1 General introduction

1. Chomsky (1957): a **language** is a set of its grammatical sentences.

1.1. Change "sentences" to "expressions".

1.2. Change "expressions" to "expressions with their structural descriptions".

1.2.1. String similarity is usually misleading:

(1) a. John is easy to please.
b. John is eager to please.

(2) a. I expected John to leave.
b. I persuaded John to leave.

(3) a. We expected several students to be at the talk.
b. We persuaded several students to be at the talk.

(4) a. A unicorn seems to be in the garden.
b. A unicorn tries to be in the garden.

(5) a. John grows tomatoes.
b. John destroys tomatoes.

(6) a. It is unlikely that Lee will be elected.
b. It is improbable that Lee will be elected.

(7) a. They saw Pat with Chris.
b. They saw Pat and Chris.

(8) a. Something disgusting has happened in this bed.
b. Something disgusting has slept in this bed.

(9) a. He looked up the word.
b. He looked at the word.

(10) a. Who do you want to see?
b. Who do you want to see Bill?

(11) a. It is easy to play **this sonata** on **this violin**.
b. **This sonata** is easy to play on **this violin**.
c. **This violin** is easy to play **this sonata** on.

1.3. Item 1.2. brings meaning into picture:

> It is assumed in *LSLT* (as in *SS*) that the theory developed is to be embedded in a broader semiotic theory which will make use of the structure of *L*, as here defined, to determine the meaning and reference of expressions and the conditions on their appropriate use, and will also encompass other investigations (statistical linguistics, etc.). (Chomsky 1975:3)

2. **Grammar** is an explicit system of rules and representations that pairs phonetic forms (sound pathway) with logical forms (meaning pathway).

3. **Acceptability** (data) versus **grammaticality** (theory).

3.1. Factors effective in acceptability are manifold and complex.

3.2. Grammar is just one among many.

3.3. Such idealization is indispensable in science.

3.3.1. Economist Dani Rodrik:

> All models are wrong. They are helpful [when] used in relevant context. Empirics without models yield no understanding.
>
> To clarify, models are wrong in the same sense that a subway map is wrong. Leaves out, misrepresents real world details.
>
> Simplicity in theory is a feature, not a bug. "But the real world is more complicated" is never good riposte. All causal theories simplify. (tweets, March 8, 2017)

4. **Descriptive** versus **explanatory** adequacy.

4.1. Description: "Given a language, what is possible to utter to mean what?"

4.1.1. A descriptively successful grammar for a given language has the widest possible coverage with a minimal set of rules and assumptions.

4.2. Explanation: "What is a possible human language?"

4.2.1. What is the common denominator of all the descriptively successful grammars?

2 Sound

1. Language is primarily based on sound.
2. Speech sounds are generated within the **vocal tract** (larynx, mouth, nose) by constricting the passage of air pumped by the lungs in various ways.
3. Three parameters: **place** of articulation, **manner** of articulation, and **voice**.
4. **Voice.**

4.1. Periodic sound waves are generated by vibrating vocal folds.[1]

4.2. Only periodic sound waves have tone; an aperiodic sound wave is noise.

4.3. A voiced consonant (e.g. [v], [b] or [z]) is a mixture of noise and periodic sound.

4.4. A voiceless consonant (e.g. [f], [p] or [s]) is noise.

5. **Place of articulation.**

Place	**Active articulator**	**Passive Articulator**	**Examples**
Bilabial	upper and lower lips	none	[p b m ɸ]
Labiodental	lower lip	upper front teeth	[f v ɱ]
Dental	tongue tip	upper front teeth	[θ ð]
Alveolar	tongue tip or blade	alveolar ridge	[t d l n s z]
Postalveolar	tongue tip or blade	rear of alveolar ridge	[ɹ ʃ]
Retroflex	tongue tip	hard palate	[ʈ ɖ ɳ]
Palatal	tongue front	hard palate	[j ɲ]
Velar	tongue back	soft palate	[k g]
Uvular	tongue back	uvula	[q ɢ]
Pharyngeal	tongue root	rear wall of pharynx	[ħ ʕ]
Glottal	vocal folds	none	[h ʔ]

6. **Manner of articulation.**

6.1. Degrees of stricture: Closure, narrowing, approximation.

6.2. The first two generate **obstruents**; it is impossible to create or sustain voice; pressure builds up in the vocal tract.

6.3. Approximation generates **sonorants**.

6.4. Stops (full-blockage):

- oral e.g. [p b t d k g] versus **nasal** e.g. [m n] – you can force a nasal stop into an oral stop by blocking your nostrils;
- **plosive** e.g. [p b t d k g] versus **affricate** e.g. [tʃ dʒ ts].

6.5. **Fricatives** (narrow but not full blockage):
median e.g. [s z f v] versus lateral e.g. [ɬ ɮ].

6.6. **Approximants** (similar to fricatives but sonorant):
median e.g. [w j] versus lateral e.g. [l ʎ].

6.7. **Taps** e.g. [d] versus [ɾ] in US English; **trills** e.g. [r ʀ] and **flaps** e.g. [ɽ].

7. **Vowels**

7.1. A vowel is a complex of periodic sound waves.

7.2. Vocal folds create a spectrum of frequencies with differing intensities. This spectrum gets filtered through the vocal tract to produce categorically perceptible vowel qualities.

7.3. Three parameters: height, location, lip position.

[1] Piano: 27.5 Hz – 4,186 Hz; typical male: 80-210 Hz; typical female: 150-320 Hz; bass voice: very rarely as low as 50 Hz; soprano voice: up to around 1,000 Hz; human ear: 20 Hz – 20,000 Hz.

3 Sound structure

1. **Basic concepts.**

1.1. **Segment.** Take the word *cat*. There are three sound units in this word, which we name **segments**. How do we know that there are three, but not two or five? The reason is that the sounds are apparently there for us to do minimal replacements to arrive at other words: e.g. *hat*, *cut*, *cap*.

1.2. **Contrast.** In both Turkish and English the lateral approximant sound (orthographically *l*) have both a non-velarized [l] and a velarized [ɬ] version. In English non-velarized [l] appears before vowels and [j], as in *look* and *familiar*, whereas the velarized [ɬ] appears before consonants (e.g. *milk*) and pauses (e.g. *cool*). **Its distribution is predictable by rule.** In Turkish, however, the same sound distinction is not fully predictable; it may distinguish words (e.g. *sol* as a direction versus a musical note). For this reason [l] versus [ɬ] is contrastive in Turkish. Voice in plosives is contrastive in both languages (e.g. *pat* versus *bat* and *pul* versus *bul*).

1.3. **Phoneme.** English *l* sounds are not limited to [l ɬ]; before dental fricatives, one finds a velarized dental – rather than velar – lateral approximant [ɫ̪], e.g. as in *healthy*. Yet another *l* sound is voiced nasalized and velarized alveolar lateral approximant [l̴̃], as in words like *film* and *kiln*. All these are **phones** that cannot make any meaning distinction in English. They all realize a sound abstraction called a **phoneme**, depicted as /l/. The set of phones [l ɬ ɫ̪ l̴̃] are called the **allophones** of the phoneme /l/.

2. **Aims of Phonology.**

2.1. Sounds of (a particular) language – the possibility space of speech sounds;

2.2. Rules of combination – **phonotactics**;

2.3. Rules of change – how do sounds "adapt" to their context.

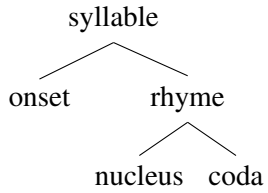
3. **Structure and process.** You can also look at phonology in terms of **structures** and **processes**.

3.1. Phonological structure is not simply a sequence of phonemes.

3.2. Speech is organized into natural "moves" of the speech organs called **syllables**.

3.3. One way to characterize syllables is templates like CVC, CV, VC, and so on.

3.4. Syllables themselves are not linear sequences of sounds, they display hierarchical organization.



3.5. Major phonological processes are: assimilation, dissimilation, deletion, insertion, weakening, strengthening.

4. **Feature theory.** Phonology further abstracts from phonetic features; around two dozen **distinctive features** characterize the notion of *a possible natural language phoneme* and take part in phonological rules.

4.1. **Major class features:**

syllabic (syl): forms a syllable peak; can bear stress. Notes: compare *ear* [ɪr] with *your* [jr̩]; the allophone of /r/ in the second is $\left[+\text{SYL}\right]$.

sonorant (son): can be voiced without effort; no pressure build-up in the vocal tract. Notes: $\left[+\text{SON}\right]$ does not mean vowel, English [w l ɹ j] are sonorant.

consonantal (cons): sounds produced with a main obstruction in the oral cavity (region after the glottis).

4.1. **Place of articulation related features:**

4.1.1. **Vowel place features:**

high: tongue is raised above the neutral position (= the position for [ɛ]).

low: tongue is lowered below the neutral position.

back: tongue is retracted from the neutral position.

round: lips are protruded.

4.1.1. **Consonant place features:**

coronal (cor): blade or tip of the tongue raised from the neutral position.

anterior (ant): produced with a constriction to the front of the alveolar ridge. Note: You can use [s] versus [ʃ] as a cut-off point for this feature, the first is $\left[\text{+ANT}\right]$ and the second is $\left[\text{-ANT}\right]$.

distributed (dist): constriction is extended (e.g. blade of the tongue touching a passive articulator results in $\left[\text{+DIST}\right]$, whereas the tip results in $\left[\text{-DIST}\right]$. This feature applies only to $\left[\text{+COR}\right]$ phones.

4.2. **Manner of articulation related features:**

continuant (cont): primary constriction does not totally block the flow through the *oral cavity*.

delayed release (del.rel): the relaxation of a stop is delayed, such that a fricative is formed; e.g. affricates [tʃ dʒ] are $\left[\text{+DEL.REL}\right]$.

nasal (nas): lowered velum, air can pass through the nasal cavity.

lateral (lat): the mid section of the tongue is lowered at the sides.

4.3. **Laryngeal features:**

spread glottis (s.g): vocal folds are spread far apart.

constricted glottis (c.g): vocal folds are tightly constricted.

voice (voi): vocal folds vibrate.

4.4. **Prosodic features:**

long has greater duration.

stress emphasized with greater pitch, amplitude and duration.

5. **Feature specifications.** A feature theory determines all the available abstractions over speech sounds. Any feature set defines a (possibly empty) set of phonemes for a given language. For instance $\left[\text{+HIGH, -ROUND}\right]$ designates the set [i ɯ], $\left[\text{+SYL}\right]$ designates the set [i y e œ ɯ a o u] in Turkish.

6. A feature specification may point to an empty set of phonemes for two reasons: (1) the phonemes may be physically impossible, say $\left[\text{+HIGH, +LOW}\right]$; (2) the phonemes may be combinatorially impossible in the sense that no phoneme has that combination of features. Phonology, in comparison to phonetics, is an abstract science, it imposes constraints that are not physical.

7. A feature theory can make it impossible to distinguish some sounds. It is a prediction of that theory that there is no language that uses these sounds contrastively. For instance, there is a pair of phonetically distinct retroflex consonants, where the apical one is attested in Hindi, while the sublaminal one is attested in Telugu. No combination of phonological features is able to distinguish between these sounds – the phonological theory is simply blind to this distinction. If one day someone discovers a language that has these two sounds, then the theory will be falsified and a revision will be needed.

8. **Phonological rules.** Simpler rules using fewer features possess more explanatory power than complex rules. Rules are directly constrained by the feature theory. For instance, given the feature theory outlined above, it is simply impossible to characterize the set [s ʃ f z] in Turkish; you cannot pick a set of features that designates all and only these sounds – you cannot leave out v for instance. This has an immediate prediction: There can be no phonological process in Turkish that works solely on this collection of sounds.

9. **Phonological rule formalism.** A rule consists of an input, output and an environment. For instance, the following rule nasalizes vowels that come before nasal segments:

$$\left[\text{+SYL}\right] \rightarrow \left[\text{+NAS}\right] \;/\; \_\_ \left[\text{+NAS}\right]$$

9.1. Some special symbols for the environment:

\# indicates word boundary;

\+ indicates morpheme boundary;

· indicates syllable boundary.

9.2. The symbol ∅ is used in input to model insertion, and in the output to model deletion.

9.3. Curly braces indicate disjunction; for instance,

$$\left[\text{+SYL}\right] \rightarrow \left[\text{-LONG}\right] \;/\; \_\_ \left[\text{-SYL}\right]\begin{Bmatrix}\text{-SYL}\\ \#\end{Bmatrix}$$

shortens a vowel before two consonants or a consonant and a word boundary.

9.4. Repetition is handled by $*$. for instance,

$$\left[+\text{SYL}\right] \rightarrow \left[+\text{ROUND}\right] \;/\; \begin{bmatrix}+\text{SYL}\\+\text{ROUND}\end{bmatrix}\left[-\text{SYL}\right]^{*} \_\_$$

rounds a vowel preceded by a round vowel and zero or more consonants.

9.5. Parentheses are used to indicate optionality.

9.6. variables make it possible to relate the components of a rule. For instance, in english nasals assimilate (= become alike) to the place of articulation of the following consonant – nasals become [m] before [p] and [n] before [t]. The feature to be assimilated is coronality. This can be done as follows:

$$\left[+\text{NAS}\right] \rightarrow \begin{bmatrix}+\text{ANT}\\ \alpha\text{COR}\end{bmatrix} \;/\; \_\_ \begin{bmatrix}+\text{ANT}\\ \alpha\text{COR}\end{bmatrix}$$

9.7. Sometimes $\left[+\text{SYL}\right]$ and $\left[-\text{SYL}\right]$ are abbreviated as V and C.

10. **Underlying form.** Morphology feeds underlying forms into phonology. Take the following data from Russian:[2]

[2] Odden (2013), Section 4.1.

(12)

Nominative singular	*Genitive singular*	
vagon	vagona	‘wagon’
avtomobilʲ	avtomobilʲa	‘car’
vet͡ʃer	vet͡ʃera	‘evening’
muʃ	muʒa	‘husband’
karandaʃ	karandaʃa	‘pencil’
glas	glaza	‘eye’
golos	golosa	‘voice’
ras	raza	‘time’
les	lesa	‘forest’
porok	poroga	‘threshold’
vrak	vraga	‘enemy’
urok	uroka	‘lesson’
porok	poroka	‘vice’
tˢvet	tˢveta	‘color’
prut	pruda	‘pond’
soldat	soldata	‘soldier’
zavot	zavoda	‘factory’
xlep	xleba	‘bread’
grip	griba	‘mushroom’
trup	trupa	‘corpse’

11. **Structure preservation.** Take the following data from Kerewe (Tanzania):[3]

[3] Odden (2013), Section 4.3.

(13)

Infinitive	*1sg habitual*	*3sg habitual*	*Imperative*	
kupaamba	mpaamba	apaamba	paamba	‘adorn’
kupaaŋga	mpaaŋga	apaaŋga	paaŋga	‘line up’
kupima	mpima	apima	pima	‘measure’
kupuupa	mpuupa	apuupa	puupa	‘be light’
kupeketʃa	mpeketʃa	apeketʃa	peketʃa	‘make fire w/ stick’
kupiinda	mpiinda	apiinda	piinda	‘be bent’
kuhiiga	mpiiga	ahiiga	hiiga	‘hunt’
kuheeka	mpeeka	aheeka	heeka	‘carry’
kuhaaŋga	mpaaŋga	ahaaŋga	haaŋga	‘create’
kuheeba	mpeeba	aheeba	heeba	‘guide’
kuhiima	mpiima	ahiima	hiima	‘gasp’
kuhuuha	mpuuha	ahuuha	huuha	‘breathe into’

Taking /h/ as underlying,

(14) $\left[\text{+S.G.}\right] \rightarrow \begin{bmatrix}\text{-CONT}\\ \text{+ANT}\end{bmatrix} \;/\; \left[\text{+NAS}\right]\_\_$

Taking /p/ as underlying,

(15) $\begin{bmatrix}\text{+ANT}\\ \text{-CONT}\\ \text{-VOI}\end{bmatrix} \rightarrow \begin{bmatrix}\text{+S.G.}\\ \text{+CONT}\\ \text{-ANT}\end{bmatrix} \;/\; \left\{\begin{matrix}\text{V}\\ \#\end{matrix}\right\}\_\_$

For rule 14, a full specification would have $\left[\text{-CONT, +ANT, +CONS, -SON}\right]$ as output specification. But the first two is enough as they uniquely identify /p/, given the segment inventory of the language.

12. **Rule ordering.** Take the following data from Bukusu (Kenya):[4]

[4]Odden (2013), Section 5.1.3.

(16)

Imperative	*3pl pres*	*1sg pres*	
t͡ʃa	βat͡ʃa	ɲd͡ʒa	‘go’
t͡ʃexa	βat͡ʃexa	ɲd͡ʒexa	‘laugh’
t͡ʃut͡ʃuuŋga	βat͡ʃut͡ʃuuŋga	ɲd͡ʒut͡ʃuuŋga	‘sieve’
talaanda	βatalaanda	ndalaanda	‘go around’
teexa	βateexa	ndeexa	‘cook’
tiira	βatiira	ndiira	‘get ahold of’
piima	βapiima	mbiima	‘weigh’
pakala	βapakala	mbakala	‘writhe in pain’
ketulula	βaketulula	ŋgetulula	‘pour out’
kona	βakona	ŋgona	‘pass the night’
kula	βakula	ŋgula	‘buy’
kwa	βakwa	ŋgwa	‘fall’

Assuming that the underlying initial consonants are those that appear in the imperative, the first rule to state is voicing of consonants after a nasal:

(17) *Post-nasal voicing*

$$\left[\text{-VOICE}\right] \rightarrow \left[\text{+VOICE}\right] \;/\; \left[\text{+NASAL}\right]\_\_$$

Also, the nasal 1sg pres marker assimilates to the place of articulation of the following consonant.

(18) *Nasal place assimilation*

$$\left[\text{+NASAL}\right] \rightarrow \begin{bmatrix}\alpha\text{ANT}\\ \beta\text{COR}\end{bmatrix} \;/\; \_\_\begin{bmatrix}\text{-SYL}\\ \alpha\text{ANT}\\ \beta\text{COR}\end{bmatrix}$$

We know that the 1sg pres marker is underlyingly /n/, thanks to the following data:

(19)

Imperative	*3pl pres*	*1sg pres*	
jiixala	βeexala	niixala	‘sit’
jaasama	βaasama	naasama	‘gape’
joola	βoola	noola	‘arrive’
jeekesja	βeekesja	neekesja	‘show’

Note that the order of place assimilation and voicing rules does not matter, they lead to the same output no matter in which order they are applied.

The following data licenses yet another rule for dealing with another set of consonants:

(20)

Imperative	*3pl pres*	*1sg pres*	
lola	βalola	ndola	‘look’
lasa	βalasa	ndasa	‘shoot at’
leβa	βaleβa	ndeβa	‘push’
lwaala	βalwaala	ndwaala	‘be sick’
ra	βara	nda	‘put’
rara	βarara	ndara	‘be stung’
roβa	βaroβa	ndoβa	‘ripen’
rusja	βarusja	ndusja	‘vomit’
rja	βarja	ndja	‘fear’
βakala	βaβakala	mbakala	‘spread’
βala	βaβala	mbala	‘count’
βasa	βaβasa	mbasa	‘forge’
βoola	βaβoola	mboola	‘tell’
jama	βajama	ɲd͡ʒama	‘scout’
jaaja	βajaaja	ɲd͡ʒaaja	‘scramble with’
joola	βajoola	ɲd͡ʒoola	‘scoop’
juula	βajuula	ɲd͡ʒuula	‘snatch’

(21) *Post-nasal hardening*

$$\left[\text{+VOICE}\right] \rightarrow \left[\text{-CONT}\right] \;/\; \left[\text{+NASAL}\right] \_\_$$

The rules 17 and 22 can be combined into:

(22) *Post-nasal voicing/hardening*

$$\text{C} \rightarrow \begin{bmatrix}\text{+VOICE}\\ \text{-CONT}\end{bmatrix} \;/\; \left[\text{+NASAL}\right] \_\_$$

Arrival of new data gives a further twist to the story:

(23)

Imperative	*3pl pres*	*1sg pres*	
tima	βatima	ndima	‘run’
taaɲa	βataaɲa	ndaaɲa	‘hack’
tiiŋa	βatiiŋa	ndiiŋa	‘filter’
rema	βarema	ndema	‘chop’
riina	βariina	ndiina	‘run away’
ruma	βaruma	nduma	‘send’
laanda	βalaanda	naanda	‘go around’
laaŋgwa	βalaaŋgwa	naaŋgwa	‘be named’
liinda	βaliinda	niinda	‘wait’
loma	βaloma	noma	‘say’
loondelela	βaloondelela	noondelela	‘follow’
luma	βaluma	numa	‘bite’

(24) *l-deletion*

$$\left[\text{+LAT}\right] \rightarrow \emptyset \;/\; \left[\text{+NASAL}\right] \_\_ \text{V}_0 \left[\text{+NASAL}\right]$$

This rule must apply before the hardening rule.