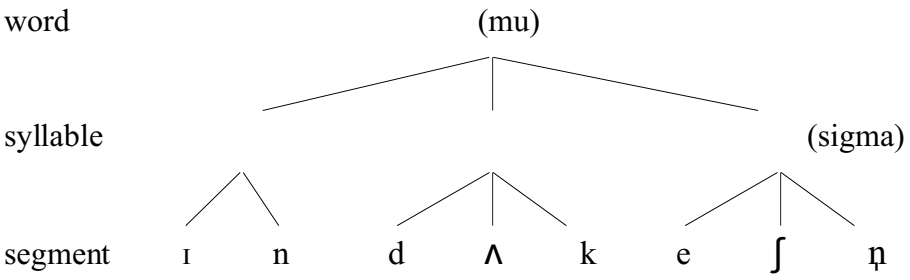
Phonology: The Organization of Sounds

Phonology is the study of the **organization of speech sounds**. Seeing a written language, it's all too easy to think that we actually process speech in terms of individual sounds as though each word consisted of beads on a string. The bead-on-a-string model of speech sounds predicts that each sound is independent of every other sound in the string. We can test this prediction by trying out different orders of sounds:

Permissible sequences:	bap, kab, slish, screk
Impermissible sequences:	pnap, osmt

What happened? A quick answer is that the bead-on-a-string model isn't right for spoken English (nothing prevents us from writing these sequences). The model doesn't account for the effect that one sound has on the next in the spoken language. The solution is to recognize a more complicated organization of sounds in the language. One feature of this organization is that sounds group together in a **hierarchical structure**. Get used to this idea now, because it will reappear at other points in our analysis of language structure. An example of the hierarchical organization of speech sounds:



Phonotactics is the branch of phonology that studies the **constraints on sequences of sounds** in languages. Different languages have different hierarchical patterns of organization. Russian, for example, has words such as *vprog* [fprɔk] 'value, good'. English speakers trying to pronounce this word would probably produce it as [fəprɔk]. Columbian Salish has words such as ksptt*íx̣*^{w}ə*x*^{w} 'spitting a lot' and *q*^{w}*sq*^{w}*a*ʔ*yáɬp* 'alder'. The Russian and Salish words violate the permissable phonotactic patterns of English syllables. What are the permissable onsets?

		p	(l)	
#	s	t	r	V
		k	(w)	
		y		

No English words start with #stl- or #spw-. This is not an **accidental gap**. The second and third consonants in these sequences have the **same point of articulation**. English does not allow 2 consonants with the same points of articulation at the beginning of a

word if the first consonant is a stop. This rule also forbids *#tl- and *#pw. The latter is a favorite of some children learning English, who produce 'play' as [pwey]. Gaps that result from the phonotactic constraints of a language are **systematic gaps**.

When we borrow words from other languages we typically modify their sound sequences to fit our own constraints, e.g., Greek words feature #ps- and #pt- initial consonant sequences: *psychology*, *psoriasis*, *pterodactyl*. The impermissable initial consonant clusters are reduced to s- or t- in English.

Sound Categories

Language sounds are formed along continuous dimensions of articulatory features. Languages, somewhat arbitrarilly, decide where to divide these dimensions into contrasting sounds. The main difference between [p] and [b] is the time at which voicing begins, e.g., peg vs. beg. This dimension is referred to as the Voice Onset Time or VOT. Technically, VOT is the time between stop release and the onset of voicing. In isolation, [b] has a VOT of 0 seconds, while [p] has a VOT of +.06 seconds. The first thing to note is that this isn't a lot of time. We're extremely sensitive to minute changes in sound. Secondly, the change in VOT between [p] and [b] is extremely abrupt. Most speakers perceive VOT of less than +.03 seconds as [b] whereas a VOT of more than +.03 is perceived as [p]. The abruptness of this change in perception is a good example of the way language changes a continuous dimension into a meaningful **contrast**.

Try out your ears on the [d]/[g] contrast

A major part of learning a language is discovering the meaningful contrasts that the language makes use of. Segments **contrast** when their presence alone distinguishes forms with different meanings from one another:

e.g.,	[s]/[z]	sip/zip
	[I]/[ey]/[a]	hit/hate/hot

The **minimal pair test** provides the best evidence that sounds contrast. A **minimal pair** is a set of 2 forms with distinct meanings that differ by only 1 segment found in the same position in each form.

sip and *zip* are minimal pairs. This shows that [s] and [z] contrast in English.

It isn't always possible to find a minimal pair for a contrast. In such cases, linguists resort to looking for **near-minimal pairs**, e.g., *azure* and *assure* or *author* and *either*. Such pairs also help to establish the contrasts in a language.

A **minimal set** is a series of minimal pairs that establish a set of contrasts, e.g.,

tip	dip	[t] [d]
sip	zip	[s] [z]

ship	chip	[ʃ] [tʃ]
lip	nip	[l] [n]

Contrasts are language specific - languages don't use the same set of contrasts, e.g.,

	English	Turkish
[bɛn]	'Ben'	'I'
[bæn]	'ban'	'I'

or [ʃʷ] / [ʃ] are distinctive in Lak (Caucasian).

Systematic Variation

Human languages allow a great deal of latitude in the way sounds are produced. The sequences sounds appear in have systematic effects on their pronounciation. This variation is **systematic** if it is **conditioned** by the phonetic context or **environment** in which the segment occurs. Sounds are affected by the phonetic characteristics of their neighbors. We learn to filter out these changes and focus on the contrasts that are distinctive for our language.

These systematic variations are often surprising. There is a systematic contrast between voiced and voiceless [l] in English, e.g.,

	voiced		voiceless
blue	[bluw]	plow	[p̥law]
leaf	[liyf]	clap	[kl̥æp]

The two kinds of [l]s appear in different environments, so they are in **complementary distribution**. They never occur in the same environment.

[l] and [l̥] are phonetically distinct, but phonologically the same. English speakers perceive them as the same sound. A **phoneme** is the linguistic term for **a group of sounds that do not contrast**. Phonemes are the difference between phonetics and phonology. **Phonetics** analyzes physical sounds or [phones], **phonology** analyzes the ways that human languages group phones into sound categories or /phonemes/. Phonemes are predictable phonetic variants that are **1. phonetically similar**, and **2. in complementary distribution**. The phonetically similar variants of a phoneme are **allophones**.

Phonemic /l/ - Note slashes!

Phonetic [l̥] [l] - Note brackets!

Environment: after voiceless stops / elsewhere

The minimal pair test is used to identify phonemes!
Sounds require some degree of phonetic similarity to be considered allophones.
[ŋ] and [h] appear in complementary distribution in English, but aren't similar enough to be considered allophones.

Phonemes seem to capture something about the way we actually use sounds in language. They are psychologically real. Still, we never actually produce a phoneme, just its allophones.
English spelling underlines the reality of the phoneme. It uses the same letter for both [l] and [l̥]. Allophonic differences are ignored in written English. Phonemic contrasts aren't ignored, e.g., /l/ and /r/. This is only true of English, though. In Japanese [l] and [r] are allophones of the same phoneme. This is part of the reason it is difficult to sound like a native speaker of a foreign language.

Phonological analysis also makes it possible to state generalizations about phonetic variation. In English, both liquids and glides have voiceless allophones after voiceless stops and voiced allophones elsewhere:

green	[griyn]	trip	[tr̥Ip]
view	[vyuw]	twin	[tw̥In]
swim	[swIm]	cute	[kẘuwt]

Liquids and glides show the same allophonic patterns - evidence that they belong to the same **natural class** of sounds. Natural classes express phonological generalizations that imply natural psychological divisions.

Liquids and glides have the features: [-syllabic, +sonorant, -nasal]
Sometimes such features do not help to distinguish a psychologically significant class.

Phonological Rules

Linguistics is just like any science. Once you observe some general processes, it would be a good idea to write them down. That way other people can check the accuracy of your observations or extend them to even more general predictions. Phonologists use phonological rules to capture their generalizations/predictions. These rules have the general form:

A B / C___D, where

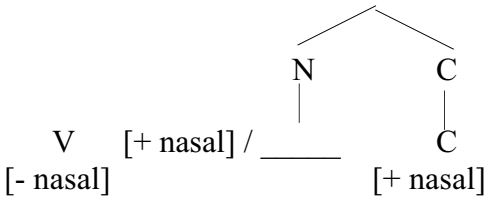
A is the **underlying representation** (UR)
B is the **phonological change**
and C___D states the **environment** where the change takes place.

Phonological rules are written in terms of phonetic features to make them as general as possible, e.g., the rule for liquid-glide devoicing would be:

$$\begin{bmatrix} -\text{ syllabic} \\ +\text{ sonorant} \\ -\text{ nasal} \end{bmatrix} \rightarrow [-\text{ voice}] \; / \; \begin{bmatrix} \text{C} \\ -\text{ continuant} \\ -\text{ voice} \end{bmatrix} \_\_\_$$

This is an example of **assimilation**.
Assimilation processes underline the importance of features. **Phonological processes** such as assimilation affect the features of sounds.

English vowel nasalization is another example:

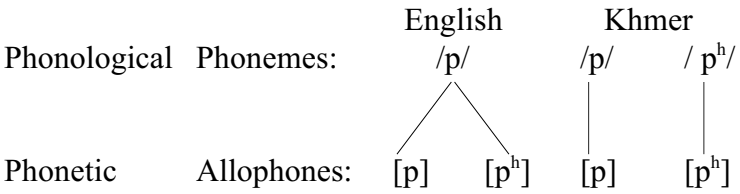


There are 2 basic problems in stating a phonological rule:
1. Figuring out the conditioning environment
2. Figuring out which sound is the underlying representation.

The process of looking for phonemic distinctions can be made systematic by:
1. Write down the minimal pairs
2. Check whether there are any allophones in complementary distribution
   - Allophones are usually phonetically similar
3. Figure out what the conditioning environment is
4. Figure out which allophone is the underlying representation
5. Write out the rule - in words if necessary
6. Look for other sounds that undergo the same process
7. If other sounds participate in the process, try to restate your phonological rule so that it applies to all the sounds that undergo the process.

It is important to emphasize that a phonemic contrast in 1 language may not be phonemic in another. The relation of phonemes to allophones varies across languages, e.g.,
stop phones in English and Khmer (Cambodian):

[p]	[p^h]	[pa:]	'father'	[p^ha:]	'silk cloth'
[t]	[t^h]	[tu:]	'chest'	[t^hu:]	'relaxed'
[k]	[k^h]	[kæ]	'to repair'	[k^hæ]	'month'



Give the class Southern Kongo (Bantu) to work out the analysis of [t,s,z] and [tʃ,ʃ,ʒ]

Southern Kongo (Bantu)

[tobola]	'to bore a hole'	[tʃina]	'to cut'
[tanu]	'five'	[tʃiba]	'banana'
[kesoka]	'to be cut'	[nkoʃi]	'lion'
[kasu]	'emaciation'	[nselele]	'termite'
[kunezulu]	'heaven'	[aʒimola]	'alms'
[nzwetu]	'our'	[lolonʒi]	'to wash house'
[zevo]	'then'	[zenga]	'to cut'
[ʒima]	'to stretch'		

The nonoccurence of [t] before [e] is an accidental gap.

Not all allophones are in complementary distribution. Allophones that occur in the same environment are in **free variation**, e.g., *stop* [stapʰ] [stapʔ] [stap¯]

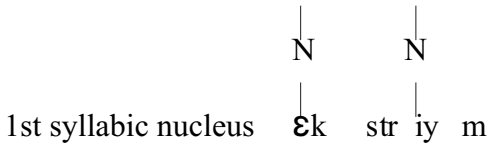
Autosegmental phonology

Autosegmental phonology examines the relations between individual sounds
use separate levels or **tiers** to describe sounds
use **association lines** to link the tiers

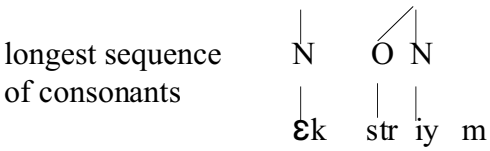
e.g., tone L H

tunko 'sheep' Duwai (West Africa)

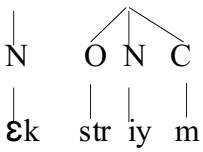
also syllables:



2nd onset

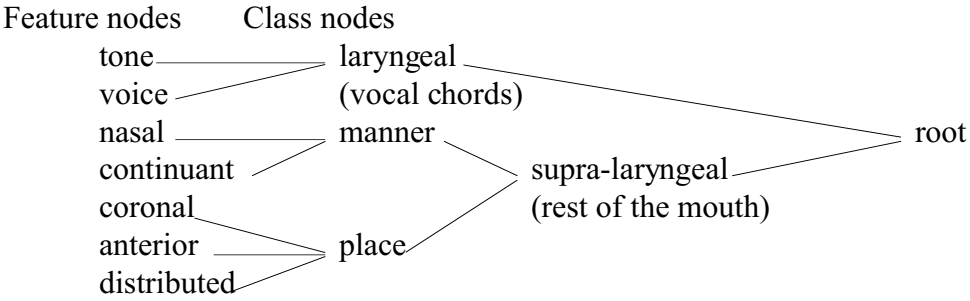


3rd coda



Use this procedure to syllabify words in any language!?
Don't just have segments at the other end of association lines. Autosegmental principles have been extended to phonetic features as well. Attempt to organize features into a hierarchy to predict the ways in which different features interact.

[continuant] often acts alone
[anterior] & [coronal] often act together

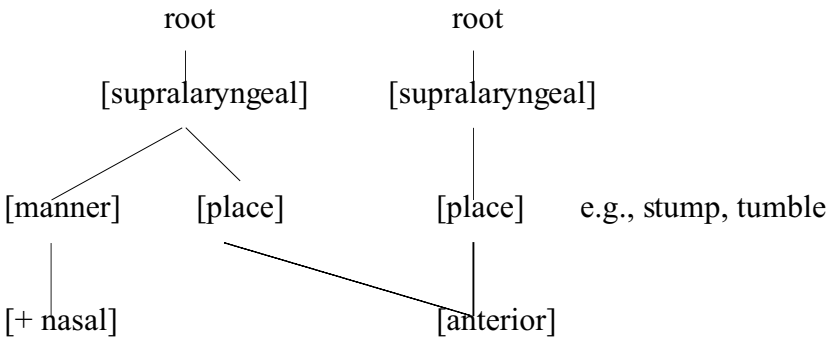


The hierarchies specify a **feature geometry**

The Root node represents the 'phoneme'
then laryngeal supra-laryngeal
[+ voice] [soft palate = nasal], [place]

The exact geometry hopefully captures the phonological processes in language.
A language might have [m] and [n], but not [ŋ]
prohibit soft palate activation without a positive value for coronal or anterior.

One may represent assimilation via association processes



You might wonder why [nasal] doesn't have its own place. Not all places may be fully specified for each feature. Leads to **underspecification theory**. Certain features may be

missing from the underlying representation, e.g., nasals may not be fully specified for place. This allows place features to associate with the following segment
assimilation
What happens if assimilation doesn't take place? Underspecified features may have a **default realization**, e.g., + coronal predictable
Underspecified features ~ **unmarked**; they occur in almost all languages, /n/