above, the Wakashan language Oowekyala has several rounded velars and uvulars phonemes, as is vividly illustrated in the following words:

(55) *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’χʷsʃakʷ	‘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.	ɢʷaχʷɢʷalaŋ̃usiwa	‘Raven-at-the-North-End-of-the-World’
j.	ɢʷiqʷχʷɢʷaχa	‘plural of: to eat bread’

A constraint illustrated in (56) requires that velars and uvulars be rounded after /u/ in Oowekyala.

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

a.	dukʷ-a (*duka)	‘to troll; Lyall’s American stinging nettle’[118]
b.	jugʷ-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 (*luq̓as)	‘Western or Lowland hemlock tree’
h.	luχʷ-a (*luχa)	‘to roll (said of a round thing)’

[118] An alternate form for ‘stinging nettle’ is duxʷa.

This constraint may be stated informally as in (57).

(57) 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. (56)), but a more general constraint in Oowekyala, is apparent from alternations. For example, the initial segment of the inchoative suffix *-xʔit*, illustrated in (58), becomes rounded after u-final stems, as illustrated in (59).

(58) *-xʔit* 'to become, to start'

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

(59) *-xʷʔit* 'to become, to start'

a.	ʔl̰xʷstu-xʷʔit	'to assume the color of blood'	ʔl'xʷstu	'color of blood, having the color 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 (60), becomes rounded after u-final stems, as illustrated in (61).

(60) *-gila* 'to make'

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

(61) *-gʷila* 'to make'

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

The initial obstruent of the suffix *-k'ala* 'noise, sound', illustrated in (62), also becomes rounded after /u/, as illustrated in (63).

(62) *-k'ala* 'noise, sound'

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

(63) *–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 (64a-c), becomes rounded after /u/, as illustrated in (64d).

(64) *-ɢu* vs. *-ɢʷu* 'together'

a.	bn̰-ɢut	'to put things close together'	bəna̰	'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 (65a-c), becomes rounded after /u/, as illustrated (65d-e).

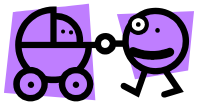
(65) –χs vs. –χʷs 'aboard'

a.	w̰n-χs	'to stow away'	w̰əna	'to hide, to sneak about'
b.	k'ʷa'-χs	'to sit in a boat'	k'ʷa'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 Ooweкyala 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[119] applies within the base, such that /u/ deletes after being copied.)

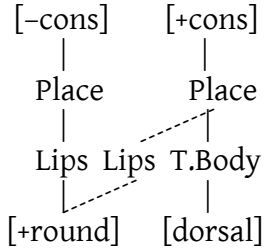
(66) *Rounding in Ooweкyala plural forms*

	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'



[119] *Syncope* refers to vowel deletion.

In sum, one can observe that the feature [+round] regularly spreads from the vowel /u/ onto a following consonant.[120]



Oowekyala also displays a variable pattern of assimilation whereby a velar or uvular obstruent becomes labialized if it immediately follows a labiovelar or a labiouvular. For example, the initial segment of the suffix -ˀχdˡa 'back', which is illustrated in (67), variably becomes rounded after rounded consonants, as shown in (68).

(67) -ˀχdˡa 'back'

a.	qˀkˀχdˡala	'motor boat'
	qˀka	'to bite (mosquito)'
b.	jipˀχdˡaʔaiɬ	'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)'

(68) -ˀχʷdˡa ~ -ˀχdˡa 'back'

a.	kˀlqˀχʷdˡa ~ kˀlqˀχdˡa	'incessantly urinating (said of a male)'
	kˀlqʷa	'to urinate (said of a male)'
b.	gʷukˀχʷdˡala ~ gʷukˀχdˡala	'boat with a cabin on the stern'
	gʷukʷ	'to live in a place, reside, dwell, settle'
c.	buqˀχʷdˡa ~ buqˀχdˡa	'person who always farts'
	buqˀala	'to fart'
d.	duqˀ-χʷdˡa ~ duqˀ-χdˡa	'to look back'
	duqʷa	'to look for sth.'

Similarly, the initial segment of the inchoative suffix –xʔit, which is illustrated in (69), variably becomes rounded after a labialized consonant, as shown in (70).

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[120] Recall from section 3.3.1.1 that [labial] becomes [+round] when it spreads from a consonant to a vowel (also Halle et al. 2000:416). As it happens, there is also some evidence that [+round] can become [labial] when it spreads from a vowel to a consonant (cf. fn. 117 on p. 135). For example, recall that Proto-Bantu */b, d, t, g, k/ became [labial, +strident] /bᵛ, pᶠ/ before /u/ in Mvumbo; see (14b) on p. 121. Comparable shifts have occurred historically in other Bantu languages. For example, in Venda */p, t, k/ changed to /f/ before /u/, and */b, d, g/ changed to /v/ before /u/ (Clements 1993:111). Similarly, */k/ changed to /f/ before /u/ in Punu, Swahili, Sango, Bembe, and Luyana (ibid.).

Another compelling piece of example is provided by Vietnamese. As Thompson (1987:4,6) describes, /k, ŋ/ are realized [k͡p, ŋ͡m], respectively, after [+round] /u, o, ɔ/ (see also Emeneau 1951:13-4). Significantly, too, Lau (2003) reports that the nasalized vowel [ɔ̃], which Vietnamese lacks, is adapted as [ɔm] in French loanwords, e.g.:

	French	*Vietnamese*	
a.	balkɔ̃	bɑŋkɔm	'balcony'
b.	savɔ̃	sɑfɔm ~ sɑbɔm	'soap'
c.	salɔ̃	sɑlɔm	'couch'

N.B.: I believe these words actually end in labial-dorsal [ŋ͡m]. They are written with final 'ng', for instance.

(69) *-xʔit* Inchoative

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

(70) *-xʷʔit* Inchoative

a.	ʤaqʷ-xʷʔit ~ ʤaqʷxʔit	‘to begin to blow (said of the ʤaqʷala wind)’
	ʤaqʷ-ala	‘north wind off the sea (also W, SW depending on location)’
b.	qakʷxʷʔit ~ qakʷxʔit	‘to begin to lose in the game’
	qakʷa	‘to suffer a loss (as in a game)’

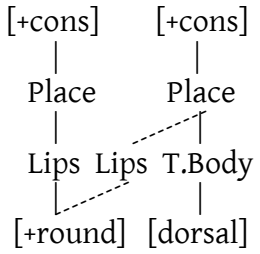
Likewise, the initial segment of the suffix –ʾχu ‘neck’, which is illustrated in (71), variably becomes rounded after a labialized obstruent, as shown in (72).

(71) *-χu* ‘neck’

a.	tqlʾχu	‘itching throat, to have an...’	tqɬa	‘to itch’
b.	gltʾχu	‘long neck, having a long neck’	glt	‘long, tall’

(72) *-χʷu ~ -χu* ‘neck’

a.	tsʾkʷχʷu ~ tsʾkʷχu	‘short neck(ed)’	tsʾkʷ	‘short’
b.	qʷlqʷχʷu ~ qʷlqʷχu	‘to sprain the neck’	qʷlqʷa	‘to sprain, wrench’
c.	mʾkʷχʷu ~ mʾkʷχu	‘to choke on sth. solid’	mʾkʷ-	



Here one can observe that the feature [+round] variably spreads from a labialized 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. (73), and there are lexical exceptions to rounding assimilation between obstruents, e.g. (74-77).

(73) *Some reduplications in Oowekyala*

a.	Kʾlχʷ-kʾlqʷa (*Kʾlχʷkʷʾlqʷa)	‘refers to a man urinating repeatedly’
	kʾlqʷa	‘to urinate (said of a male)’
b.	kʾiχʷ-kʾiχʷa (*kʾiχʷkʷiχʷa)	‘run, stop, run (repeatedly)’
	kʾiχʷa	‘to run away, escape, flee from’
c.	ɢuχʷ-ɢuχʷa (*ɢuχʷɢʷuχʷa)	‘to scoop repeatedly’
	ɢuχʷa	‘to scoop up loose things with one's hand’
d.	qʾcxʷ-qʾckʷa (*qʾcxʷqʷckʷa)	‘to eat meat’
	qʾckʷ	‘hair seal meat that has been cut up’

(74) *-χs* 'aboard'

a.	qɬikʷχs (*qɬikʷχʷs)	'to lie in the boat (said of animate beings)'
	qɬikʷa	'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'

(75) *-qəja* 'forehead'

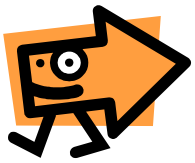
a.	tɬʼuqʷqəja (*tɬʼuqʷqʷəja)	'bald head, to be bald-headed'
	tɬʼuqʷa	'to make bald or bare, to cut off all hair'
b.	tɬʼaqʷqəja (*tɬʼaqʷqʷəja)	'red hair(ed)'
	tɬʼaqʷa	'red'
c.	mukʷqəjaut (*mukʷqʷəjaut)	'to tie sth. to the top of the head'
	mukʷa	'to tie a rope to something'
d.	buqʷqəja (*buqʷqʷəja)	'toque'

(76) *-(k)ga* 'inside'

a.	tsʼutsʼχʷga (*tsʼutsʼχʷgʷa)	'to wash the inside of things (e.g. of a pail), to do dishes'
b.	wɬukʷga (*wɬukʷgʷa)	'inside of sth. hollow (e.g. of a boat, cup, dish)'

(77) *-kaswɬu* 'plural'

a.	bukʷkaswɬu (*bukʷkʷaswɬu)	'books'
b.	tsʼikɬʷkaswɬu (*tsʼikɬʷkʷaswɬu)	'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 nɬkʼ 'siphon': nɬkʼgʷuɬ (*nɬkɬʷgʷuɬ). The nominalizer –kʷ also fails to induce rounding in a preceding (labializable) consonant, as exemplified here:

(78) *-kʷ 'nominalizer'*

a.	tʼəmakkʷ	'(door) locked with a key'
	tʼəmaka	'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 round-

ing "is typically concentrated on the release phase of the primary articulation that it accompanies." Similarly, Watson (1999:298):[121]

> 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.[122]

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 (79)-(81).

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

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

(80) *-(ʔ)iɲin ~ -(ʔ)uɲun 'resident of'* (Archangeli 1984:145)

a.	ʔal'tʰ-iɲin	'resident of salt-grass' (Poso Creek tribe)
b.	pal'(u)w-uɲun	'resident of west; westerner'

(81) *-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 (82-83).

(82) *-al ~ -ol 'dubitative'* (Archangeli 1984:78)

a.	ṯiʔs-al	'might make'
b.	hotʰn-ol	'might take the scent'

---

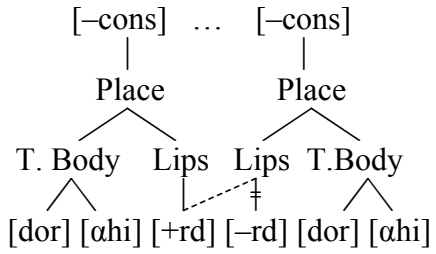
[121] Cf. Gussenhoven and Jacobs (1998:197):

> 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.

[122] 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 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 and Pulleyblank 1994) the progressive nature of rounding assimilation can be understood as appropriately reflecting the physical fact that rounded consonants are post-labialized, such that a following (labializable) consonant is naturally rounded.

(83) *-hatin ~ -hotin 'desiderative'* (Archangeli 1984:79)
- a. t'aw-hatin-xo:hin 'was trying to win'
- b. t̪os-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 "–".)



Exercises:

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

B. Explain the allomorphy in the following Turkish data.

(84) *Turkish* (Halle et al. 2000:396)

a.	ʃimdiki	'current'
	ʃimdi	'now'
b.	bugynky	'today's'
	bugyn	'today'
c.	jarɨnki	'tomorrow's'
	jarɨn	'tomorrow'

C. The Kwa language Nawuri (Casali 1990, 1993) has rounding assimilation, as illustrated with the singular noun-class prefix in (85a). Propose an explanation for the lack of rounding harmony in (85b).

(85) *Nawuri* (Halle et al. 2000:419)

a.	gujo	'yam'	b.	gɨ-mu	'heat'
	gu-ku:	'digging'		gɨfufuli	'white'
	gʊ-sʊ	'ear'		gɨ-pula	'burial'
	gʊ-lɔ	'illness'		gɨ-bo:to:	'leprosy'
				gɨ-k͡po:	a type of dance

3.3.2. Tongue Blade

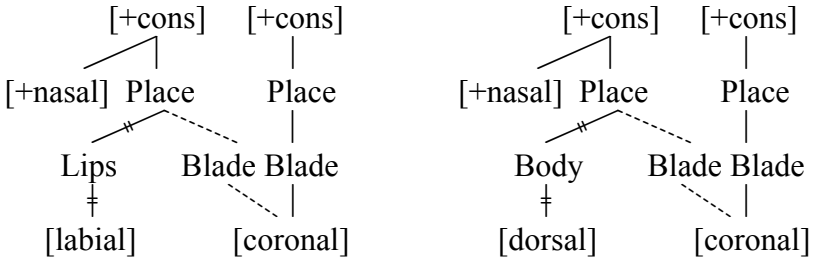
In this section we consider assimilatory and dissimilatory processes which involve the Tongue Blade features [coronal], [±anterior], and [±distributed].

3.3.2.1. [coronal]

An example of [coronal] assimilation occurs in the Sri Lankan Portuguese Creole (Smith 1978, Hume and Tserdanelis 1999, 2003, de Lacy 2002:326). In this language, a labial nasal becomes [coronal] preceding a [coronal] consonant, as shown in (86a), and similarly, a velar nasal assimilates to a following [coronal] consonant, as shown in (86b). 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 (86c).

(86) *Sri Lankan Portuguese Creole*

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



Another example is provided by nasal place assimilation in Chukchi (Chukotko-Kamchatkan: Bogoras 1922 et seq.[123]). As the following paradigm illustrates, an underlying /ŋ/ (87a) converts to [n] before coronals (87b-h).[124] Note that in (87d-h) *ŋ* assimilates the [coronal] articulation of *j*, *ɻ*, and *tʃ* but not their other Tongue Blade features [-anterior] or [+distributed].[125]

[123] Skorik (1961), Krause (1980), Kenstowicz (1980, 1986), Odden (1987), Spencer (2002), de Lacy (2002), Hume and Tserdanelis (2003).

[124] [a] ~ [e] alternations are due to vowel harmony (see section 3.3.3.2, p. 162ff. below). Bogoras’ and Kenstowicz’s *r* is written *ɻ* after its description in Spencer (2002:2.1) as “retroflex glide (like Standard British English)”. (87b) is from Spencer (2002:9.4.1.12).

[125] This surgical pattern of assimilation is not predicted by standard Articulator Theory nor by Vowel-Place Theory, since these theories assume that [±anterior] and [±distributed] depend on [coronal].

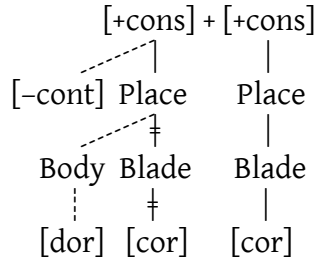
(87) *Place assimilation in Chukchi* (Bogoras 1922:653-7, Kenstowicz 1980:90-1)

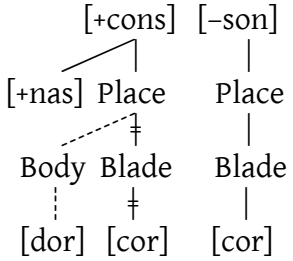
a.	[teŋ-əɬʔ-ən]	‘good’	e.	[tan-ɻan]	‘good house’
b.	[tan-leut]	‘good head’	f.	[tan-ɻʔaɻqə]	‘good breastband’
c.	[tan-ɬəmŋəɬ]	‘good story’	g.	[tan-tʲottʲot]	‘good pillow’
d.	[ten-jəɬqetək]	‘sleep well’	h.	[tan-tʲai]	‘good tea’

As an example of [coronal] dissimilation, consider first 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 (89a). However, when both C’s of the copied syllable are [coronal], one is realized as [k] in reduplication, as shown in (89b). This change in Dakota reduplication is an instance of [coronal] dissimilation.

(88) *Dakota reduplication*

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





Syllable-final /n/ followed by a [coronal] obstruent in coda position also changes to [dorsal] in Swedish. This “dental dissimilation rule” (Hellberg 1974:140), which is both optional and lexically restricted, is illustrated in (89).

(89) *Swedish coronal dissimilation* (Hellberg 1974:138-9)

a.	*balans*	[balán:s] ~ [baláŋ:s]	‘balance’
b.	*annons*	[anɔ́n:s] ~ [anɔ́ŋ:s]	‘advertisement’
c.	*excellent*	[ʃarmán:t] ~ [ʃarmáŋ:t]	‘excellent’
d.	*pomerans*	[pumərán:s] ~ [puməráŋ:s]	‘bitter orange’

On this assumption in Articulator Theory, see Sagey (1986b, 1990), Halle (1988, 1989, 1992, 1995), McCarthy (1988), Pulleyblank (1989, 1995), Shaw (1991), Broe (1992) Keyser and Stevens (1994), and Clements and Hume (1995:245-75). For the same assumption in Vowel-Place Theory, see references in fn. 117 on p. 135.

These theories of feature geometry also cannot account for nasal Place assimilation in Acehnese (Austronesian: Durie 1985, Al-Harbi 2003): only [m] occurs before labials (e.g., *gumpa* ‘earthquake’), only [n] occurs before coronals (e.g., *mɨntrə* ‘vizier’), and only [ŋ] occurs before dorsals (e.g., *naŋgrə* ‘country’). Crucially, /ɲ/ is a phoneme in Acehnese (Durie 1985:19) yet apico-alveolar [n], not palatal [ɲ], also occurs before palatals (e.g., [hanco], *[haɲco] ‘broken’); for discussion, see Al-Harbi (2003:13-4).

In Chukchi (cf. (87) above) [coronal] *j* changes to [dorsal] ɣ when followed by a coronal consonant (Kenstowicz 1980, Odden 1987, Rice 1996:521):[126]

> [T]he change of [j] to the velar spirant [ɣ] before coronals ... is a quite regular rule, as evidenced by the behavior of Russian loanwords such as *ʧaj* 'tea': cf. *ʧaɣ-te* (plural), but *ʧaj-paw-ək* 'to drink tea', *ʧaj-kojŋ-ən* 'tea cup'. (Kenstowicz 1986:87)

In many languages, including English, coronals are permitted before *r* (e.g., *three*, *tree*, *dream*) at the beginning of syllables whereas they are disallowed before *l* in the same position (*θlV, *tlV, *dlV).[127] This seems to be a particular case of coronal dissimilation involving [+lateral]. This dissimilation effect is especially apparent in Ewe (Westermann 1930, Clements 1976, Halle and Clements 1983, Hume 1994:31-2), where [r] and [l] are in complementary distribution: [l] is used after [labial] or [dorsal] consonants (90a) whereas [r] is used after [coronal] consonants (90b).

(90) *Ewe liquids*

a.			b.		
	blá	'to tie'		trɔ́	'to turn'
	kló	'to uncover'		ɲrà	'to be enraged'
	k͡plɔ̀	'to accompany'		dᶻrá	'to sell'
				jrɔ̀	'to be dried up'

Finally, recall from section 3.3.1.1 that [labial] becomes [+round] when it spreads from a consonant to a vowel (also Halle et al. 2000:416). Akin to this peculiarity, [coronal] appears to become [–back] when it spreads from a consonant to a vowel (ibid.). For instance, non-final /o/ converts to [ø] after coronals in Moroccan Arabic (Hume 1994:8-9), e.g., (91a) (cf. (91b)). The change from [coronal] to [–back] is shown in (92).

(91) *Moroccan Arabic* (David Odden, p.c.)

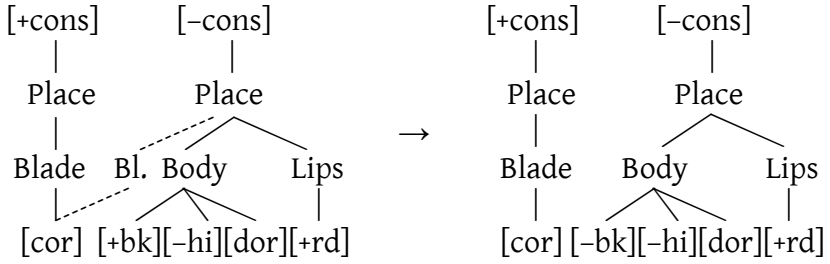
a.			cf.		
	qtløh	'they killed him'		qtlo	'he killed him'
	ma qtløʃ	'they didn't kill'		qtlo	'they killed'
	dhɛʃøk	'they surprised (2s)'		dhɛʃo	'they surprised'
	ma wznøʃ	'they didn't weigh'		wuzno	'they weighed'
	ʕaqdøh	'tie (pl.) him!'		ʕaqdo	'tie (s.) him!'
	ma ṣəmtøʃ	'they weren't quiet'		ṣəmto	'they were quiet'
	ma ktəbtøʃ	'I didn't write it'		ktəbto	'I wrote it'
	ma xəbzøʃ	'they didn't bake it'		xəbzo	'they baked'
	ħəbsøh	'they arrested him'		ħəbso	'they arrested'

[126] The change may actually be to [k], as in Dakota, since [k] regularly lenites to [ɣ] preconsonantally (Kenstowicz 1986:80).

[127] /s, ʃ/ are exceptional in being permitted before /l/ syllable-initially, e.g., *sleep*, *Schlepp*. These segments are known to be exceptional in general. For instance, they are the only consonants permitted before nasals, e.g., *snow*, *small*, *schnapps, schmuck*. Note that words beginning in ʃ+C, where C ≠ ɹ, derive from Yiddish.

b.	lemmoh	‘they covered him’	cf.	lemmo	‘they covered’
	ʒleboh	‘they attracted him’		ʒlebo	‘they attracted’
	təbɣoh	‘they tanned him’		dəbɣo	‘they tanned’
	ma ḍərboʃ	‘he didn’t hit him’		ḍərbo	‘he hit him’
	ma wqfoʃ	‘they didn’t stand’		wuqfo	‘they stood’
	ma ḅxxoʃ	‘they didn’t spit blood’		ḅxxo	‘they spit blood’

(92)



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).

(93)

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		

C. Almost 400 years ago, two French missionaries, Chaumonot and Sagard, wrote two dictionaries of Huron, an Iroquoian language once spoken in Quebec and Ontario (Mithun 1985). Some of the words they wrote down show differences in [t] vs. [k], e.g.:

(94)

	Chaumonot		*Sagard*	
a.	atjɛ̃	‘to sit down’	sakjɛ̃	‘sit down’
b.	ɛ̃tjek	‘at noon’	ɛ̃kjeke	‘at noon’
c.	akatjerɔ̃	‘I would do’	tekakjerha	‘I do nothing’

One possibility is that the two missionaries described different dialects of Huron, and that these dialects differed in their use of [t] vs. [k] in some context. Indeed, the same differences are found across modern dialects of Mohawk, another Iroquoian language of Quebec and Ontario, e.g.:

(95)

	Caughnawaga dialect	*Akwesasne dialect*	
a.	satjʌ̃	sakjʌ̃	'sit down'
b.	ʌ̃tje	ʌ̃kje	'noon'
c.	na:tjereʔ	na:kjereʔ	'I would do it'

Another possibility is that the two missionaries described alternate pronunciations of the same word in Huron. For example, in Cayuga, an Iroquoian language spoken in Ontario, the same words are still pronounced with either [t] or [k], e.g.:

(96)

a.	satjɛ̃ ~ sakjɛ̃	'sit down'
b.	na:tje:ʔ ~ na:kje:ʔ	'I would do it'
c.	thɛ̃ʔ thaʔjetje:haʔ ~ thɛ̃ʔ thaʔjekje:haʔ	'I don't do it'

Give a formal phonological account of the alternation between [t] and [k] in these various Iroquoian languages.

D. Explain vocalic differences between Classical Armenian and the Agn dialect of this language (Vaux 1999a).

(97) *Armenian* (Halle et al. 2000:400)

	Classical	*Agn*			*Classic*	*Agn*	
a.	doł	dʰøʁ	'tremor'	k.	galoł	gʰaløʁ	'coming'
b.	gałt-uk	gʰaʁdyk	'secret'	l.	heɾu	heɾy	'last year'
c.	atʰor	atʰør	'chair'	m.	bot͡sʰ	bʰot͡sʰ	'flame'
d.	moraț͡sʰoł	moɾț͡sʰøł	'forgetting'	n.	poɾt	boɾd	'navel'
e.	t͡ʃʰoɾs	t͡ʃʰøɾs	'four'	o.	pʰołkʰ	pʰoχg	'throat'
f.	t͡ʃuχa	t͡ʃyχa	'cloth'	p.	Muʃeł	Muʃeχ	a personal name
g.	d͡ʒuɾ	d͡ʒʰyɾ	'water'	q.	kot͡sʰ	gʰot͡sʰ	'closed'
h.	nor	nør	'new'	r.	kʰor	kʰor	'unit of grain'
i.	χoʃoɾ	χoʃøɾ	'large'	s.	gud	gud	'grain'
j.	soχ	søχ	'onion'	t.	χuț͡sʰ	χuɾț͡sʰ	'room'

3.3.2.2. [±anterior][128]

[+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:

(98) a. *-na:* present

mɽd-na:	'be gracious'	iʂ-ɳa:	'seek'

b. *-na* passive participle

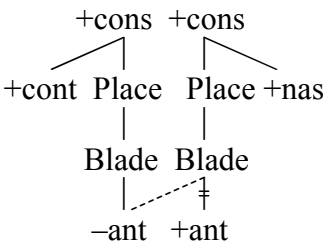
bʱug-na-	'bend'	puːɽ-ɳa	'fill'
		vɽk-ɳa-	'cut up'

c. *-aːna* middle participle

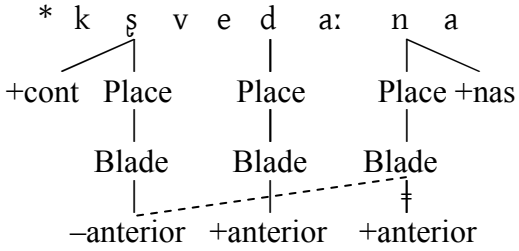
maɽj-aːna-	'wipe'	puɽ-aːɳa	'fill'
kʂved-aːna-	'hum'	kʂubʱ-aːɳa	'quake'

d. *-maːna* middle participle

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:



[128] This section owes much to Kenstowicz (1994).

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 (99). Pairs such as *slow̰* 'eagle' vs. *ʃlow̰'* 'goal line' show that [±anterior] is contrastive. Barbareño has a process of "sibilant harmony" whereby sibilants must agree in anteriority within a word, e.g.:

(99) *Sibilants in Barbareño Chumash*

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

(100) *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 (101) alternate in terms of [±anterior] in words with the suffixes in (102), as illustrated in (103).

(101) *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'		

(102) *Barbareño suffixes with sibilants*

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

(103) *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'

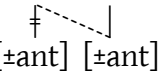
c.	/k-saʔ-su-kuj/	ksaʔsukuj	/s-su-kuj-aʃ/	ʃʰujujaʃ
	1-future-caus.-boil	'I will boil it'	3-caus.-boil-result.	'boiled islay'

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 (101)-(102) are provided in (104) (from Shaw 1991). As shown, [s] assimilates [–anterior] from [ʃ] or [tʲ] in (104a,b,c); and [ʃ] assimilates [+anterior] from [s] in (104d).

(104)	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-naɲ/	piʃanaɲ	'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.

(105)



The forms in (106) highlight an important distinction between long-distance assimilations in Sanskrit and Barbareño: the nonsibilant coronals [t, n, l] do not trigger (106a), do not undergo (106b) and do not block (106c) the assimilation of [±anterior]. (There are several examples of these facts also in (103) and (104) above.)

(106)	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 (105): 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),[129] 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", "target", 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. Try to explain the changes illustrated in the following data from Tsuut'ina (Athapaskan, Alberta) (Cook 1984).

(107)	a.	/si-tˢogo/	ʃìtˢógò	'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'

B. Michif is the traditional language of Canada's Métis people (Bakker 1997).[130] Explain the difference between the following words in French and Michif:

(108)	*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'

[129] 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.

[130] 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.

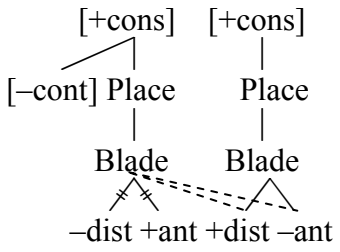
3.3.2.3. [±distributed]

The feature [±distributed] often patterns with the other Tongue Blade feature, [±anterior], in phonological processes. Consider a first example from English (109). In casual speech, the coronal stops /t, d, n/ become dental before [θ], postalveolar before [ʃ, ʒ], and retroflex before [ɹ].

(109)

	[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 pre-preceding coronal stop. 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 are the outcome of coronal assimilation.



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):

(110)

a.	/taːn-ɖimbʱaːn/	[taːɳɖimbʱaːn]	‘those infants’
b.	/taːn-dᶻanaːn/	[taːɲdᶻanaːn]	‘those people’
c.	/etat-tᶴʰattram/	[etatʲtᶴʰattram]	‘this umbrella’
d.	/tat-ɖaukate/	[taʈɖaukate]	‘it approaches’
e.	/tatas-tʲa/	[tataʃtʲa]	‘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.

alveolar	*palatal*	*retroflex*
t	tᶴ	ʈ
s	ʃ	ʂ
n	ɲ	ɳ
		ɽ
[+ 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.

(111) a. /maha:n-kavih/ [maha:nkavih] ‘great poet’
b. /maha:n-bʱa:gah/ [maha:nbʱa:gah] ‘illustrious’

Exercises:

A. In Tarma Quechua, “/ʃ/ is retroflex [ʂ] before /ʈ/, palatal [ʃ] in other environments; /puʃʈu/ [púʂʈu] ‘a bean dish’; /aʃtaj/ [áʃtaj] ‘ to carry’” (Adelaar 1977:32). Explain.

B. 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
	n̰								ʔ

Provide a full explanation for the following alternations.

1. *Alternations in* ‘1st person sing.’

a.	θɛθðɛɬ	‘I’m hot’
b.	hudiʃtʃa	‘I love them’
c.	ɛskʼa:	‘I’m gutting fish’
d.	dɛθkʷʊθ	‘I cough’
e.	ɛʃdʒɪni	‘I’m singing’
f.	nadɛdɛ:sba:tɬ	‘I hung myself’
g.	ɛθdu:θ	‘I whipped him’
h.	ɬɛnɛʃtʃu:ʃ	‘I’m folding it’
i.	ɛsdan	‘I’m drinking’
j.	mɛθɛθɛθ	‘I’m wearing (on feet)’
k.	nɛʃjɛɬ	‘I’m growing’
l.	sɛsxɛɬ	‘I’m going to kill it’
m.	naθtθ’ɛt	‘I fell off’
n.	nɛstɛɬ	‘I’m sleepy’
o.	ɛdɛdɛθdu:θ	‘I whipped myself’
p.	noʔɛdɛ:ʃɬɛdʒi	‘I melted it over and over’
q.	taθtθaɬ	‘I’m dying’
r.	jaʃtɬ’ɛtʃ	‘I splashed it’
s.	xaʔɛθtʼaθ	‘I’m cutting the hair off’

2. *Alternations in* ‘1st pers. pl.’

a.	dɛθigitɬ	‘we threw it’
b.	dɛsidzɛl	‘we shouted’
c.	iʃitʃotɬ	‘we blew it up’
d.	naθiba:tɬ	‘we hung it’
e.	xasi:dɛts	‘we plucked it’
f.	tɛ:dɛnɛʃidʒu:t	‘we chased it away’
g.	θi:tθædi	‘we ate it’
h.	dɛsitʼʌs	‘we are walking’
i.	uʃidʒɛ	‘we are called’
j.	nisitʼa:ts	‘we got up’
k.	mɛʔɛʃitʼotʃ	‘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]

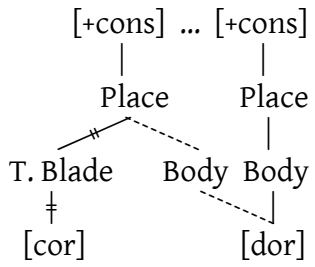
Assimilation of the feature [dorsal] is perhaps most dramatically illustrated by "velar harmony" in child phonology, e.g. (112a). In most cases, this process of [dorsal]-spread targets coronals, and it is usually regressive. As Bernhardt and Stemberger (1998:558) observe, "there is often velar harmony in *take* (/teɪk/ [kʰeɪk]) but not in *Kate* (/keɪt/ [kʰeɪt])." This process can therefore be represented as in (112b).

(112) *Velar harmony* (Bernhardt and Stemberger 1998)

a.

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

b.

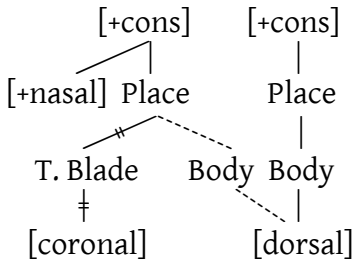


In section 3.3.1.1 (p. 131ff.), we saw that a nasal assimilates to a following [labial] consonant in many languages; compare *in-destructible* vs. *im-possible*. In English, a nasal does not always assimilate to a following [dorsal] consonant, e.g., *in-competent*, but velar assimilation is indeed obligatory within morphemes, e.g., *bu*[ŋk]*er*, *hu*[ŋg]*er*.[131]

[131] 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 (113a) and labiovelars (113b,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'.)



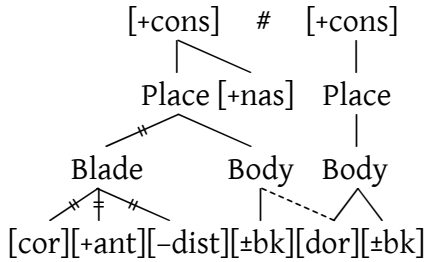
(113)

a.	ŋ-klɛmpɛ	'my basin'
b.	ŋ-g͡bekɛ	'my child'
c.	ŋ-k͡pai	'my cheeks'

That [dorsal] spreads separately from other Tongue Body features such as [±back] is well-illustrated by Irish dorsal assimilation (de Bhaldraithe 1945:§260, Ní Chiosáin 1994:95-6): a word-final coronal nasal optionally assimilates to the dorsal articulation of a following consonant, regardless of whether either the source or the target of assimilation is palatalized or velarized, e.g. (114).[132] Here the articulator feature [dorsal] spreads from a consonant to a preceding coronal nasal, independently of the specification for [back] in either the source or the target (Halle et al. 2000:421-3, 434-9).

(114) *Irish* (Ní Chiosáin and Padgett 1993:7)

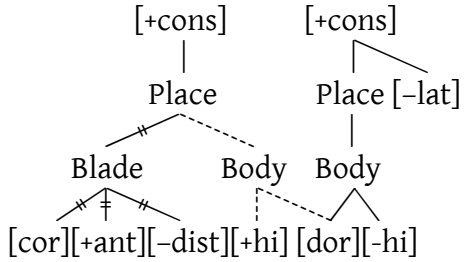
a.	dʲekʲhʲinʲ	'I would see'
	dʲekʲhʲiŋʲ gan eː	'I would see without it'
b.	dʲiːlən	'a diary'
	dʲiːləŋ gʲiːvʲrʲi	'a winter's diary'



A comparable point can be made with Child French (data from Rose 2000b:237). Initial coronal stops assimilate to the dorsality of a following uvular rhotic /ʁ/, as shown in (115).[133] [dorsal] spreads from the rhotic to a preceding coronal, independently of [high]; the target is assigned [+high], while the source [ʁ] is [–high].

(115) *Théo* 2;05-4;00 (Rose 2000b:237)

	Target	*Child*	
a.	dʁol	gʁol	'funny'
b.	dʁɑgɔ̃	kx̟ɔgɔ̃	'dragon'
c.	tx̟ɛ̃	kx̟ɛ	'train'
d.	tx̟o	kx̟o	'too much'
e.	sitx̟ʊj	kʁœj	'pumpkin'



[132] Non-palatalized consonants are velarized in Irish, particularly when adjacent to front vowels (Ní Chiosáin and Padgett 2001). This is not shown in (87). See Ní Chiosáin (1994:103, n. 2) for arguments that [back] is indeed responsible for palatalized/non-palatalized contrasts in Irish.

[133] Only coronals are targeted; cf. [bʁɑ] 'arm' (2;10.05), [px̟i] 'occupied' (2;09.12) (ibid.).

Cases of [dorsal] assimilation discussed so far have been regressive.[134] 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:

> The forms in [(116a)] show that /-te/ is realized without change after a root-final /m/. ... It is the examples in [(116b)] that interest us here: the input sequence /ŋ+t/ is realized [ŋk]. The /t/ has assimilated to the velar place of the preceding [ŋ].[135]

(116) *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'

Another likely case of progressive [dorsal] assimilation is the velarization of nasals in syllable-final position, a pattern that is remarkably common across languages.[136] This process targets a specific syllable-final nasal in some instances, for example, the palatal nasal in Canadian French: "When /ɲ/ occurs preconsonantally or in word-final position, that is to say at the end of a syllable, a productive process causes it to be realized as the velar [ŋ]" (Walker 1984:115), e.g. (117).[137] This change is unconditioned by the height or backness of the preceding vowel.

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[134] 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.

[135] 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.

[136] Examples abound in Austronesian (e.g., Aronoff et al. 1987, Goldsmith 1990:131), Bantu (e.g., Hyman 1975a:168), Niger-Congo (e.g., Creissels 1989:93-6, Olawsky 2002:206-11), West Germanic (e.g., Kuepper 1992, Hoeksema 1999, Van Oostendorp 1999 et seq.), Romance (e.g., Resnick 1975:29, Lipski 1975, Porto Dapena 1976, Guitart 1981, Harris 1983, Anderson 1986, Durand 1988a, 1988b, Bullock 1995, Van Deyck 1996), Papuan (e.g., Wurm 1982), Cariban (e.g., Jackson 1972:47, Peasgood 1972:39, Edwards 1978:226, Abbott 1991), Totonacan (e.g., MacKay 1994:380), Sino-Tibetan (e.g., Chen 1973, Chen 1981, Rutgers 1998), Japanese (e.g., Trigo 1988, Yip 1991), Mongolian (Poppe 1970:55), and elsewhere. Coda nasals also velarize in child language (e.g., Hua and Dodd 2000:27).

[137] Carrier (Athabaskan: Cook 1985) also velarizes syllable-final /ɲ/.

(117) *Nasal velarization in Canadian French* (Walker 1982:76, my transcriptions)

a. *Onset position*		b. *Word-finally*		c. *Preconsonantally*	
gɑɲe	'won'	gɑŋ	'win!'	gɑŋpɛ̃	'job' (win-bread)
ãseɲe	'taught'	ãsɛŋ	'teach!'	ãsɛŋmã	'teaching'
peɲe	'combed'	pɛŋ	'comb!'	pɛŋwaʀ	'peignoir'
liɲe	'lined'	lɪŋ	'line'	ãlɪŋmã	'alignment'

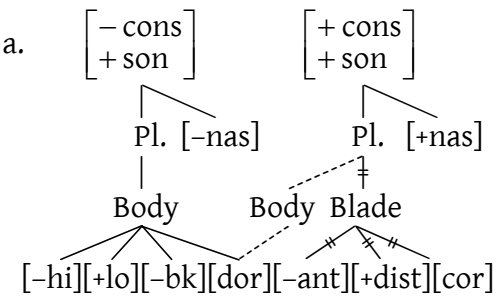
All syllable-final nasals are targeted in other languages, such as Ligurian (Romance: Ghini 1995) which distinguishes /m, n, ɲ, ŋ/ (e.g., *ramu* 'branch', *raɲu* 'spider', *pena* 'pen', *peŋa* 'pain'), but which permits only [ŋ] in syllable-final position: word-finally (118a) and even before heterorganic[138] consonants (118b,c). Again, the quality of the vowel preceding the nasal seems immaterial to the change; the resultant nasal is always high and back.

(118) *Nasal velarization in Ligurian* (Ghini 1995:58-9)

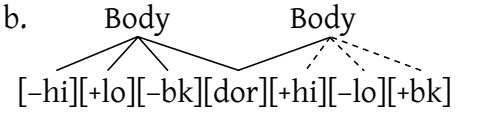
a. *Word-finally*		b. *Before labials*		c. *Before coronals*	
viŋ	'wine'	puŋpa	'pump'	tʲaŋta:	'plant (v.)'
tʲaŋ	'even'	riŋbursu	'refund'	veŋde	'sell'
noŋ	'not'	ruŋfu	'I snore'	fiŋze	'pretend'
feŋ	'fine'	kaŋpaŋŋa	'bell'	iŋʃa:	'blow up'

Crucially, syllable-final velarization can be understood as [dorsal] assimilation. To illustrate, consider the French word [pæɲ] 'skirt'. Because the [dorsal] feature is terminal in the vowel tree, it can spread individually to the following nasal (ɲ), causing its Place features to delink, as represented in (119a). The other Tongue Body features for [ŋ] are then filled in, as in (119b). This is arguably what happens in Canadian French where /ɲ/ becomes [ŋ] syllable-finally, e.g., /kãpæɲ/ → [kãpæŋ] 'countryside' (cf. [kãpæɲaʀ] 'country person'), /ɛspæɲ/ → [ɛspæŋ] 'Spain' (cf. [ɛspæɲol] 'Spanish'). Note that in these particular examples, none of the other Tongue Body features of the vowel [æ], namely [–high, +low, –back], are obviously spread to [coronal] *ɲ* which nonetheless converts to [dorsal] *ŋ*, which is [+high, –low, +back].[139]

(119) a.



b.



[138] Heterorganic means 'at a different place of articulation'.

[139] In Canadian French (unlike in Standard French) [back] is contrastive at every vowel height level, even [+low]: e.g., [pæt] 'paw' *vs.* [pɑt] 'noodle', [tæʃ] 'stain' *vs.* [tɑʃ] 'task', [mæl] 'case' *vs.* [mɑl] 'male' (Walker 1984:77-8).

Turning to dissimilation of [dorsal], consider the case of Gullah English (Klein and Harris 2001) where /wn/ regularly becomes [wŋ] word-finally, e.g., *down* [dawŋ], *drown* [dɹawŋ], *around* [(ə)ɹawŋ], *sundown* [sʌndawŋ]. Evidently [dorsal] spreads from labiodorsal /w/ to /n/, giving [ŋ]. Interestingly, Klein and Harris (2001) observe that this assimilation fails if it would result in tautosyllabic[140] dorsal consonants, e.g., *gown* [gawn], *[gawŋ]; *ground* [gɹawn], *[gɹawŋ]. This is a dissimilation effect: Gullah avoids two [+consonantal, dorsal] segments in the same syllable.

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. Suggest an explanation of the following speech error: *extracted* >^{e} [ɛkstɹæptɪd] (Fromkin 1971).

C. 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.)

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

D. 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’

E. 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)

[140] Tautosyllabic means ‘in the same syllable’.

puppy	pəʔiː	*can*	kænd	*walked*	wɑkt
kick	kɪʔ	*did*	dɪʔ	*Bobby*	bɑʔiː
baby	beɪʔiː	*beat*	biːt	*tag*	tæg
walks	wɑkt	*cake*	keɪʔ	*paper*	peɪʔəɹ
ran	rənd	*died*	daɪʔ	*takes*	teɪkt
men	mænd	*took*	tʊk	*dogs*	dɑgd
pet	pɛt	*bit*	bɪt	*toot*	tuːʔ
				suit	tuːʔ

F. 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. (Halle & Clements 1983)

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

G. Syllable-final [t, n] shifted to [k, ŋ] in some Min dialects of Chinese (Chen 1973, Rice 1996:512), such that the Xiamen words *tsʰit* 'seven' and *sin* 'new' are pronounced with final [k, ŋ] in adjacent Chaozhou (cf. Xiamen/Chaozhou: *pak* 'north', *taŋ* 'winter') (Norman 1988:236-7). Suggest an account of this development.

H. Alveolar and uvular rhotics alternate freely in many dialects of European languages. Interestingly, in several such dialects [r] is favored in syllable-initial position while [ʁ] is favored in syllable-final position. Zhirmunksii (1962) first reported this distribution for some Cologne dialects of German. For instance, he found that syllable-final [ʁ] in, e.g., *Ferkel*, *werfen*, *Sturm* is realized [r] if these words are pronounced with anaptyxis: *fęrəkəl*, *vęrəpə*, *štorəm* (p. 378). Suggest an account of this alternation.

3.3.3.2. [±back]

Mataco, a Macro-Guaicuruan language spoken in Argentina and Bolivia, contrasts velar *vs.* uvular stops. The uvular stop is always [q] but, for some reason, the velar stop varies freely between [–back] [kʲ] and [+back, +round] [kʷ], e.g.:

(121) *Mataco velars vs. uvulars* (Claesson 1994)

a.	ʔitaːkʷàh ~ ʔitaːkʲàh	name	*cf.*	ʔnoːqàs	‘plant’
b.	ʔakʷah ~ ʔakʲah	‘ow!’		qamax	‘still’
c.	ʔnoːwukʷe ~ ʔnoːwukʲe	‘house’		qelhih	‘hurry!’
d.	ʔakʷih ~ ʔakʲih	‘oh!’		ʔnoːqileʔ	‘picked bone’
e.	niːjàkʷ ~ niːjàkʲ	‘cord’		ʔnolhàq	‘food’
f.	teːtakʷ ~ teːtakʲ	tree		qalaːq	‘heron’
g.	ʔõːkʷéjʔ	‘my hand’		ʔõːqéjʔ	‘my habit’
h.	tokʷ	‘not’		toːq	‘toucan’

As shown in (121), 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]. However, [q] is never found syllable-finally after [e, i], whereas [kʲ] does occur in that environment, e.g.:

(122) *Mataco velars vs. uvulars* (Claesson 1994)

a.	nẽkʲ	‘(s)he comes’	*cf.*	*nẽq
b.	jikʲhiːjelah	‘(s)he’ll go for it’		*jiqhiːjelah

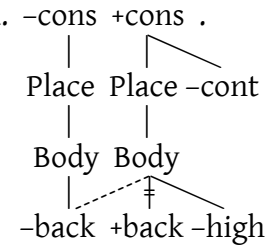
To account for this gap, Claesson (1994:16) gives the following rule:

$$q \rightarrow k / \left\{ \begin{matrix} e \\ i \end{matrix} \right\} \text{---} .$$

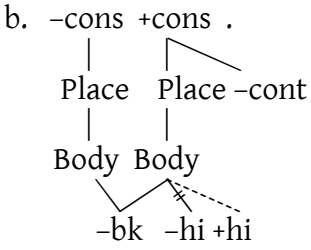
That is, a syllable-final uvular becomes velar when preceded by a front vowel. Reference to the syllable boundary (shown in IPA by a period “.”) appears necessary as the assimilation occurs only between segments in the same syllable; cf., e.g., ʔiːqatˢih ‘s/he is there’ (Claesson 1994:17).

In featural terms, this rule can be understood as follows: [–back] spreads from a vowel to syllable-final [q], as in (123a), and concomitantly [–high] is changed to [+high], as in (123b). (Recall that uvulars are [–high] while velars are [+high].)

(123) a.

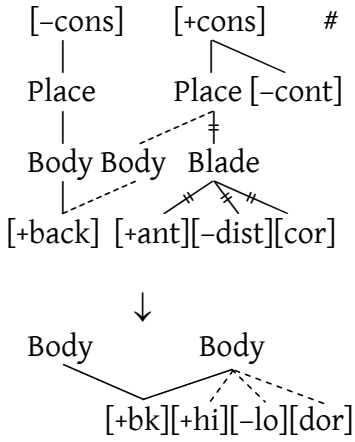


b.



An interesting example of [+back] spreading is found in the Hue dialect of Vietnamese (Thompson 1987:82-5, Rice 1996:508-9). As a comparison with the Hanoi dialect reveals, final [t, n] have shifted to [k, ŋ] after back vowels in Hue (125a,b). This velarization effect does not extend to coronals after front vowels (125c), nor to noncoronals (125d,e). As such, it may be treated as [+back] assimilation, with other Tongue Body features filled-in, as in (124).

(124)



(125)

	Han.	*Hue*			*Han.*	*Hue*	
a.	mə̰t	mə̰k	'one'	b.	ŋɔn	ŋɔŋ	'be tasty'
	xwʌ́t	xuʌ́k	'to exit'		xwʌn	xuʌŋ	'to exit'
	lwə̰̀t	luə̰̀k	'law'		twʌ̀n	tuʌ̀ŋ	'week'
	ɤ̌t	ɤ̌k	'pimento'		hɤn	hɤŋ	'be more'
	biét	bíʌk	'know'		xɛn	xɛʌŋ	'commend'
	ɗút	ɗúk	'to break'		vɯ̰̀n	vɯ̀ʌŋ	'garden'
c.	sétˢ	sét	'book'	d.	tíʌŋ	tíʌŋ	'noise, sound'
	æɲ	æn	'elder brother'		nɯ́ɤk	nɯ́ʌk	'water'
	ít	ít	'be little'	e.	tiép	tíip	'continue'
	ɗén	ɗén	'arrive'		ɯ́ɤp	ɯ́ɯp	'to perfume'

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

(126) *Polish* (Rubach 1984, Gussmann 2002)

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 similar but more complex assimilation occurs in Acadian French (Hume 1994). The consonants affected in this case are /k, g/. As illustrated in (127), [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 palatalization in Polish. The variable change to [tʃ, dʒ] (*coronalization*) is really a change

from [dorsal, -back] to [coronal, –anterior, +distributed], a switch which is rather common across languages. For discussion of this switch, which makes eminent sense articulatorily, see Calabrese (1993a, 1993b) and Halle et al. (2000).[141]

(127) *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 palatalized. For example, the plural suffix is [lʲɑrʲ] after stems with palatalized consonants, and [lɑr] otherwise; the ablative suffix is [dʲɑnʲ] after stems with palatalized consonants, and [dɑn] otherwise. Compare kuŋ-lɑr-dɑn 'servant-PL-ABL' vs. kʲunʲ-lʲɑrʲ-dʲɑnʲ 'day-PL-ABL'. This pattern is peculiar because [–back] spreads across intervening [+back] vowels, yet these remain unaffected by the harmony process. A full analysis of this pattern is now available in Nevins and Vaux (2003).

(128)

	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. (129a), or all [+back], e.g. (129b) (Poppe 1970, Steriade 1979, Svantesson 1985, Goldsmith 1985).

(129) a. [k ø t e l b y r i] 'instruction' — [–bk]

b. [u ɣ u t ɑ] 'bag' — [+bk]

[141] For the treatment of palatalization/coronalization in Vowel-Place Theory (fn. 117, p. 135), see esp. Hume (1994, 1996, also Clements and Hume 1995).

In Turkish, suffix vowels alternate in [±back] depending on the [±back] specification of the stem vowels, as illustrated in (130) (Lees 1961, Ringen 1980, Yavas 1980, Kardestuncer 1983, Roca and Johnson 2000).

(130) *Turkish* (Goldsmith 1990:304)

	Nom. sg.	*Gen. sg.*	*Nom. pl.*	*Gen. pl.*
'rope'	ip	ip-in	ip-ler	ip-ler-in
'hand'	el	el-in	el-ler	el-ler-in
'girl'	kɯz	kɯz-ɯn	kɯz-lar	kɯz-lar-ɯn
'stalk'	sap	sap-ɯn	sap-lar	sap-lar-ɯn
'container'	kap	kab-ɯn	kap-lar	kap-lar-ɯn

Similarly, suffix vowels generally agree with the [±back] specification of root vowels in Hungarian (Ringen 1988, Ringen and Kontra 1989, Ringen and Vago 1998), e.g., (131a-c).

(131) *Hungarian*

			'to'	'from'
a.	ørøm	'joy'	ørøm-næk	ørøm-tø:l
	idø:	'time'	idø:-næk	idø:-tø:l
	tømeg	'crowd'	tømeg-næk	tømeg-tø:l
b.	ha:z	'house'	ha:z-nak	ha:z-to:l
	varos	'city'	varos-nak	varos-to:l
	mo:kus	'squirrel'	mo:kus-nak	mo:kus-to:l
c.	vi:z	'water'	vi:z-næk	vi:z-tø:l
	ke:ʃ	'knife'	ke:ʃ-næk	ke:ʃ-tø:l
d.	katʃi	'coach'	katʃi-nak	katʃi-to:l
	radi:r	'eraser'	radi:r-nak	radi:r-to:l
	kave:	'coffee'	kave:-nak	kave:-to:l
	bo:de:	'hut'	bo:de:-nak	bo:de:-to:l

Roots with only [–back] /i, e/ will normally take suffixes with [–back] vowels (131d).[142] But a complication is shown in (131c): when a [+back] vowel precedes [–back] /i, e/ in a root, the suffix alternant is still [+back]. In this respect, /i, e/ are said to be "transparent" (or "neutral", or "skippable": Smith and McCarthy 2003) to [±back] harmony in Hungarian. Most phonologists impute this transparency effect to the fact that these vowels have no [+back] counterparts in Hungarian (*ɨ, *ʉ, *ɘ, *ɤ): [–back] is thus non-

[142] There is an exceptional class of roots with [–back] /i, e/ which nonetheless take a [+back] suffix, e.g.:

		'to'	'from'
ki:n	'torture'	ki:n-nak	ki:n-to:l
hi:d	'bridge'	hi:d-nak	hi:d-to:l
tˢe:l	'target'	tˢe:l-nak	tˢe:l-to:l

The standard view is that in these cases "the root morpheme has a floating [+back] feature" (Ringen and Vago 1998:399, see also Clements 1977, Hulst and Smith 1985, Kiparsky 1981, etc.)

contrastive in /i, e/. By contrast, [–back] /y, ø, æ/ are carefully distinguished from [+back] /u, o, ɑ/, respectively.[143] In other words, Hungarian grammar appears to spread contrastive [±back] over *non-contrastive* [–back] in vowel harmony.

(132) a. r ɑ d i r - n ɑ k
[+bk][*–bk*]

b. b o: d e: - t o: l
[+bk][*–bk*]

Turning now to dissimilation, consider the following pattern from Ainu, a linguistic isolate of northern Japan (Ito 1984, Archangeli and Pulleyblank 1994). The transitivizing suffix alternates between *-i* and *-u*; it surfaces as [–back] *-i* when the root vowel is [+back], e.g. (133a), and it surfaces as [+back] *-u* when the root vowel is [–back], e.g. (133b). This appears to be a case of dissimilation on [±back]: the transitivizing vowel alternates in [±back] in order to avoid a situation in which two [+back], or two [–back], occur in the same word.

(133) *Transitivizing suffix in Ainu*

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

Exercises:

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

(134)	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. Explain the alternations in the form of suffixes in the following data from Turkish (cf. (130)) (Roca and Johnson 2000:167-8).

[143] Hungarian [æ, ɑ] are actually closer to English [ɛ, ɒ], respectively.

(135)

		Nom. sg.	*Gen. sg.*	*Nom. pl.*	*Gen. pl.*
a.	'face'	jyz	jyzyn	jyzler	jyzlerin
b.	'stamp'	pul	pulun	pullar	pullarɯn
c.	'village'	køj	køjyn	køjler	køjlerin
d.	'end'	son	sonun	sonlar	sonlarɯn

C. Explain the alternations in the form of suffixes in the following data from Finnish (Roca and Johnson 2000:168)

(136)

talo-ssa	'in the house'	kylæ-ssæ	'in the village'
turu-ssa	'in Turku'	kæde-ssæ	'in the hand'
pori-ssa	'in Pori'	vene:-sæ	'in the boat'
porvo:-ssa	'in Porvoo'	helsiŋŋi-ssæ	'in Helsinki'
tuo-ko	'that?'	tæmæ-kø	'this?'
tuo-ssa-ko	'in that?'	tæ-ssæ-kø	'in this?'
naise-lta	'from the woman'	tytø-ltæ	'from the girl'
sisare-lta	'from the sister'	velje-ltæ	'from the brother'

N. B.: The Finnish vowel system is as follows:

i	y	u
e	ø	o
æ		a

D. Explain the alternations in the aorist suffix in Wikchimani (a California Penutian language).

(137) *-ʃi ~ -ʃy ~ -ʃu 'aorist'* (Archangeli 1984:159)

a.	pʰiɲ̰-ʃi	'stung'
	t̰ʰan-ʃi	'went'
	mo:xit̰-ʃi	'got old'
b.	t̰yʔys-ʃy	'made'
c.	hut̰-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*.)

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 realized as [q] when it occurs in the same syllable as a nonhigh back vowel: [a, ɔ, o], e.g. (138a). Elsewhere, /k/

surfaces simply as [k], e.g. (138b). In other words, /k/ assimilates the [–high] feature of a tautosyllabic [+back] vowel.

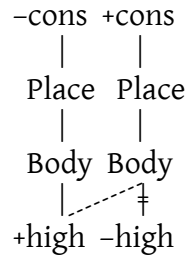
(138) *Turkana* (Zetterstrand 1996)

a.	/ɛ-kɔrɪ/	[ɛ.qɔ.rɪ]	‘rattle’ (sg.)
	/ɛ-kɔlɔcɔr/	[ɛ.qɔl.cɔrː]	‘pelican’
	/e-kod/	[e.qod]	‘tax’ (sg.)
	/e-koji/	[e.qoj]	‘matter’
	/ɛ-kɑːleːs/	[ɛ.qɑ.leːs]	‘ostrich’
	/ŋɪ-kɑjo/	[ŋɪ.qɑ.jo]	‘tree’ (pl.)
b.	/ɑ-kiru/	[ɑ.ki.ru]	‘rain’
	/ɑ-mɑkuk/	[ɑ.mɑ.kuk]	‘stool’
	/ŋi-keno/	[ŋi.ke.no]	‘fireplace’ (pl.)
	/ŋɑ-kɪmɑ-k/	[ŋɑ.kɪ.mɑq]	‘old woman’
	/ɑ-rʊkʊm/	[ɑ.rʊ.kʊm]	‘cough’
	/ɑ-kɛpʊ/	[ɑ.kɛ.pʊ]	‘vein’

That Turkana uvularization is a form of height assimilation is confirmed by the fact that /k/ tends not to uvularize when preceded by a high vowel (*i*, *ɪ*, *u*, *ʊ*). This tendency is suggestive of a variable process which spreads [+high], thereby countering uvularization.

(139) *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’

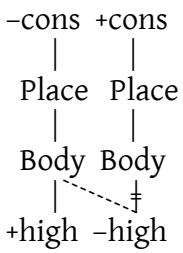


A related pattern is found in Sibe (Li 1996, Vaux 1999b). This Tungusic language distinguishes [+high] /i, y, ɨ, u/ from [–high] /ɛ, ø, ɑ, ɔ/. [+high] *k*, *x* change to [–high] *q*, *χ* (respectively) when preceded *anywhere in the word* by one of the [–high] vowels. This “long-distance” assimilation of [–high] is illustrated by suffixal alternations in (140). (Note that these suffixes also participate in rounding harmony; see section 3.3.1.2.)

(140) *Sibe* (Li 1996, Vaux 1999b)

a.	ɨldɨ(n)-kɨn	‘bright’	*vs.*	gølmi(n)-qɨn	‘long’
	ulu-kun	‘soft’		dʒɑlu-qun	‘full’
				adʒi(g)-qɨn	‘small’
b.	tyry-xu	‘to rent’	*vs.*	bɔdu-χu	‘to consider’
	tɨ-xɨ	‘to sit’		ømi-χɨ	‘to drink’
				lɑvdu-χu	‘to become more’

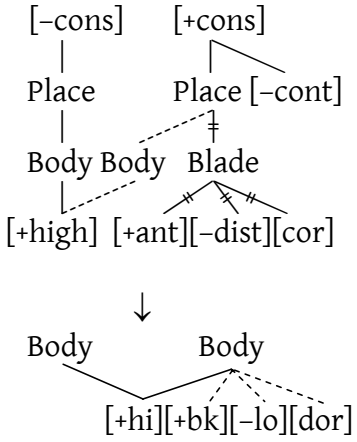
In many other languages, it is uvular consonants which lower high vowels. For instance, in Ayacucho Quechua "/u/ and /i/ are replaced by /o/ and /e/ respectively before /q/" (Parker 1969:20). In other words, [+high] /u i/ assimilate to [–high] /q/.[144]



[+high] spreading can sometimes result in a consonant becoming velar. For instance, a comparison between Modern Standard German and Cologne German (McCawley 1967, Chen 1973:49, Rice 1996:513, Ségéral and Scheer 2001:314) reveals that in the latter dialect ("Kölsch"), coronal [t, n] have shifted to dorsal [k, ŋ] after both high front vowels (142a) and high back vowels (142b). No such change occurred after nonhigh vowels, e.g.:

MHG[145] *ʃtejn* > CG *ʃtajn* 'stone',
MHG *flowtə* > CG *flawtə* 'flatness',
MHG *brejt* > CG *brejt* 'broad'.[146]

(141)



The change of coronals to dorsals after high vowels in Cologne German is sketched in (141).[147]

(142)

		Stand.	*CG*			*Stand.*	*CG*	
a.		hɔjtə	hyk	'today'	b.	bʁawt	bʁuk	'bride'
		pintə	piŋk	'pint'		bunt	buŋk	'colorful'
		ʁajn	ʁiŋ	'Rhine'		bʁawn	bʁuŋ	'brown'
		nɔjn	nyŋ	'nine'		tˢawn	tˢuŋ	'fence'

Comparably, nonetymological [k] was added to final [*i, *u] in the development of Franco-Provençal (Pougnard 1950:129, Bullock 1995:51), e.g. (143), and of Hyenghène New Caledonian (Blust 1978:474-5, see also Collins 1983:45ff. on Trengganu Malay), e.g. (144). Such velar epenthesis can also be treated as [+high] spread (cf. (141)).[148]

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[144] /q/ is realized [χ] except after /n/, where it is optionally realized as [q] (Parker 1969:19).

[145] Middle-High German, about 1050-1350 A.D.

[146] A similar but more complex pattern is found in the Dutch spoken in Antwerp. As Taeldeman (2001) describes, coronal /n/ velarizes after a long high vowel which thereafter becomes short, e.g., /ɣry:n/ → [ɣryŋ] 'green' (cf. [ɣry:nə] 'green'), /sxu:n/ → [sxuŋ] 'shoe' (cf. [sxu:nə] 'shoes'). Underlyingly short high vowels do not trigger velarization, e.g., [kin] 'chin'.

[147] Recall that [+back] spreading similarly changed [t, n] into [k, ŋ] in Hue Vietnamese; see (124)-(125a,b) above.

[148] Blust (1994) provides copious examples of [k] (or [x]) epenthesis after high vowels, mainly

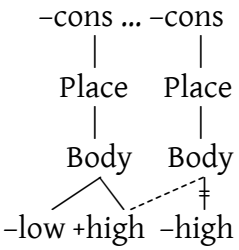
(143)

a.	*abri	> abrik	‘shelter’
b.	*epi	> epik	‘divider wall’
c.	*klu	> kluk	‘nail’
d.	*seul	> suk	‘alone’

(144)

a.	*kai	> ceek	‘tree’
b.	*qupi	> kuuk	‘yam’
c.	*kuṯu	> ciik	‘louse’
d.	*paṯu	> paik	‘stone’

Many Bantu languages show a type of vowel harmony which also involves [±high]. The examples in (145)–(148) 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, –low] vowel in the stem (see (b) examples).



(145) *‘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’

(146) *‘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’

(147) *‘Perfective’ suffix -irir- ~ -erer-*

a.	pind-a	‘pass’	pind-irir-a	‘to pass right through’
	ɓudʃ-a	‘come out’	ɓudʃ-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’

---

from Austronesian and Tibeto-Burman. In most cases the paragogic velar coronalizes to [c] (or [ʃʃ]) after /i/, and in some cases it further depalatalizes to [t] (or [s]) (ib., p. 130). Compare palatalization/coronalization in Acadian French (see (127) above).

(148) *'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'

[–high] assimilation in Shona does not target only [–back] vowels. For instance, *u* of the 'reversive' suffix *-ur-* in Shona, e.g., *naman-ur-a* 'unstick', lowers following *o* in, e.g., *monon-or-a* 'uncoil'. The fact that mid vowels (*e*, *o*), but not the low vowel *a*, trigger height assimilation suggests that the latter is sensitive only to *contrastive* [±high]. 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]).

Finally, an apparent case of [±high] dissimilation 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.

(149) *Yowlumne*

	sing.	*plural*	*pl.:* expected	
a.	naʔaːt̪	naːʔit̪	*naːʔat̪	'older sister'
	napaːt̪ʰm	naːpt̪ʰim	*naːpt̪ʰam	'male relation by marriage'
b.	nopʰoːpʰ	noːpʰipʰ	*noːpʰopʰ	'father'
	t̪'oɲ̃oːtm	t̪'oːɲ̃tim	*t̪'oːɲ̃tom	'transvestite'
c.	niʔiːs	niːʔas	*niːʔis	'younger brother'
	tipniː	tiːpan	*tiːpin	'one endowed with magic powers'
d.	nuʂuːʂ	nuːʂaʂ	*nuːʂuʂ	'paternal aunt'
	huluːsc'	huːlsac'	*huːlsuc'	'one who is sitting down'

Exercises:

A. Explain the alternations in the following sets from Veneto Italian (Walker 2001).

(150) *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.)

(151) *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 (Nikiema 2002) 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.

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 (152). In a related pattern, the infinitival suffix is [+low] *a* if the verb vowel is [+low] (*æ, a, ɒ*), and [–low] *ə* if the verb vowel is [–low] (*ə, e, i, u, ɯ*), as shown in (153). These patterns point to a process of [±low] assimilation, as represented in (154).

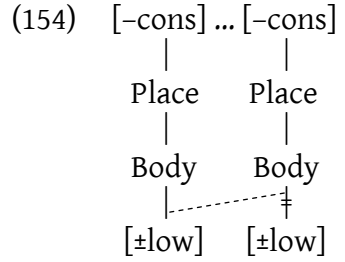
(152) *Korean sound symbolic words*

[+low]	[–low]	
k’aŋcɒŋ	k’əŋcuŋ	‘skipping’
cʰals’ak	cʰəls’ək	‘lapping’
panc’ak	pənc’ək	‘flashing’
k’ɒlk’ak	k’ulk’ək	‘swallowing’
sɒkt’ak	sukt’ək	‘whispering’
p’æcɒk	p’icuk	‘protruding’
cælkaŋ	cilkəŋ	‘chewing’
talkakak	təlkəkək	‘rattling’
cʊmɒllak	cumullek	‘kneading’
cæcal	cicəl	‘chattering’
cʰɒllaŋ	cʰulləŋ	‘splashing’
allɒk	əlluk	‘molted’

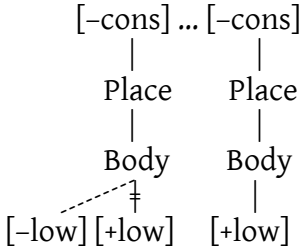
(153) *Korean infinitives*

[+low]		[–low]	
cap-a	‘grasp’	mək-ə	‘eat’
nɒk-a	‘melt’	cuk-ə	‘die’
		me-ə	‘carry’
		ki-ə	‘crawl’
		nuc-ə	‘be late’

(154)



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.)



Exercise

Explain the vowel changes in the development from Proto-Malayo-Polynesian to Muna (Van Den Berg 1991:6).

(155)

PMP		*Muna*
*tasik	'sea'	tehi
*laŋuy	'swim'	leni
*babuy	'pig'	wewi
*tapi	'winnow'	tepi
*qapur	'lime'	ɣefi
*sabur	'scatter'	hewi
*hapuy	'fire'	ifi
*isa	'one'	ise
*quzan	'rain'	ɣuse
*putaq	'white'	pute

3.4. Soft Palate

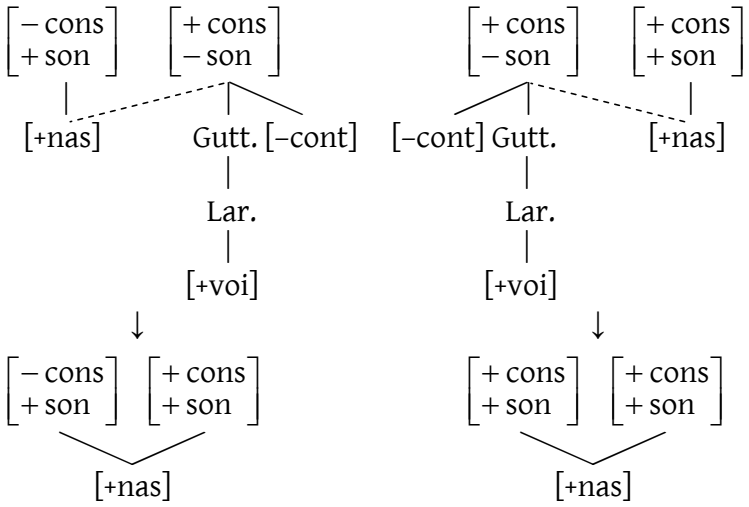
Our first example of [+nasal] assimilation comes from Canadian French: in this dialect voiced stops are optionally changed to their nasal counterparts when they are adjacent to a nasal segment (Walker 1984:113-4). As a comparison between Standard French (SF) and Canadian French (CF) reveals, this nasal assimilation applies after nasalized vowels (156) as well as before nasal consonants (157).

(156)

	SF	*CF*	
a.	gʀɑ̃d	gʀɑ̃n	'tall' (f.)
b.	blɔ̃d	blɔ̃n	'blond' (f.)
c.	ʒɑ̃b	ʒɑ̃m	'leg'
d.	ɔ̃bʀ	ɔ̃m	'shadow'
e.	ʒœ̃gl	ʒœ̃ŋ	'jungle'
f.	lɑ̃g	lɑ̃ŋ	'language'

(157)

	SF	*CF*	
a.	admiʀe	ænmiʀe	'admire'
b.	fʀwadmɑ̃	fʀwænmæ̃	'coldly'
c.	ɑ̃ʒɑ̃bmɑ̃	ɑ̃ʒɑ̃mmæ̃	'enjambement'
d.	djagnɔstik	djæŋnɔstɪk	'diagnostic'
e.	fʀagmɑ̃	fʀæŋmæ̃	'fragment'
f.	lɔ̃gmɑ̃	lɔ̃ŋmæ̃	'lengthily'



Next, 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 (158). The generalization 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:

(158) *Southern Barasano*

[+nasal]		[–nasal]	
mãnõ	‘none’	juka	‘vulture’
mĩnĩ	‘bird’	wati	‘going?’
mãĥãŋĩ	‘comer’	wesika	‘above’
ŋãmõr̃õnĩ	‘ear’	hikoro	‘tail’
ẽõnõ	‘mirror’		

(159)

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?’

As Gomez-Imbert and Kenstowicz (2000:421-2) discuss:

> Nasality is not a phonemic but a morphemic feature. ... There is no segmental opposition between oral and nasal segments. The lexicon exhib-

> its contrasts only between entirely oral (160a) and entirely nasal roots (160b). The nasal autosegment of the roots in (160b) nasalizes all the voiced segments —vowels, sonorants, and plosive consonants— of the root. The nasal allophones of the voiced plosives ... are: [m] for /b/, [n] for /d/, [ɲ] for /dʒ/ and [ŋ] for /g/ ... Voiceless plosives are transparent to nasal spreading.

(160)

a. *[–nasal] roots*			b. *[+nasal] roots*		
/baː-re/	[baːre]	'to swim'	/baː-re/ +n	[mãːr̃ẽ]	'to pour powder with hands'
/bibi-re/	[bibire]	'to blink'	/bibi-re/ +n	[mĩmĩr̃ẽ]	'to suck'
/tia-re/	[tiare]	'to sew'	/tia-re/ +n	[tĩãr̃ẽ]	'to stoke the fire'
/uka-re/	[ukare]	'to draw/ write'	/baka-re/ +n	[mãkãr̃ẽ]	'to look for'

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.[149]

(161)

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 realized *-in-* when it is preceded by a nasal anywhere in the stem.

(162)

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 make dance for'

Turning to nasal dissimilation, a first example is provided by 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*."

[149] There is an interesting complication. See exercise D on p. 177 below.

(163) *Takelma nasal dissimilation* (Sapir 1912)

a.	gʷãn	'road'	ha-gʷa:l-am	'in the road'
b.	xãn	'urine'	xa:l-amtk	'my urine'
			xa:l-ax-amte	'I urinate'

Another case of nasal dissimilation is found in Chukchi (Bogoras 1922). Recall that Chukchi /ŋ/ usually Place-assimilates to a following consonant: it becomes [m] before labial, and [n] before a coronal; see (87) on p. 146. However, as shown in (164), when /ŋ/ precedes a nasal, it turns into [ɣ] instead (Chukchi lacks [g]).

(164) *Chukchi nasal dissimilation* (Krause 1980:20)

a.	[ratʃwəŋ-ək]	vs.	[mət-ratʃwəɣ-mək]	'we competed'
b.	[taraŋ-ək]	vs.	[nə-taraɣ-more]	'let's build a place to live'
c.	[enawrəŋ-ək]	vs.	[enawrəɣ-nən]	'he presented him'
d.	[petʔiŋ]	vs.	[petʔiɣ-ŋinqej]	'boy with a cold'

Historical cases of nasal dissimilation are also relatively common. For example, Proto-Germanic *himin 'heaven' evolved into *hibin then *heaven* in English, and into *Himmel* in German. That is, dissimilation affected the first nasal in English, the second in German. In dialectal English as well as in Child English one finds 'chimney' pronounced as 'chimley' or else 'chimbley', with epenthetic [b]. Analogous changes occurred in the history of Romance languages (Robert Murray, p.c.), e.g., Portuguese: *memorare* 'to remember' → *lembrar*; Spanish *homine* 'man' → *homne* → *homre* → *hombre*; *femina* 'woman' → *femna* → *femra* → *hembra*; cf. *anima* 'soul' → *anma* → *alma*. The following examples are from Romanian (Rosetti 1965).

(165) *Nasal dissimilation in Romanian* (Rosetti 1965:27)

a. *Regressive*
inimă 'heart' → irimă
fănină 'flour' → fărină
venin 'venom' → verin
cănunt 'gray (hair)' → cărunt
genunchi 'knee' → gerunchi
junincă 'génisse' → jurincă
mănunt 'menu' → mărunt
mănunchi 'faisceau' → mărunchi
păninc 'millet à l'épi noir' → părinc
rănunchi 'rochon, rein' → rărunchi
amenința 'to menace' → amerința, amelința

b. *Progressive*
nimeni 'person' → nimeri
pecingine 'dartre' → pecingire
pîngăni 'profaner' → pîngări
sîngena 'saigner' → sîngera
grănunț 'grain' → grăunț

Exercises:

A. Explain Indo-European **swepnos* 'sleep' > Sanskrit *svapnaḥ* vs. Latin *somnus*.

B. Explain the changes observed in the following data from Korean (Cho 1999).

(166)

a.	kak - mok	kaŋmok	'stick'
b.	nap - nita	namnita	'sprout'
c.	kat^{h} - ni	kanni	'Is it the same?'
d.	kuk - mul	kuŋmul	'soup'

C. Explain the alternations in the following data from Welsh (Davenport and Hannahs 1998).

(167)

kɛgɪn	'kitchen'	əŋ ŋ̊ɛgɪn	'my kitchen'
bʊθɪn	'cottage'	əm mʊθɪn	'my cottage'
tiː	'house'	ən n̥iː	'my house'
pɛntrɛ	'village'	əm m̥ɛntrɛ	'my village'
dəfrɪn	'valley'	ən nəfrɪn	'my valley'
kəmriː	'Wales'	əŋ ŋ̊əmriː	'my Wales'

D. Use the following remark by Ao (1991) to develop an explanation of the Kikongo data below (cf. (175) above).

> In Kikongo the [+nasal] feature of a preconsonantal nasal is always predictable, since the only consonant clusters in this language are homorganic [+nasal][–nasal, –sonorant] clusters. ... [+nasal] is noncontrastive in that position (although it is contrastive elsewhere, as in the near minimal pair /kikini/ 'dancer' versus /kizidi/ 'face'). (Ao 1991:195)

(168) *Kikongo* (Ao 1991, Walker 2000)

a.	kamb-ila	'to intercept'	b.	tu-meŋg-ini	'we hated'
	somp-ela	'to borrow from/for'		tu-meŋg-ono	'we were hated'
	bind-ula	'to unlock'		tu-mant-ini	'we climbed'
	kunt-ila	'shake for'		wu-mant-unu	'it was climbed
	tu-biŋg-idi	'we hunted'			
	koŋk-ela	'to push to'			

E. How many English words begin with *sNVN* (N any nasal, V any vowel)? Explain your finding.

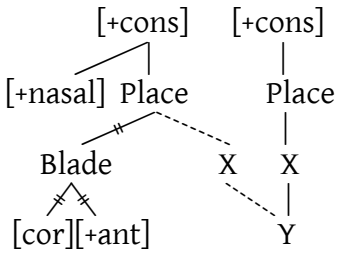
3.5. Guttural

The grouping of [radical] and [glottal] as "Guttural" is suggested by the fact that Place 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 (169j-l). This is expected. Assimilation here results from spreading Place features to a preceding nasal, delinking its original [coronal] specification. Gutturals have no such Place node to spread.

(169)

	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., where 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, whether or not they are adjacent (McCarthy 1981).

3.5.1.2. [±ATR]

Palestinian Arabic (Davis 1995) shows a pattern of regressive [–ATR] assimilation: as shown in (170a), segments become pharyngealized, or [–ATR], when they precede an "emphatic" —a pharyngealized segment. This often leads to the whole word being [-ATR], as shown in (170b). (The diacritic [ˠ] indicates pharyngealization, or [–ATR], on a segment.)

(170) *Palestinian Arabic*

a.			b.		
	ʕaṯʃaːn	'thirsty'		balːaːs	'thief'
	mazaṣːaṣiʃ	'it didn't become solid'		ħaðˠː	'luck'
	naṣiːħa	'advice'		ʔabsaṯ	'simpler'
	kaṯːuːʕa	'piece of mat'		baːs	'bus'
	siħːa	'health'		maṇaːfiðˠ	'ashtrays'
	zarːiʕa	'offspring'		xajːaːṯ	'tailor'
				naʃaːṯ	'energy'
				taṃʃiːṭa	'hair stylist'

In other languages, [±ATR] spreads only to vowels. For instance, recall from exercise B in section 2.5.1.2 (see esp. (119) on p. 68) that high vowels alternate in [±ATR] in Canadian French: they are [+ATR] in open syllables and [–ATR] in closed syllables,[150] e.g., [ptˢi] 'small (masc.)' *vs.* [ptˢɪt] 'small (fem.)', [etydᶻi] 'studies (v.)' *vs.* [etʏd] 'study (n.)', [ekute] 'to listen' *vs.* [ekut] 'listens'. Walker (1984:61ff.) reports a separate pattern ('laxing harmony') in which high vowels in open syllables assimilate to [–ATR] in a following high vowel, e.g.:

(171) *Canadian French* (Walker 1984:61)

pɔzɪtˢɪf	*positif*	cf.	pɔzitˢivite	*positivité*
pʁimɪtˢɪf	*primitif*	cf.	pʁimitˢivite	*primitivité*
mʏzɪk	*musique*	cf.	myzisjɛ̃	*musicien*
kɥɪzɪn	*cuisine*	cf.	kɥizine	*cuisiner*
mɪnɪs	*ministre*	cf.	ministɛːʁ	*ministère*

Here are more examples of this 'laxing harmony':

(172) *Canadian French* (Walker 1984:61)

abʊzɪf	*abusif*	ɪnʊtɪl	*inutile*
bɪsɪk	*bicycle*	ʒʏʁidᶻɪk	*juridique*
ʃʊkʁʊt	*choucroute*	mɪnʏt	*minute*
klɪnɪk	*clinique*	fɪlɪp	*Philippe*
kɔmʏnɪs	*communisme*	pɪlʏl	*pillule*

[150] A syllable is called 'open' if it ends in a vowel (e.g., V or CV) and 'closed' if it ends in a consonant (e.g., VC or CVC).

kʊzɪn	*cousine*	pʏpɪt	*pupitre*
kʊtˢʏm	*coutume*	skʁʏpʏl	*scrupule*
defɪnɪtˢɪf	*définitif*	sʊkʊp	*soucoupe*
dᶻɪfɪsɪl	*difficile*	tʊʁɪs	*touriste*
abɪtˢʏd	*habitude*	ʏnɪk	*unique*

In the West African language Akan, the [ATR] specification of vowels in prefixes and suffixes agrees with the [ATR] specification of neighboring vowels in stems. For example, in (173a) the prefix is [+ATR] *o-*, as it is next to a [+ATR] vowel in the stem *bi̱sa*. But in (173b) the same prefix is [–ATR] *ɔ-*, as it is next to a [–ATR] vowel in the stem, *kɑ̱ri*. Conversely, in (173a) the suffix is [–ATR] *-ɪ*, as it is next to a [–ATR] vowel in the stem *bisɑ̱*, while in (173b) it is [+ATR] *-i*, as it is next to a [+ATR] vowel in the stem, *kari̱*.

(173) *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.

(174) *Wolof* (West Atlantic Africa)

[+ATR]		[–ATR]	
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'
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'
reːr-oːn	'was lost'	rɛːr-ɔːn	'had dinner'
ɲow-oːn	'came'	jɔx-ɔːn	'gave'
bægg-oːn	'wanted'	tɑkk-ɔːn	'tied'
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'
genn-ændoː	'to go out together'	dɛnd-ɑndɔː	'to be neighbors'
teːx-ændoː	'to smoke together'	tɔpp-ɑndɔː	'to imitate'
dækk-ændoː	'to live together'	wɑx-ɑndɔː	'to say together'

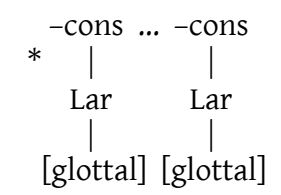
Exercise:

Based on the following data from Kinande (Bantu, Congo), give a formal explanation for the various forms of the 'benefactive' suffix in Kinande. (You can ignore the final -ɑ suffix; it is added to all words in Kinande.)

a.	hʊm-ɪr-ɑ	'to beat for'
b.	bɔh-ɛr-ɑ	'to tie for'
c.	lim-ir-ɑ	'to exterminate for'
d.	himɑt-ɪr-ɑ	'to squeeze for'
e.	huk-ir-ɑ	'to cook for'
f.	kɑr-ɪr-ɑ	'to tie for'
g.	lɪm-ɪr-ɑ	'to cultivate for'
h.	hɛk-ɛr-ɑ	'to carry for'
i.	gumɑt-ɪr-ɑ	'to stuff mouth for'

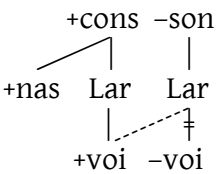
3.5.2. Larynx

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). Another example comes from dialectal Spanish. As you may know, many Spanish dialects change /s/ to glottal [h] syllable-finally. For example, determiners such as /dos/ 'two' and /mis/ 'my (pl.)' are normally pronounced with [h], e.g. *do*[h] *amigos* 'two friends', *mi*[h] *amigos* 'my friends'. However, the change from /s/ to [h] is blocked when the next consonant is also [h], e.g., *do*[s] *o*[h]*os* 'my eyes', *mi*[s] *hi*[h]*os* 'my children' (Lipski 2000).

3.5.2.2. [±voice]

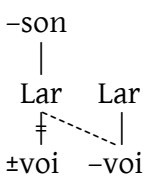


Assimilation of [+voice] is very common, especially with nasals. For example, in Japanese an obstruent regularly becomes voiced after a nasal. Thus the gerundive suffix *-te* (e.g., *mi-te* 'seeing') becomes *-de* after a nasal (e.g., *jon-de* 'reading', *ʃin-de* 'dying'). Similarly, in the Puyo Pungo 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'). The same pattern can be observed in (175b,c) from Zoque, a Mixe-Zoquean language of Mexico (Wonderly 1965).

(175) *Zoque* (Wonderly 1965)

a.	tih-u	'he arrived'	min-u	'he came'
b.	tih-pa	'he arrives'	min-ba	'he comes'
c.	tih-keʔtu	'he arrived again'	min-geʔtu	'he came again'

[±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], *dog*[z], and the past tense *hack*+[t] (*hacked*) vs. *ban*+[d] (*banned*), *drag*+[d] (*dragged*).[151] 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.



Many patterns of [±voice] assimilation ignore sonorants because their [+voice] is not contrastive (predictable). For instance, word-final obstruents can contrast in voicing in Hungarian (176a). However, such a contrast is lost when another obstruent follows, since obstruents assimilate to the [±voice] specification of a following obstruent (176b,c). Crucially, obstruents do not assimilate the voicing of a following sonorant (176d), nor do sonorants assimilate the [±voice] specification of a following obstruent (176e). The same state of affairs holds in Sudanese Arabic; see (177) below.

(176) *Assimilation of obstruents in Hungarian* (Gnanadesikan 1997:22)

a. *Contrasts in isolation*

na**p**	[p.]	'day, sun'
ba**b**	[b.]	'bean'

b. *Voiceless assimilate to voiced*

té**p**des	[b.]	'tear, frequentive'
lö**k**dös	[g.]	'shove, frequentive'

c. *Voiced assimilate to voiceless*

me**g**talál	[k.]	'find, perfective, 3p. sing.'
ren**d**kívul	[t.]	'unusual'
é**v**tized	[f.]	'decade'

d. *No change of obstruent before sonorant*

na**p**nyugta	[p.]	'sunset 1'
na**p**lemente	[p.]	'sunset 2'
me**g**magyaráz	[g.]	'explain, perfective, 3p. sing.'
me**g**lát	[g.]	'catch sight of, perfective, 3p. sing.'

[151] 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.

e. *No change of sonorant before obstruent*

ké**n**ko	[n.]	'sulfur stone'
ké**n**dioxid	[n.]	'sulfur dioxide'
nyo**m**kod	[m.]	'presses repeatedly'
nyo**m**da	[m.]	'publishing press'

(177) *Assimilation of obstruents in Sudanese Arabic* (Gnanadesikan 1997:52)

a. *Contrasts in isolation*

sama**k**	'fish'
saba**b**	'reason'

b. *Obstruents are voiced before voiced*

ʔa**g**bar	'bigger/older'	cf. **k**abiːr 'big/old'
ʔa**z**baːb	'reasons'	cf. **s**abab 'reason'
ʔa**b**ɢaːl	'mules'	cf. **b**aɢal 'mule'

c. *Obstruents are voiceless before voiceless*

ʔa**ṭ**faːl	'children'	cf. **ṭ**ifil 'child'
ja**p**sim	'to smile, imperf.'	cf. **b**asam 'to smile, perfect'
ʔa**k**saːm	'divisions'	cf. **g**isim 'division'

d. *No change of obstruent before sonorant*

ʔa**s**maːk	'fish, pl.'
ʔa**g**laːm	'pens'

A fascinating case of [±voice] assimilation in which sonorant consonants are ignored is provided by Russian (Calabrese 1995). As shown in (178), obstruents assimilate to the [±voice] specification of a following obstruent, as we saw in Hungarian (176) and Sudanese Arabic (177). The additional data in (179b) show that [±voice] assimilation between obstruents can occur "at a distance", across intervening sonorant consonants. That is, sonorants are transparent to voicing assimilation. This shows clearly that only *contrastive* instances of [±voice] is spread in Russian.

(178) *Voicing assimilation in Russian*

o[t] ozera	'from a lake'	be[z] ozera	'without a lake'
o[t pt]its	'from birds'	be[s pt]its	'without birds'
o[d b]anka	'from a bank'	be[z b]anka	'without a bank'
o[d bd]enija	'from a vigil'	be[z bd]enija	'without a vigil'
o[d gr]exa	'from a sin'	be[z gr]exa	'without a sin'
o[t str]asti	'from passion'	be[s str]asti	'without passion'
o[t Pr]agi	'from Prague'	be[s Pr]agi	'without Prague'

(179) *Voicing assimilation in Russian*

a.	pe[sn^{j}]	'song'	[tr]avá	'grass'
	ži[zn^{j}]	'life'	[dr]ová	'wood'
b.	o[t nr]avov	'from morals'	be[z nr]avov	'without morals'
	o[t mt^{s}]enska	'from Mtsensk'	be[s mt^{s}]enska	'without Mtsensk'
	o[t mst]itel^{j}nosti	'from vindictiveness'	be[s mst]itel^{j}nosti	'without vindictiveness'
	o[d mgl]ɨ	'from fog'	be[z mgl]ɨ	'without fog'
	o[d lg]uni	'from the liar'	be[z lg]uni	'without the liar'

An example of a language that spreads only *marked* instances of [voice] is provided by Ukrainian (Zilyns'ky*i et al. 1979). In this language, [+voice] spreads between obstruents (180a), but [–voice] does not (180b).

(180) *Assimilation of obstruents in Ukrainian* (Gnanadesikan 1997:43, Cho 1999)

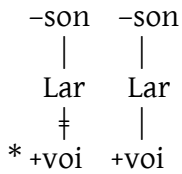
a. *Voiceless obstruent voices*

/boro**t**^{j}-ba/	[d^{j}.]	'struggle'
/ja**k**-ʒe/	[g.]	'how'
/o**s**^{j}-de/	[z^{j}.]	'here/there'

b. *Voiced obstruent unaffected*

/ʃ vy**d**ko/	[d.]	'quick'
/v^{j}i**d**-pov^{j}idajte/	[d.]	'answer (imper.)'

Finally, a case of dissimilation of *marked* [+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 (181a-d). This process ("rendaku") is blocked (or undone) in (181e-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.). Crucially, unmarked instances of [+voice] in vowels and sonorant consonants fail to trigger [+voice] dissimilation.



(181) *Compounds in Japanese*

a.	jo	+	sakura	→ jozakura	'blossoms at night'
	'night'		'cherry'		
b.	ko	+	tanuki	→ kodanuki	'baby raccoon'
	'child'		'raccoon'		
c.	mizu	+	seme	→ mizuzeme	'water torture'
	'water'		'torture'		
d.	ori	+	kami	→ origami	'origami'
	'fold'		'paper'		

e.	mori 'serve'	+	soba 'soba'	→ morisoba	'soba serving'
f.	iro 'white'	+	tabi 'tabi'	→ irotabi	'white tabi'
g.	ore 'broken'	+	kugi 'nail'	→ orekugi	'broken nail'
h.	kami 'heaven'	+	kaze 'wind'	→ kamikaze	'divine wind'

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.

/xpi̯l/	[xbiʔl̃]	'ten'	/kitˈ'/	[gɪʔtˈ']	'vermillion'
/paχ/	[bɐχ̃]	'to run'	/tkʷantxʷ/	[tʰgʷantxʷ]	'to trip, stumble'
/pan/	[bɑn]	'belly'	/qan/	[ɢɑn]	'tree, wood'
/taw/	[dɐw]	'ice'	/quːt/	[ɢəːtʰ]	'heart'
/xtiː/	[xdiː]	'tea'	/qatˢ/	[ɢɑtˢ]	'spill'
/tuːs/	[duːs]	'cat'	/nikʷuːt/	[nɪgʷə́ːtʰ]	'father'
/tˢakʷ/	[dᶾɐkʷʰ]	'kill'	/nikʷuːt+i/	[nɪgʷə́ːdi]	'my father'
/tˢákʷasxʷ/	[dᶾɐgʷɐsxʷ]	'animal'	/wak/	[wɛkʲ]	'brother'
/kat/	[gʲɛ̯tʰ]	'man'	/wak+m/	[wɐ̯gʲm̩] ~	'our brother'
/kup/	[gup]	'to eat'		[wɐ̯gʲɪm]	

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. Explain all alternations in the following data from Japanese (Clements 1999). Note: the verb /fum/ means 'step on'.

a.	tˢukeru	'attach'	fun-dᶻukeru	'trample on'
b.	kiru	'cut'	fuŋ-giru	'give up'
c.	ʃibaru	'tie'	fun-dʒibaru	'immobilize'

D. Give a formal account of the different pronunciations of consonants in French vs. English words:

a.	ɔpseʁve	'observe'				
b.	anɛgdɔt	'anecote'	d.	bezbɑl	'baseball'
c.	ɔptəniʁ	'obtain'	e.	ɛgzɛʁsis	'exercise'

E. Explain all alternations in the following data from Zoque (Mexico: Wonderly 1965).

paloma	'bird'	m-baloma	'my bird'
pama	'clothing'	m-bama	'my clothing'
burru	'burro'	m-burru	'my burro'
tatah	'father'	n-datah	'my father'
tˢima	'calabash'	n-dᶻima	'my calabash'
disko	'disk'	n-disko	'my disk'
tʃoʔŋgoja	'rabbit'	ɲ-dʒoʔŋgoja	'my rabbit'
kama	'cornfield'	ŋ-gama	'my cornfield'
gallu	'rooster'	ŋ-gallu	'my rooster'

F. 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'	

3.5.2.3. [±spread glottis]

A first example of [+spread glottis] assimilation is provided by the Seville dialect of Spanish (Vaux 1998a:504, Javier Martin-Gonzales, personal communication). Here syllable-final /s/ not only regularly lenites to [h], as it does in many dialects of Spanish (see, e.g., (147) on p. 81), it also causes a following stop to become aspirated, e.g., *los padres* 'the parents' is pronounced [loh pʰaðreh].[152]

In the New Julfa dialect of Armenian (Vaux 1998b), the future prefix is *k(ə)-* preceding voiceless unaspirated stops (182a), and *kʰ(ə)-* preceding voiceless aspirated stops and fricatives (182b). In other words, the feature [+spread glottis] spreads leftward from syllable to syllable. (Note that /s/ again behaves as [+spread glottis]; see Vaux (1998a, 1999a) for additional information.)

(182) *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	'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 Larynx. The data in (183) 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).

(183) *Ancient Greek*

triːb-	'rub'	triːb-oː	tɛtriːp-tai
grapʰ-	'write'	grapʰ-oː	gɛgrap-tai
pɛmp-	'send'	pɛmp-o	ɛpɛmpʰ-tʰeːn
triːb-	'rub'	triːb-oː	etriːpʰ-tʰeːn
klɛpt-	'steal'	klɛpt-oː	klɛb-deːn
grapʰ-	'write'	grapʰ-oː	grab-deːn

[152] The glottal [h] that results from syllable-final /s/ actually deletes before pause or a consonant in Seville Spanish, though not without aspirating a following stop (a "stability" effect) (Lévesque 1992:17-8, Dobrovolsky and Shaw 1993).

después	[deˈpʰwe]	'after'
más pobre	[maˈpʰoβɾe]	'poorer'
lo hiciste	[loiˈsitʰe]	'you did it'
los tíos	[loˈtʰio]	'the uncles'
escuchar	[ekʰuˈtʃaɾ]	'to listen'
dos cosas	[doˈkʰosa]	'two things'

Similarly, according to Lombardi (1991:140) [+voice] and [+spread glottis] both spread in Sanskrit, e.g. (184).[153] Note that unlike Greek, Sanskrit has voiced aspirates, and its laryngeal assimilation is progressive.

(184) *Sanskrit*

a.	budʰ-ta	→	budʰdʰa	(no glosses provided)
b.	labʰ-ta	→	labʰdʰa	
c.	rundʰ-tʰas	→	rundʰdʰas	

Ancient Greek and Sanskrit also provide a famous example of dissimilation of [+spread glottis]. As shown in (188), [+spread glottis] stops deaspirated historically when they were followed by another [+spread glottis] stop in the same word. (This effect is known as "Grassmann's Law", after the mathematician and philologist Hermann Grassmann (1809-1877) who discovered it.)

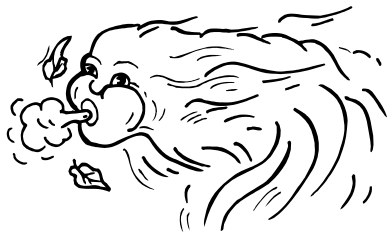
(185) *Grassmann's Law* (Lombardi 1991)

a. *Greek*

pʰepʰuka	→	pepʰuka	'converted'
tʰitʰeːmi	→	titʰeːmi	'I put'
tʰrikʰos	→	trikʰos	'hair'
tʰrepʰo	→	trepʰo	'I rear'

b. *Sanskrit*

bʰabʰuːva	→	babʰuːva	'became'
bʰodʰati	→	bodʰati	'he/she knows'
bʰubʰodʰa	→	bubodʰa	'he/she knew'
dʰadʰaːmi	→	dadʰaːmi	'I put'



Exercises:

A. Suggest an explanation for the adaptation of consonants in loanwords from Greek into Classical Armenian (Vaux 1998a).

(186)

	Greek		*Classical Armenian*	
a.	Psammetikʰos	→	Pʰsametikos	'Psammetichus'
b.	psalmos	→	pʰsalmos	'psalm'
c.	apsintʰion	→	apʰsndin	'wormwood'
d.	Kserkseːs	→	Kʰserkʰseːs	'Xerxes'
e.	ksesteːs	→	kʰsest	'sextary, jar'
f.	douks	→	dukʰs	'leader, prince'
g.	kuriakeː	→	ki(w)rakeː	'Sunday'
h.	pantʰeːr	→	pantʰer	'panther'

[153] Lombardi (ib.) explains that C^hC^h is always realized phonetically as CC^h.

B. Suggest an explanation for the fact that vowels devoice before /s/ and /h/ in Comanche (Northern Uto-Aztecan: Armagost 1986, Dobrovolsky and Shaw 1993).

C. According to Buckley (1994:83), aspiration does not get copied in reduplication in Kashaya (Southern Pomo), e.g., /RED-kʰi/→ [kikʰi] 'gill cover', /RED-tʰe-n̰/ → [teːtʰen̰] 'my mother'. Suggest an explanation.

D. Suggest an explanation for why voiceless stops are aspirated at the beginning of stressed syllables in English (e.g., [pʰ]*ill*, [tʰ]*ill*, [kʰ]*ill*), but not after /s/ (e.g., *s*[p]*ill*, *s*[t]*ill*, *s*[k]*ill*).

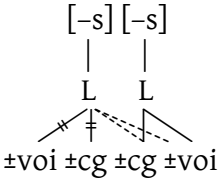
3.5.2.4. [±constricted glottis]

A first example of [+constricted glottis] assimilation is provided by the Cushitic language Oromo (Owens 1985, Fallon 2002). Glottalization spreads from a stem-final consonant to a suffix-initial consonant, e.g., (187a). In fact, progressive laryngeal assimilation appears to be quite general in Oromo, since voicing also spreads in this way (187b).

(187) *Oromo* (Fallon 2002:43)

a.	/tʃʼap'-ti/	[tʃʼap'tʼi]	'it (f.) breaks'
	/meːkʼ-te/	[meːtʼtʼe]	'you turned'
	/meːkʼ-ta/	[meːtʼtʼa]	'you turn'
cf.	/tʃʼap'-s-ta/	[tʃʼap'sita]	'you break sth.'
b.	/did-te/	[didde]	'you refused'
	/kʼab-ta/	[kʼabda]	'you have'
	/gub-tan/	[gubdan]	'you (pl.) burn sth.'
	/fiːg-te/	[fiːgde]	'you escaped'

Literary Adyghe (West Circassian: Kumaxov 1967, Fallon 2002) shows a comparable pattern, except that laryngeal assimilation is regressive in this case. For instance, the personal pronouns (*sə* 'I', *tə* 'we', *ɕʷə* 'you (pl.)', etc.) assimilate [+constricted glottis] (188a) as well as [+voice] (188b) in a following consonant.



(188) *Adyghe* (Fallon 2002:47-8)

a.	/p-ʃəʁe/	[pʼʃəʁe]	'you made'
	/t-ʃəʁe/	[tʼʃəʁe]	'we made'
b.	/s-ʁekʷʼaʁ/	[zʁekʷʼaʁ]	'I forced to go'
	/t-ʁekʷʼaʁ/	[dʁekʷʼaʁ]	'we forced to go'
	/ɕʷ-ʁekʷʼaʁ/	[ʑʷʁekʷʼaʁ]	'you (pl.) forced to go'

Similarly in Mingrelian (Kartvelian: Harris 1991:339, Fallon 2002:55ff.) the prefixes for first person and second person objects assimilate the [±constricted glottis] and [±voice]

features of a following obstruent, but they do so even across an intervening sonorant consonant (*r*, *n*), as shown in (189-190).

(189) *First person object*: p- ~ p'- ~ b-

a.	p-rtʃχunk	'you wash me'
cf.	p-tχoruns	'he buries me'
b.	p'-rtˢ'q'unk	'you water me'
	p'-ntˢ'q'unk	'you ruin me'
cf.	p'-tʃ'k'uns	'it eats me'
c.	b-rdunk	'you raise me'
cf.	b-goruns	'he looks for me'

(190) *Second person object*: k- ~ k'- ~ g-

a.	k-rtʃχuns	'she washes you'
cf.	me-k-tʃi	'I gave you (sth.)'
b.	k'-rtʃ'ip'uns	's/he stretches you'
c.	g-rduns	's/he raises you'

Such laryngeal assimilation "at a distance" also occurs in Tepehua, a language isolate spoken in Eastern Mexico (Watters 1985). The second person singular is marked on verbs by mapping a [+constricted glottis] feature onto all glottalizable segments, i.e., stops and /h/ in this language. (Note that only prevocalic stops are eligible docking sites.) This pattern, which is illustrated in (191), suggests that the second person singular is the feature [+constricted glottis], and that this feature is spread across the word.

(191)

	3sg. (unmarked)	*2sg.*	
a.	ʔaqtajhuː-j	ʔaqtʼʔajʔuː-j	help-IMPF
b.	paːtahuː-j	pʼaːtʼaʔuː-j	fall-IMPF
c.	nahun	naʔun	say
d.	wahin	waʔin	eat (intrans.)
e.	paʃaː-j	pʼaʃaː-j	bathe
f.	ʃapa-j	ʃapʼa-j	plane

Another possible example of long-distance spreading of [+constricted glottis] is found in Cowichan (Hukari 1977). In this Coast Salish language spoken on Vancouver Island, morphological reduplication is accompanied by the glottalization of all sonorants, except word-initial ones, as shown in (192). Again, this pattern suggests that a [+constricted glottis] feature is spread across the word, targeting sonorants in this case.

(192)

	Perfective	*Imperfective*	
a.	lémət	lḛ́lə̰mə̰t	'look at (it)'
b.	wénʃ	wḛ́wə̰n̰ʃ	'throw (it)'
c.	hésəm	héʔsə̰m̰	'sneeze'

Turning to dissimilation of [+constricted glottis], a clear example is provided by Shuswap, an Interior Salish language (Kuipers 1974, Thompson and Thompson 1985, Fallon 2002:206). As Kuipers (1974:23) describes,

> if a root has the shape K_1VK_2, K_1VRK_2, K_1RVK_2, and K_2 is glottalized, then K_1 is never glottalized. In any type of reduplication, the first occurrence

of a reduplicated obstruent is never glottalized. Thus ...p'... is reduplicated ...p...p'... [K = obstruent, R = sonorant, V = vowel]

Deglottalization is illustrated below in two types of Shuswap reduplication, one prefixal (CV-), the other suffixal (-VC).

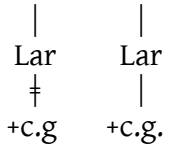
(193) *Shuswap* CV- *reduplication* (Thompson and Thompson 1985:136, Fallon 2002:206-7)

a.	tˢ'lut	'rushes'	tˢi-tˢlútlexʷ	'tubular goosegrass'
b.	k'jej	'be cold, freeze'	t-kj-k'ij-t	'chilled'
c.	ʔs-t'il	'to stop, quit'	te-t'il-t	'keeping still'
d.	t'ekʔ-ém	'support, prop up'	x-tek-t'ekʔ-éχn	'crutches'
e.	q'iw-t	'to break'	qw-q'íw	'brittle'

(194) *Shuswap* –VC *reduplication* (Taylor 1996:84ff., Fallon 2002:210)

/pat'-RED/	pət-át'	'overflow, boil, hang down around edges'
/t-xet'-RED/	t-xət-ét'	'to join, to fall in with (a herd)'
cf. /qʷ'uxʷ-RED/	qʷ'əxʷ-úxʷ	'stiff (from cold)'

The dissimilation of glottalized consonants is also evident historically. The following examples illustrate deglottalization in the development of Shuswap from Proto-Interior-Salish. (Data from neighboring and closely related Thompson River Salish are also provided, for comparison.)



(195) *Deglottalization in Shuswap* (Thompson and Thompson 1985:136, Fallon 2002:219)

	PIS		*Shuswap*	*Thompson*
a.	*k'íp'	'pinch'	kip'-m	k'íp'-m
b.	*qʷ'atˢ'	'full'	qʷétˢ'-t	qʷ'étˢ'-t
c.	*p'utɬ'	'fog'	s-pút'-nt	s-p'útɬ'-t
d.	*tˢ'ékʷ'	'bright, shine'	tˢekʷ-tˢekʷ'	tˢ'ékʷ'

Exercises:

A. According to Golla (1964), the Yokuts (Penutian) word *taḻim 'trout' has become [t'aḻim] in Chukchansi. Suggest an explanation.

B. The Georgian words *k'ak'-ali* 'walnut' and *k'otˢ'aχur-i* 'barberry' have been borrowed into Svan (Kartvelian: Schmidt 1991:480) as *gak'* and *gotˢ'χir*, respectively. Similarly, the Mingrelian word *p'ap'a* 'priest' has been borrowed into Svan as *bap'*. Explain the adaptation of consonants.

3.5.3. Tone

This final section discusses assimilation and dissimilation effects involving the tonal features [±upper register] (H/L) and [±raised pitch] (h/l).

3.5.3.1. [±upper register]

Yoruba (Benue-Congo: Pulleyblank 1994, 1998) is a tonal language (e.g., *kó* 'build' vs. *kò* 'refuse') which tends to avoid contour tones, e.g., it has no words of the form

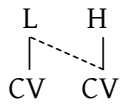
CV̌, CV̂, CV̌CV̀, CV̂CV́, CV̌CV́, CV̂CV̀, CV̀CV̂, CV́CV̌, CV̌CV̂, CV̂CV̌, CV̌CV́CV́, CV̂CV̀CV, CV́CV̌CV́, CV̀CV̂CV̀, CV́CV́CV̌, CV̀CV̀CV̂, CV̀CV̂CV̌, etc.

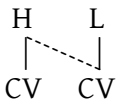
We might say that Yoruba has a *paradigmatic* constraint against contours, i.e., against pitch that changes during a syllable, either rising or falling. Interestingly, Yoruba also has *syntagmatic* constraints against sequences of different level tones: there are no surface forms such as

CV̀CV́, CV́CV̀, CV̀CV́CV́, CV́CV̀CV̀, CV́CV̀CV́, CV̀CV́CV̀, CV́CV́CV̀, or CV̀CV̀CV́.

As Pulleyblank (1994, 1998) explains, sequences of different level tones are systematically modified by two tonal assimilation rules in Yoruba (see also Akinlabi and Liberman 2000): on the one hand, L spreads to a following H, creating a rising contour (196a); on the other, H spreads to a following L, creating a falling contour (196b). Words illustrating the application of these two rules are presented in (197a,b), respectively;[154] both rules apply to the words in (197c).

(196) *Progressive tonal assimilation in Yoruba*

a. 

b. 

(197)

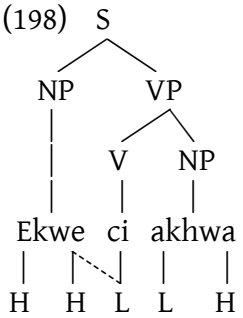
a.	àlá	→	àlă	'dream'
	ìg͡bá	→	ìg͡bă	'garden egg'
	jōrùbá	→	jōrùbă	'Yoruba'
	òkútā	→	òkŭtā	'stone'
	èlùbó	→	èlùbŏ	'yam flour'
b.	rárà	→	rárâ	'elegy'
	tíʃà	→	tíʃâ	'teacher'
	ɛ̄lɛ́dɛ̀	→	ɛ̄lɛ́dɛ̂	'pig'
	k͡pátákò	→	k͡pátákô	'hoof'
	dáŋ͡mk͡pàrā	→	dáŋ͡mk͡pârā	'foot yaws'

[154] Yoruba also has mid-tones (V̄), as seen in some of the examples. These behave as if they were toneless, as Pulleyblank (1998:73) states: "mid tones in Yoruba are actually the result of the default assignment of a mid pitch to a vowel not otherwise specified for tone" (see Pulleyblank 1986).

c. àbúrò → àbŭrô ‘younger sibling’
tákàdá → tákâdă ‘paper’

Uhuhu Igbo (Goldsmith 1976a), another Benue-Congo language, has tone assimilation across words which also creates contour tones. Consider the sentences below. No special tonal behavior is observed when the subject noun phrase ends in L ([–upper]) and the following verb stem is also L, e.g., (199a). However, when a subject that ends in H ([+upper]) is used with the same stem, a falling contour is created. To explain this, Goldsmith (1976a) gives the assimilation rule shown in (198): the L tone of a verb spreads to a preceding H tone of the subject, deriving a contour.

(198)



(199) *Uhuhu Igbo* (Goldsmith 1976a)

a. Ézè cì àkhwá ‘The chief was carrying eggs’ Ézè ‘chief’
Chief carry eggs

Ùwà cì àkhwá ‘Uwa was carrying eggs’ Ùwà (a name)
Uwa carry eggs

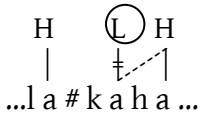
b. Ékwê cì àkhwá ‘Ekwe was carrying eggs’ Ékwé (a name)
Ekwe carry eggs

Àdhâ cì àkhwá ‘Adha was carrying eggs’ Àdhá (a name)
Adha carry eggs

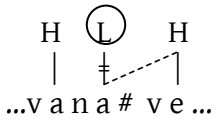
Another example of tone assimilation across words is provided by the Bantu language KiPare (Odden 1985, 1986): H spreads leftward when preceded by HL, yielding downstep.

(200) *Kipare* (Odden 1985, 1986)

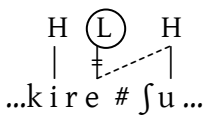
a. kílá kàhándì → kílá ꜜ káhándì
‘each knife’



b. vánà véˡkíràʃíndᶾìjà → váꜜná véˡkíràʃíndᶾìjà
‘the children were sleeping’



c. tètúfíníkírè ʃúvè → tètúfíníkíꜜré ʃúvè
‘we didn’t cover the baboon’



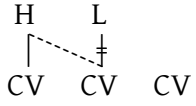
H-spread similarly yields downstep in Anufo, a Kwa language spoken in Ghana and Benin (Stanford and Stanford 1970, Bird 2003). Examine the following paradigms, focusing on downstep effects:

(201) *Tone patterns in Anufo* (Bird 2003:10)

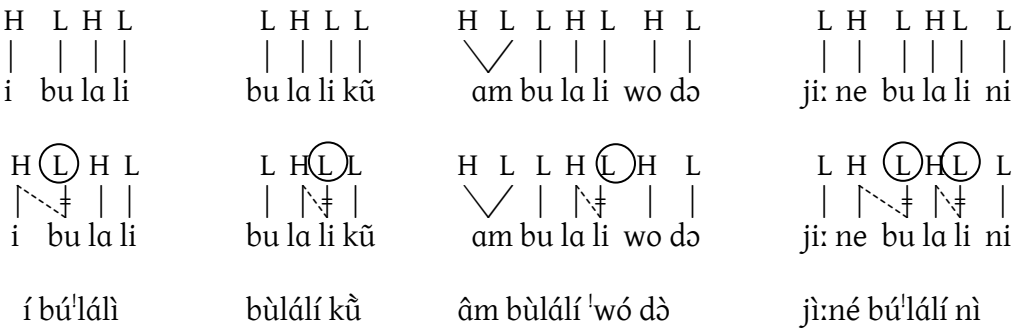
		'his ...'	'one ...'	'your (pl.) ...'	'that ...'
bàká	'tree'	í bá꜒ká	bàká kṵ̂	âm bàká wó dɔ̀	jì:né bá ꜒ká nì
sàkâ	'comb'	í sá꜒ká	sàká kṵ̂	âm sàká wó dɔ̀	jì:né sá꜒ká nì
búrì	'duck'	í búrì	búrí kṵ̂		jì:né búrí nì
sírî	'goat'	í sírî	sírí kṵ̂	âm sírí wó dɔ̀	jì:né sírí nì
gádó	'bed'	í gádó	gádó kṵ̂		jì:né gádó nì
gɔ̀rɔ̀	'brother'	í górɔ̀	gɔ̀rɔ̀ kṵ̂	âm gɔ̀rɔ̀ wó dɔ̀	
cǎ	'dog'	í cà	cà kṵ̂	âm cà wó dɔ̀	jì:né cá nì
ní	'mother'	í ní	ní kṵ̂		jì:né ní nì
jɔ̀kɔ̀rɔ́	'chain'	í jɔ́kɔ̀rɔ́	jɔ̀kɔ̀rɔ́ kṵ̂	âm jɔ̀kɔ̀rɔ́ wó dɔ̀	jì:né jɔ́kɔ̀rɔ́ nì
tókóró	'window'	í tókóró	tókóró kṵ̂	âm tókóró wó dɔ̀	jì:né tókóró nì
bùlálì	'iron'	í bú꜒lálì	bùlálí kṵ̂	âm bùlálí ꜒wó dɔ̀	jì:né bú꜒lálí nì
mísínì	'needle'	í mísínì	mísíní kṵ̂	âm mísíní ꜒wó dɔ̀	jì:né mísíní nì

As Bird (2003:12) discusses, "Rule (202) applies to any sequence of three syllables (CV) where the first is linked to an H tone and the second is linked to an L tone. The rule spreads H to the right, delinking the L. Crucially, the L itself is not deleted, but remains as a floating tone, and continues to influence surface tone as downstep. Example (203) shows the application of the H spread to forms involving *bùlálì*. The first row of autosegmental diagrams shows the underlying forms, where *bulali* is assigned an LHL tone melody. In the second row, we see the result of applying H spread. Following standard practice, the floating low tones are circled. Where a floating L appears between two H tones, it gives rise to downstep. The final assignment of tones to syllables and the position of the downsteps are shown in the last row of the table."

(202)



(203)



An interesting case of tonal spread is found in Mende, a Mande language, as discussed by Goldsmith (1976a, based on Leben 1973):

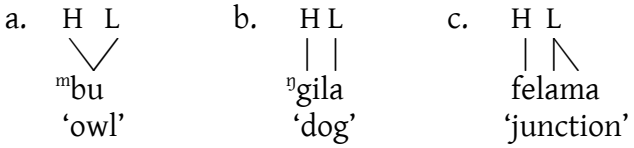
> "On short vowel in Mende, we can find Low, High, Rising, Falling, or Rising-Falling tones. Morphemes are one to three syllables long, and if the distribution of tones over these syllables were random, we would expect to find five tonal classes of 1-syllable words, 5^2 or 25 classes of 2-syllable words, and 5^3 or 125 classes of 3-syllable words: 155 types in all. In fact, there are 5 classes for each, not 5^n, and they are of a very particular sort. ... [T]here are only five available underlying melodies in Mende, and ... the melody is mapped from left to right onto the word. The five possibilities are:

(204) *Mende* (Mande: Goldsmith 1976a)

H	kɔ́	'war'	pɛ́lɛ́	'house'	háwámá	'waistline'
L	k͡pà	'debt'	bɛ̀lɛ̀	'trousers'	k͡pàkàlì	'tripod chair'
HL	ᵐbû	'owl'	ᵑgílà	'dog'	félàmà	'junction'
LH	ᵐbă	'rice'	fàⁿdé	'cotton'	ⁿdàvúlá	'sling'
LHL	ᵐb͡â	'companion'	njàhâ	'woman'	nìkílì	'groundnut'

In other words, tone is a property of words, not individual vowels, in Mende. Thus a tonal melody such as H+L is applied to words regardless of their actual length. These two tones form a contour in monosyllabic words, e.g., (205a), they each associate to one vowel in disyllabic words, e.g., (205b), and the second tone is spread between two vowels in trisyllabic words, e.g., (205c).

(205) *Mende* (Mande: Goldsmith 1976a)



That the end tone "spreads out" in longer words is confirmed by the behavior of *toneless* syllables, such as the postpositions *hu* 'in' and *ma* 'on'. These assimilate H from preceding H or LH syllables, e.g., (206a), and they assimilate L from preceding L or HL syllables, e.g., (206b).

(206)

			'in ...'	'on ...'
a.	kɔ́	'war'	kɔ́ hú	kɔ́ má
	pɛ́lɛ́	'house'	pɛ́lɛ́ hú	pɛ́lɛ́ má
	ᵐbă	'rice'	ᵐbă hú	ᵐbă má
b.	bɛ̀lɛ̀	'trousers'	bɛ̀lɛ̀ hù	bɛ̀lɛ̀ mà
	ᵐbû	'owl'	ᵐbû hù	ᵐbû mà

Prefixes in Tanacross (Athabaskan: Holton 2000:84) are also toneless and receive their tonal specification from preceding stems: they are L after low tone stems, e.g., (207a) but H after a high tone stem, e.g., (207b).

(207) *Toneless prefix in Tanacross* (Holton 2000:84-5)

a. /sè:j n-ɛk-ʔɛ̏h/ → [sè:j nɛ̀kʔɛ̏h] 'I see the knives'
knife THM-1SG-see:IMPF

b. /ɬóx n-ɛk-ʔɛ̏h/ → [ɬóx nɛ́kʔɛ̏h] 'I see the fish hooks'
fish.hooks THM-1SG-see:IMPF

Marghi (Chadic: Pulleyblank 1986, Odden 1995:465-6) has toneless suffixes (208a) as well as toneless roots (208b,c) which assimilate adjacent tones.

(208) *Toneless morphemes in Marghi* (Chadic: Pulleyblank 1986)

a.	/tá-na/	→	[táná]	'cook and put aside'
	/ⁿdàl-na/	→	[ⁿdàlnà]	'throw away'
b.	/ɗəl-bá/	→	[ɗə́lbá]	'buy'
cf.	/ⁿdàl-bá/	→	[ⁿdàlbá]	'throw out'
	/tá-bá/	→	[tábá]	'cook all'
c.	/skə-ɗà/	→	[skə̀ɗà]	'wait for me'
cf.	/ná-ɗà/	→	[náɗà]	'give me'
	/hàì-ɗà/	→	[hàrɗà]	'bring me'

Turning to dissimilation, recall our earlier discussion of "polarity", a term used to describe morphemes whose tone is always contrary to that of an adjacent root (p. 91ff.). For instance, in Marghi the tense prefix *a-* is H before a L root (196a) or a LH root (196a), and L before a H root (196c). Similarly the third person plural enclitic *ⁿda* is H after a H root (196a) but L after a LH root (196b) or a H root (196c).

(209) *Polarising morphemes in Marghi*

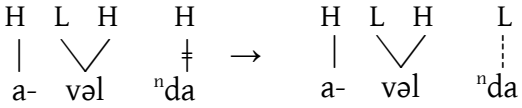
a. á- wì ⁿdá 'they run'
TENSE-run 3PL

b. á- vəl ⁿdà 'they fly'
TENSE-fly 3PL

c. à- sá ⁿdà 'they err'
TENSE-err 3PL

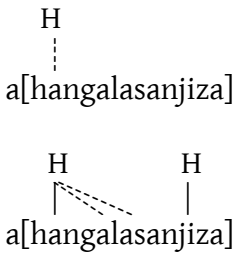
Pulleyblank (1986) suggests that these polarity morphemes are underlyingly H, and that their H dissimilates to the H of an adjacent root, as shown here for *á-vǎl ⁿdà* 'they fly':

(210) *Polarity as dissimilation*



In their discussion of polarity in Gur languages, Kenstowicz, Nikiema and Ourso (1988) argue more generally that "polarity" morphemes do not exist; they are simply H morphemes which regularly dissimilate to adjacent H tones. It may be more appropriate, therefore, to refer to "dissimilating" morphemes. (Compare the "non-dissimilating" suffix *-bá*, e.g., *tá-bá* 'cook all' (208b).)

A dissimilation effect between H tones is also seen in Chizigula (Bantu: Kenstowicz and Kisseberth 1990). The third person singular prefix in this language carries a H which docks onto the first syllable of the stem, as shown in the last column of (211) below. Longer stems, such as those in (211b), reveal that the H spreads rightward.[155] However, the H never spreads to a syllable that itself precedes a H (see p. 94ff. above). Kenstowicz and Kisseberth (1990:168) describe this as H-dissimilation.



(211) *Chizigula* (Kenstowicz and Kisseberth 1990:167-8)

	Infinitive		*1st pers. sing.*	*3rd pers. sing.*
a.	ku-lulungánja	'take advantage of'	na-lulungánja	a-lúlungánja
	ku-bindilíza	'finish'	na-bindilíza	a-bíndilíza
b.	ku-hangalasánja	'carry many things at once'	na-hangalasánja	a-hángálasánja
	ku-hangalasanjíza	'carry many things for'	na-hangalasanízja	a-hángálásanjíza
	ku-hangalasanjizíza	'carry many things for (intensively)'	na-hangalasanizízja	a-hángálásánjizíza

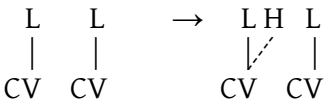
[155] Note that only H is shown in the data. Indeed, Chizigula tonal phonology (including H-spread; see also p. 94ff.) seems simpler if we assume that "all tone bearing units which fail to associate with a High tone are assigned a Low tone by default" (Kenstowicz and Kisseberth 1990:168).

Standard Chinese provides an example of low tone dissimilation. As Yip (2003:181) describes: "When two of these [L] tones come together, the first changes to the high rising 'second tone': *lào lì* → *lǎo lì* 'Old Li'. The change is clearly dissimilatory ...: L.L → LH.L." Additional examples are provided in (212), from Duanmu (2000:237ff.). In each case, the phonological change occurs as in (213).

(212) *Standard Chinese Tone 3 sandhi*

a.	mì-tᶜʲòu	→	mǐ-tᶜʲòu	'rice-wine'
b.	nì xào	→	nǐ xào	'you good' (how are you?)
c.	mài mà:	→	mǎi mà:	'buy a horse'
cf.	mǎi mà:	→	mǎi mà:	'bury a horse'

(213)



Exercises:

A. *Moore* (Kenstowicz 1994)
Moore is a two-tone Gur language spoken in Burkina Faso. In the transcriptions below, high-toned syllables are marked by the acute; low-toned syllables are unmarked.

i. The language has a system of noun class suffixes marking singular and plural. Examples from the most productive classes are listed in (1). What principle underlies the alternation in suffixal tone?

(1)

sg.	pl.		sg.	pl.	
kor-gó	kor-dó	'sack'	sá-ga	sá-se	'broom'
ro-gó	ro-tó	'house'	wáŋ-ga	wám-se	'hollow'
wób-go	wób-do	'elephant'	gob-ré	gwab-á	'left-hand'
láŋ-go	lán-do	'hole'	tʊb-ré	tʊb-á	'ear'
tɪ-gá	tɪ-sé	'tree'	kúg-ri	kúg-a	'stone'
ke-gá	ke-sé	'green'	bɛ́d-re	bɛ́d-a	'big'

ii. Develop an analysis to account for the appearance of the raised exclamation mark in the data of (2). In the first paradigm the nouns sá-ga ('broom') and kor-gó ('sack') appear as complements to the verbs zá ('bring') and ko ('give'). The second paradigm consists of noun+adjective constructions. This construction has the peculiarity that the morphology does not generate a number suffix on the noun in Moore.

(2)

ko sága	'give a broom'	kor bɛ́da	'big sacks'
ko korgó	'give a sack'	kor kegá	'green sack'
zá sága	'bring a broom'	sá bɛ́da	'big brooms'
zá kórᵎgó	'bring a sack'		

iii. In Moore a suffixal vowel is deleted when a word appears in the middle of the phrase. Examine the associative constructions in (3) and discuss the tonal effects produced by the deletion rule. Derive each of the phrases, explaining the steps involved.

(3)				
	nɛ́d-a	'man'	na-bá	'chief'
	nɛ́d korgó	'man's sack'	nab kór$^{!}$gó	'chief's sack'
	nɛ́d $^{!}$sága	'man's broom'	nab sága	'chief's broom'

iv. So far we have seen two tonal patterns for Moore nominals: low on the root and high on the suffix (e.g., kor-gó) and high on the root and low on the suffix (e.g., sá-ga). There is in fact an additional tonal pattern: a high appears on both the root and the suffix (4). But nominals with a low tone on both the root and the suffix are absent in Moore.

(4)						
	bíd-gó	bíd-gó	'sorrel'	bó-gá	bó-sé	'goat'
	mó-gó	mó-dó	'straw'	wám-dé	wám-á	'calabash'
	bá-gá	bá-sé	'dog'	rá-ré	ré-yá	'day'

These nominals appear with a low tone when combined with a following adjective (5).

(5)				
	mo saŋgó	'good straw'	ba bɛ́da	'big dogs'
	bʊ saŋgó	'good goat'	wam kegá	'green calabash'

Develop and analysis to explain this alternation as well as the absence of nominals with a low on both the root and the suffix.

B. ***Shona*** (Bantu: Odden 1980, 1995)

a.	mbwá	'dog'	né-mbwa	'with dog'
b.	hóvé	'fish'	né-hove	'with fish'
c.	mbúndúdzí	'army worm'	né-mbundudzi	'with army worm'
d.	hákátá	'diviner's bones'	né-hakata	'with diviner's bones'
e.	bénzíbvunzá	'inquisitive fool'	né-benzibvunzá	'with an inquisitive fool'

i. Rewrite the words in the left-side column, using autosegmental formalism to represent high tone.
ii. Assuming that the words in (i) are like underlying representations, name and describe what happens when a high tone prefix is added to them, as shown in the second column. Give an autosegmental rule to account for the alternation.
iii. Try to explain why the word-final H in bénzíbvunzá does not lower, while the H of the first two vowels does.
iv. How does this exercise argue in favour of autosegmental (as opposed to linear) representations in phonology?

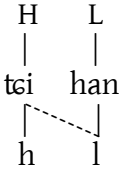
3.5.3.2. [±raised pitch]

An example of [±raised] assimilation is provided by Gao'an Chinese (Bao 1990a:111, Yip 1995:491): high tones [H,h] become falling [H,hl] before any l-tone, whether mid [H,l] (214a) or extra-low [L,l] (214a), that is, [–raised] spreads leftward onto a preceding syllable, independently of [±upper].

(214) *[–upper] (l) spread in Gao'an* (Bao 1990a:111)

/sóng tɕī/ → sṓng tɕī 'bi-seasonal'

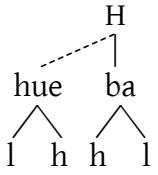
/tɕí hàn/ → tɕí hàn 'egg'



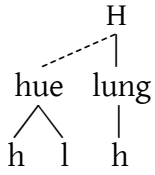
[±upper] can also spread independently of [±raised]. A first example is provided by Chaozhou Chinese (Bao 1999, Yip 2003:54), where the first syllable of a compound assimilates to [±upper] in a following syllable. For instance, the words 'fire' and 'goods' have the same segments but they differ in tone: they are [lh] and [hl], respectively. As illustrated in (215), these words obtain their [±upper] specification through spreading from the second syllable in compounds.

(215) *Chaozhou* (Bao 1999, Yip 2003:54)

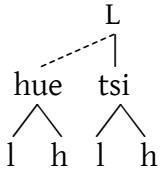
hú̍e bá
fire handle
'torch'



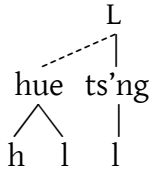
hú̍e lúng
goods ship
'freighter'



hù̍e tsì
fire arrow
'rocket'



hù̍e ts'ǹg
goods storage
'warehouse'



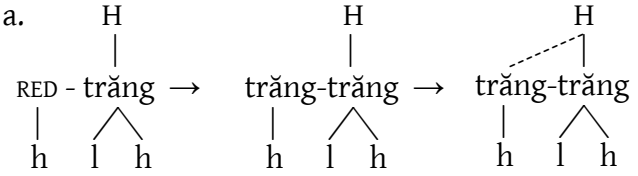
Another example is provided by reduplication in Vietnamese, a Mon-Khmer language (Nhàn 1984). As Yip (2003:208) describes, "if the input syllable is ... [+upper] ... then the prefixal reduplicant surfaces as [high-toned], as in (216a). If the input syllable is ... [–upper], then the prefixal reduplicant surfaces as [mid-toned], as in (216b)."

(216) *Reduplication in Vietnamese*

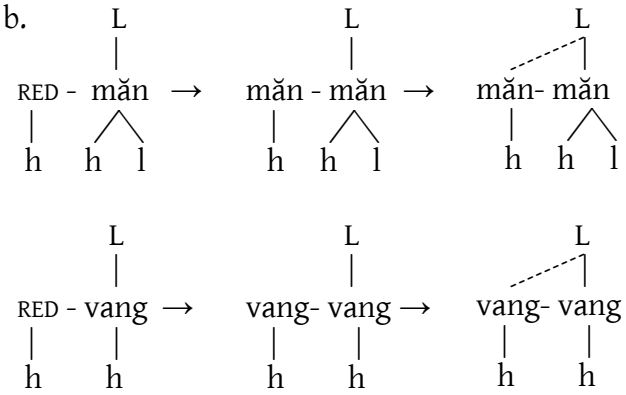
a.	/RED-trắng/	→	trắng-trắng	'whitish'
	/RED-xánh/	→	xánh-xánh	'blueish'
b.	/RED-mặ̄n/	→	mặ̄n-mặ̄n	'rather salty'
	/RED-vāng/	→	vāng-vāng	'yellowish'

This pattern can be understood as follows: the reduplicative prefix (RED) is always [+raised] (h) but it assimilates the [±upper] (H/L) specification of the base, as illustrated here for the data in (216).

(217) a.



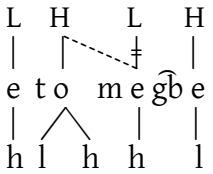
b.



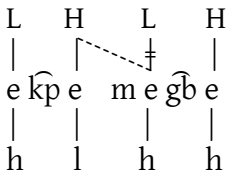
Finally, in Ewe (Gbe, Ghana: Odden 1995:453) a mid tone ([L,h]) is raised to extra-high ([H,h]) when it is flanked by high tones ([H,l]), that is, [+upper] (H) spreads to, and delinks, an adjacent [–upper] (L), without affecting the specifications for [±raised] (h/l), e.g., (218a,b).

(218) *Mid tone raising in Ewe*

/ētő mēg͡bé/ → [ētő mḗg͡bé]
'behind a mortar'



/ēk͡pé mēg͡bé/ → [ēk͡pé mḗg͡bé]
'behind a stone'

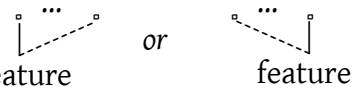


cf. /āk͡plɔ̄ mēg͡bé/ → [āk͡plɔ̄ mēg͡bé]
'behind a spear'

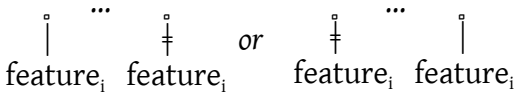
3.6. Intersegmental Phonology: Conclusion

While words and morphemes are stored with single underlying representations in memory (Halle 2002b, McCarthy 2003), they typically surface with various realizations due to the application of phonological processes. In particular, we have seen that the phonological features which make up words and morphemes commonly assimilate to, and dissimilate from, each other, yielding (sometimes radically) different surface forms. Following Goldsmith's (1976b) original proposal, we have characterized these processes with graphs in autosegmental representations:

(219) a. *Assimilation*



b. *Dissimilation*



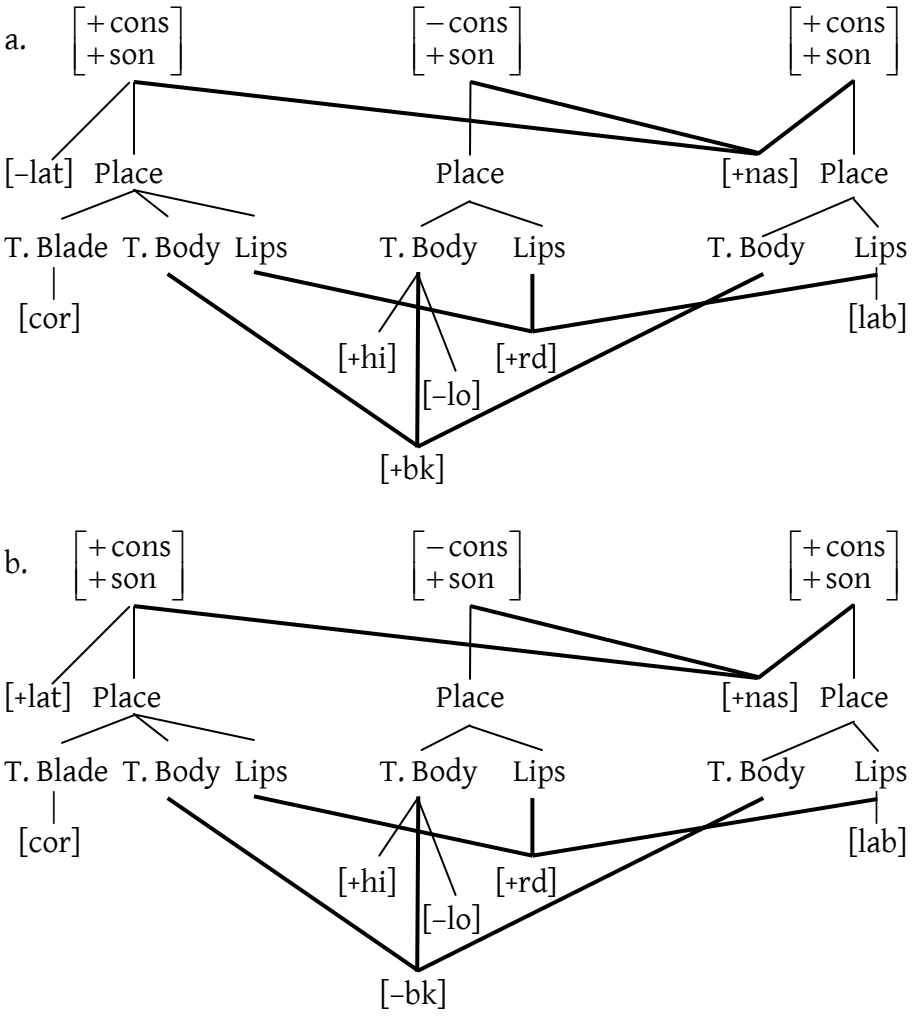
Interestingly, since more than one pattern of assimilation or dissimilation can affect the same set of segments in a word/morpheme, graphs are necessarily three-dimensional in phonology. For instance, Kelly and Local (1989:218-41) carefully describe a variety of Guyanese English in which three features "spread out" in words: [+nasal], [+round], and [±back]. Words illustrating this three-fold assimilation are provided here:

(220) *Words in Guyanese English* (Kelly and Local 1989)

[ʒ̃ˠũm̰ˠ]	'room'	[ʲœyt̰ʲ]	'loot'	[kjeybˠ]	'cube'
[ʲỹm̰ʲ]	'loom'	[ʲeyt̰ʲ]	'lute'	[ɹ̃ˠɪpʲ]	'rip'
[ʒ̃ˠũm̰ˠ]	'zoom'	[ʒ̃ˠṵ̃ʲ]	'rule'	[ɹ̃ˠɛdˠ]	'red'
[ɻˠut̰ˠ]	'root'	[f̰jeydˠ]	'feud'		

Coleman and Local (1991:329ff.) discuss this case of triple assimilation in detail, and argue that the three features in question are lexically associated with independent segments in each word, so they must spread independently. They conclude that "Autosegmental Phonology is necessarily nonplanar" (p. 335), since "planar graphs are not in general adequate for Autosegmental Phonological Representations of Guyanese English, because the Autosegmental Representations of *room* and *loom* cannot be planar" (ibid.). Autosegmental diagrams of these two words in Guyanese English are given in (221a,b), respectively. (Some irrelevant features have been suppressed.) That three different features can link independently (thick lines) to the same three segments is conclusive geometric proof that phonological representations are three-dimensional.

(221) *3-D diagrams of* 'room' *and* 'loom' *in Guyanese English*



Before concluding we need to ask why syntagmatic processes such as assimilation and dissimilation should exist in the first place. As Pulleyblank (1997:62-3) discusses:

> It is generally assumed that a derivational grammar with simpler rules is simpler than a comparable grammar with more rules. ... But pursuing this logic to its extreme would mean that the simplest grammar would be one where there are no rules, where all inputs are identical to all outputs. In other words, why deviate from [input/output] identity at all? Isn't the simplest phonology one that isn't? While interpreting fewer rules as simpler might at first seem desirable, there is an immediate and apparent problem: none of the anticipated simple grammars without phonological rules have ever been found. Why should complexity be an apparently unavoidable property of sound systems?

This question remains very much open among phonologists, but there is some consensus that "a rule applies if and only if its effect is to increase the well-formedness of the representation" (Goldsmith 1995b:7). This assumption (sometimes called "harmonic ascent") holds especially for Generative Phonotactics (Singh 1987), Harmonic Phonology (Goldsmith 1993), the Theory of Constraints and Repair Stategies (LaCharité and Paradis 1993), Declarative Phonology (Scobbie 1993), and Optimality Theory (Prince and Smolensky 1993, Moreton 1996/1999). For instance, in the latter theory, which now dominates the field (e.g., Lombardi 2001), it has been proposed that features spread because there is a preference to *align* them with the edge of a domain, whether phonological (e.g., syllable) or morphological (e.g., word) (Kirchner 1993, Akinlabi 1994, Archangeli and Pulleyblank 2004), or because a sequence of opposite values for a given feature is avoided in some languages (Smolensky 1993, Pulleyblank 2002). (For alternative approaches to assimilation in OT, see, e.g., Cole and Kisseberth 1994, Beckman 1997, Bakovic 2000.) For various approaches to dissimilation in OT, see, e.g., Myers (1997), Alderete (1997, 2003), Suzuki (1997), and Fukazawa (1999).

Have a great holiday!

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