

Phonology

Phonemes, Features, and Phonological Rules

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THEORETICAL CONSIDERATIONS

Importance of theories:

- Representation of abstract knowledge
- Representation and production of input
- Derivation of developmental change
- Guidance and directing of clinical work; offer of a variety of clinical possibilities; different perspectives on the problem to be solved

Theories are based on observations and experiments, but they abstract away from them, attempting to find order and rules

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How Phonology was born

- difficulties of the instrumental analyses:
French /ʁ/ = [x], [χ], or [ʀ]
rue, dur, secret
- mental level of language: capacity to recognize an abstract reality that unites family of sounds.
- identify those abstract realities – the phonic elements of language (**phonemes**) – and to classify them according to their function. The new science that would do this = Phonology.

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Phonological theory

- Abstract aspect of grammar
- **Competence** = the speaker's interpretation system.
- **Phonology studies this interpretation system**; it investigates the principles governing the sound systems.
- Speech sounds vs. phonemes:
 - Speech sounds = phones, segments, allophones;
 - Phonemes establish meaningful units in a language.

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Phoneme: Historics

- **Jan Beaudouin de Courtenay** in 1870 (Kazan School, St Petersburg);
 - phoneme = sum of phonetic properties that all together constitute an indivisible unit
 - sound duality = differences between a physiologically concrete sound realization and its mental image.
 - Phoneme = psychological sound unit, the sound "intended" by the speaker and "understood" by listeners.
- Concept popularized by **N. Kruszewski** in

Phoneme: definitions

- **three ways to consider a phoneme:**
 - 1) **Psychological** (Baudouin de Courtenay, 1870): phoneme is a mental reality, as the intention of the speaker or the impression of the hearer, or both.

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Phoneme: definitions

2) **Physical** (Daniel Jones, 1918): phoneme is a head term of a family of speech sounds.

- **allophones**: phonetic similarity and complementary distribution

E.g. - /l/: [l̥], [ɫ], [ɭ]
leg, pill, play
 - but: /h/ and /ŋ/

free variation:

E.g. *step*
 [p] = (un)aspirated, (un)released, or [ʔ]

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Phoneme: defitions

- **Functional** (Nikolai Trubetzky, 1926): phoneme is the sum of the phonologically relevant properties of a sound. A phoneme is a minimal unit that can distinguish meanings.

- contrast between speech sounds (**contrastive distribution**); **commutation test**:

minimal pairs: *ran, man, tan, can, ban, fan*
near minimal pairs: *mission vs. vision*

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A phoneme is...

- a mental reality, as the intention of the speaker or the impression of the hearer, or both.
- a head term of a family of speech sounds.
- an abstract phonological unit that serves as a reference model for a set of speech sounds related to each other.
- the smallest unit without meaning that can be delimited in speech. Its main function is to distinguish words.
- discrete units that keep lexical items apart.
- a sum of phonetic properties that all together constitute an indivisible unit.
- phoneme is the sum of the phonologically relevant properties of a sound.
- a set of co-occurring features.

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Features: Phonetic Features

- The production of every segment is **complex** (voicing, place, manner);
- Articulatory components depend on each other.
- Different combinations > different sounds.

[t] + voicing = [d]
 [t] + lower the tongue tip = [s]
 [ŋ] - nasalization = [k]

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■ Natural classes – patterns in behaviour

[t], [d] = alveolar stops > flapping (English)
 [p], [t], [k] = voiceless stops > aspiration (English)
 [b], [d], [g] = voiced stops > fricativisation in intervocalic position (Spanish)
 [d, s, ŋ, ʃ] not a natural class

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Phonetic Features

- Articulatory characteristics can be translated into features:

	[b]	[d]	[g]	
voiced	+	+	+	
bilabial	+	-	-	
labiodental	-	-	-	
dental	-	-	-	
alveolar	-	+	-	OR
palatal	-	-	-	
velar	-	-	+	
uvular	-	-	-	
pharyngeal	-	-	-	

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■ **matrices of features:**

<p>[b]</p> <ul style="list-style-type: none"> + voiced + bilabial - labiodental - dental - alveolar - palatal - velar - uvular - pharyngeal 	<p>[d]</p> <ul style="list-style-type: none"> +voiced - bilabial - labiodental - dental + alveolar - palatal - velar - uvular - pharyngeal 	<p>[g]</p> <ul style="list-style-type: none"> + voiced - bilabial - labiodental - dental - alveolar - palatal + velar - uvular - pharyngeal
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Phonetic Features

- Binarism (+ or -)
- Natural class [b, d, g]:
 - +voiced
 - labiodental
 - dental
 - palatal
 - uvular
 - pharyngeal
- Putative natural class

- A same set of features should be able to account for all and only sounds of human languages
- Generation of sounds:

<ul style="list-style-type: none"> + bilabial - labiodental +dental -alveolar + palatal - velar + uvular - pharyngeal 	<ul style="list-style-type: none"> + bilabial + labiodental + dental + alveolar + palatal + velar + uvular - pharyngeal 	<ul style="list-style-type: none"> - bilabial - labiodental - dental - alveolar - palatal - velar - uvular - pharyngeal
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- Problems with articulatory features:
 - such grammar is too powerful
 - it makes wrong predictions
 - different features for consonants and vowels
- Need of a more abstract set of features > phonological features.

Phonological Features

- Distinctive features = smallest indivisible sound properties that establish phonemes; they demonstrate similarities and dissimilarities between phonemes.
- Roman Jakobson, 1928:
 - a universal system of phonemic representation
 - phoneme is a bundle of distinctive features
 - phonemes are distinguished by their unique feature combination
 - the specification for any phoneme stated through a set of binary values [+/-] for each distinctive feature

- Jakobson, Fant and Halle (1952) ("Preliminaries to Speech Analysis") = an elaborated version of the distinctive feature theory; acoustic features
- Jakobson and Halle (1956) a new distinctive feature system that included articulatory features.
- Chomsky and Halle ("The Sound Pattern of English" (SPE), 1968) are defined primarily according to articulatory features.
 - principle of universality
 - principle of binarity

■ **Features that divide segments into major classes:**

- [+/- **syllabic**] vowels vs. consonants and glides
- [+/- **consonantal**] consonants vs. vowels and glides
- [+/- **sonorant**] obstruents (stops, fricatives, affricates) vs. sonorants (nasals, liquids, glides, vowels)

Vowels	Glides	Sonorant Cs	Obstruents
[+syll]	[-syll]	[-syll]	[-syll]
[-cons]	[-cons]	[+cons]	[+cons]
[+son]	[+son]	[+son]	[-son]

■ **Features that specify the state of glottis and place of articulation :**

- [+/- **voiced**] voiced vs. voiceless
- [+/- **coronal**] segments that are pronounced with the tongue tip or blade vs. with the centre, back or root of the tongue
- [+/- **anterior**] segments that are pronounced within the limits of the lips up to the alveolar ridge

Labial	Alveolar/ Dental	Palatal	Velar/ Uvular
[+ant]	[+ant]	[-ant]	[-ant]
[-cor]	[+cor]	[+cor]	[-cor]

■ **Features that specify manner of articulation:**

- [+/- **continuant**] presence vs. absence of the airflow.
 - [+continuant]: fricatives, glides, rhotics, and laterals
 - [-continuant]: stops, nasal stops, and affricates
- [+continuant] group:
 - [+ **strident**] noisy or hissing airflow. The others are [- **strident**];
 - [+/- **lateral**] distinguishes rhotics and laterals.
- [-continuant] group:
 - [+/- **delayed release**] distinguishes affricates and stops;
 - [+/- **nasal**] makes difference between stops and nasal stops

■ **Other features:**

- [+/- **high**] high vowels and [k, g, ŋ] vs. the rest
- [+/- **low**] low vowels and [h, ʔ] vs. the rest
- [+/- **back**] back vowels and [k, g, ŋ] vs. the rest
- [+/- **round**] rounded vowels and [w] vs. the rest
- [+/- **front**] or [+/- **anterior**] front vowels
- [+/- **tense**] or [+/- **ATR**] reflects the presence of muscular tensing of the body of the tongue. When the feature is there, the sound is longer and more peripheral.

- all these features are available in the Grammar
- not necessarily all of them are needed in a particular grammar
 - E.g. to represent a richer vocalic system one will need more features than for example for a language that has only 3 vowels [i, a, u]
- Problems: [+hi, +lo]

Phonological Rules

- E.g.
 - Bat [bæt] : [b] = voiced bilabial stop
 - Pat [pʰæt] : [pʰ] = voiceless aspirated bilabial stop
 - Spat [spæt] : [p] = voiceless unaspirated bilabial stop
- The difference between voiced and voiceless sounds is **distinctive**, but the phonetic feature of aspirations is a predictable, or **redundant** feature.

- distinctive features of a phoneme = lexicon (arbitrary knowledge) and form the **underlying representation** of that phoneme
- predictable features are derived from **phonological rules** that operate on underlying representations
- result is a **phonetic (surface) representation**
- complete description going from the UR through the set of phonological rules to the surface representation is called **derivation**

Phonological form	/p/
phonological rules	...
Phonetic form	[p ^h]

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- Phonological rules - **transformation rules** (or a *rewrite rules*) - are stated in a formalized notation system:

A > B / C __ D

- Segments, or full or partial matrices of features. If a matrix contains a full specification, it refers to one segment, if it's partially specified, then it stands for a natural class.
- By convention the minimal specification possible is given for the affected segment and all and only the features that change are given for the change.
- Such transformation rules operating on the underlying forms represent the link between the underlying level (Phonology) and the surface level (Phonetics).

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Terminology and symbols:

- A affected segment (/ /)
- B change ([])
- C and D context (environment)
- → (>) becomes
- / in the environment

Notes:

- A, B, C, D are distinctive feature matrices
- A or B but not both may be null
 - $\emptyset \rightarrow B / C _ _ D$ (insert B)
 - $A \rightarrow \emptyset / D _ _ D$ (delete A)
- C or D or both may be absent
- A consists of only 1 feature column
- C and D may contain or consist solely of # (word boundary) and + (morpheme boundary)

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- V vowel ([+syll])
- C consonant ([-syll])
- G glide ([-syll, -cont])
- C₀ zero or more consonants
- \emptyset null
- # word boundary
- + morpheme boundary
- \$ syllable boundary
- () optionality
- { } disjunctive choice (or)

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- Analysis of data (phonetic)
- Coming up with the UR
- Coming up with a (set of) rule(s)
- How to do it?

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- E.g. pass [pæs] pass you [pæ:jʊ]
- this [ðɪs] this year [ðɪ:jɪə]
- passed
- passing
- passes
- [s] form [ʃ] or [ʒ] from [s]?

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■ **How to choose the underlying form?**

The underlying form should be

- one of the surface forms
- the simplest form
- has the widest distribution, so that the rule writing be easier
- phonetically natural: 'expected form', found across languages, motivated by the features nature:

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1) wider distribution: [s] appears in more contexts than [ʃ]

2) naturalness of the process:

[s] is [+cor, +ant];

[ʃ] is [+cor, -ant];

[j] is [+cor, -ant].

[ʃ] and [j] have features in common, while [s] is not similar to the segments it precedes in the examples above.

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/s/ > [ʃ] / ____ [j]

[+stri, +cor, +ant] > [-ant] / ____ [-cons, +hi, -ant]

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■ **Rule ordering:**

Can't [kæ̃t] : a deletion rule is needed to delete the nasal consonant, and nasalization rule is needed to account for the nasalized vowel:

Rule of deletion: $[+nas] > \emptyset / [+voc] _ [+cons]$
 Nasalization: $[+voc] > [+nas] / _ [+cons, +nas](C1)\$$

UR	/kænt/	UR	/kænt/
Nasalization	æ̃	Deletion	∅
Deletion	∅	Nasalization	-
Phonetic form	[kæ̃t]	Phonetic form	[kæ̃t]

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■ **Example of clinical application:**

soap [tɔwp]
 kiss [kɪt]
 zoo [du]
 nose [nɔwd]

- /s/ > [t] and /z/ > [d] at the beginning and end of words

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- /s/ > [t] / # __, __ #

- /z/ > [d] / # __, __ #

[+cons, +cor, +ant, +cont, +stri, -voi] > [-cont, -strid] / __ #, # __

[+cons, +cor, +ant, +cont, +stri, +voi] > [-cont, -strid] / __ #, # __

[+cons, +cor, +ant, +cont, +stri] > [-cont, -strid] / __ #, # __

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- **Vacuous rule application (no change)**
 - E.g. German umlaut (a vowel becomes front before a front high vowel):
/gast + I/ → [gæsti]
 - V → [-bck] / ___ [V, +hi, -bck] (immediately followed)
 - V → [-bck] / ___ C₀ [V, +hi, -bck] (in another syllable)

Collapses to:

- V → [-bck] / ___ (C₀) [V, +hi, -bck]
- Note that by letting this rule apply to segments which are already [-bck] (vacuous rule application) a feature is saved as otherwise it would be necessary to specify the input to the rule as [V, +bck].

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- E.g. In Korean [r] and [n] are in complementary distribution: [r] only occurs when preceded by a vowel:

- r → n / # ___
- r → n / C ___
- or r → n / {#, C} ___
- or n → r / ___ V
n / elsewhere

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Conclusion

- Generative phonologies expanded the analysis to include underlying forms. The underlying form (or representation, UR) is a purely theoretical concept that is thought to represent a mental reality behind the way people use language. UR represents the person's language competency and serves as points of orientation to describe regularities of speech.
- System of binary features involves a big effort for the analysis and abstraction, because we need to
 - manipulate matrices of features instead of phonetic symbols,
 - find natural classes and
 - formulate phonological rules that apply to them;
 - deduct underlying forms
 - apply rules in good order

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What does this all give us?

- **Economy:** instead of stocking all possible variants of pronunciation of a segment or a word we give one underlying form and one rule.
- **Productivity:** if we learn a new word, we can apply an already known rule:
 - E.g. French: divine ~ divin
'schtoumphine' ~ 'schtoumphin'
- **Variation:** allows to account for geographic and social variation (changing the order of rules application).
 - E.g.:

	Southern French	Standard French
UR	/anne/	/anne/
Rule1: CiCi > Ci	-	/ane/
Rule2: Nasalization	/āne/	-
Rule3: Vowel lowering	/āne/	-
Phonetic form	[āne]	[ane]

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- Generative phonology is an attempt to understand and explain the sound patterns of languages.
- Although not originally intended to serve such purpose, phonological rules can also be used to describe the sound patterns of children with disordered phonological systems.

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