Foundations of Language Science and Technology

Phonology

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FR 4.7, Phonetics
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Levels of linguistic description

- Phonetics

- Phonology

- Morphology

- Lexicon

- Syntax

- Semantics

- Pragmatics

- Psycholinguistics

- ...linguistics (socio, neuro, patho, ...)

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Phonology

- Scientific study of the *sound system* of a language

- Inventory and organization of speech sounds in a specific language

Minimal pair analysis

- Determination of the *phoneme inventory*, by minimal pair analysis

  - minimally different phonetic form

  - distinct meaning

  - use lists instead of pairs as shortcut

    hit

    hot

    hut

    hat   fat   sat   cat

Minimal pair analysis

- Determination of the *phoneme inventory*, by minimal pair analysis

- hemmen – Hennen – hängen
  /hɛmən/ – /hɛnən/ – /hɛŋən/

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  /miːtə/ – /mɪtə/ /ʁaːtə/ – /ʁatə/   /høːlə/ – /hœlə/

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  → /m n ŋ iː ɪ aː a øː œ/

    - can distinguish meaning of words

    - are *phonemes* of German

- Determination of the *phoneme inventory*, by distribution analysis

  - complementary distribution

    - [ç] - [x]
      "nicht" [nɪçt] - "Nacht" [naxt]
      *[nɪxt] *[naçt]

    - [h] - [ŋ]
      [h] only word-initial, [ŋ] never word-initial

Distribution analysis

- Criterion of phonetic similarity

    - [ç] ≈ [x] → /x/ (one phoneme, two allophones)

    - [h] ≠ [ŋ] → /h/ /ŋ/ (two phonemes)

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Phonology: technical terms

- *Phoneme*: smallest unit that distinguishes meanings

  - unit of speech in the sound system of a language that can distinguish the meanings of (pairs of) words

  - distinctive / contrastive function

  - phonetic differences that do not contribute to distinguishing meaning are phonologically irrelevant

- *Phoneme*: speech sound as structural unit, e.g.   /t/

- *Phone*: phonetic realization of a phoneme, e.g.   [t]

- *Allophone*: systematic realization variant, e.g.   [t^h]

Allophones

- *Allophones* are free or context-dependent variants of phonemes

  - free: e.g. realizations of /r/ as [rʀʁɾɣ] (in Ger., Eng.)

  - context-dependent: e.g. realization of "ch" as [x] after back vowels, as [ç] elsewhere

- Problem: phonemic value of complex sounds, such as diphthongs [aɪ] [aʊ] or affricates [pf] [ts]

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Cf. Phonetics: technical terms

- *Phone*: single identified speech sound

- *Features* of speech sounds

    - articulatory, acoustic, auditory

- *Features* of phonetic utterances

    - segmental (pertaining to speech sounds)

    - suprasegmental (exceeding individual speech sounds)

    - again: articulatory, acoustic, auditory

- Dynamic processes

    - coarticulation, assimilation

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Phoneme

- *Observation*: Despite systematic and statistical (chance?) variation in the realization of speech sounds, e.g. of /a/ in "Mann", we identify all these realizations as /a/.

- Evidently, some of the differences in pronunciation are *contrastive* and *distinctive*, while others are not.

- Sound differences that can distinguish the meaning of words in a language tend to become phonologized, they become elements of the phonological inventory.

- *Definition*: The smallest unit of speech that can distinguish the meaning of words in a language is the *phoneme*.
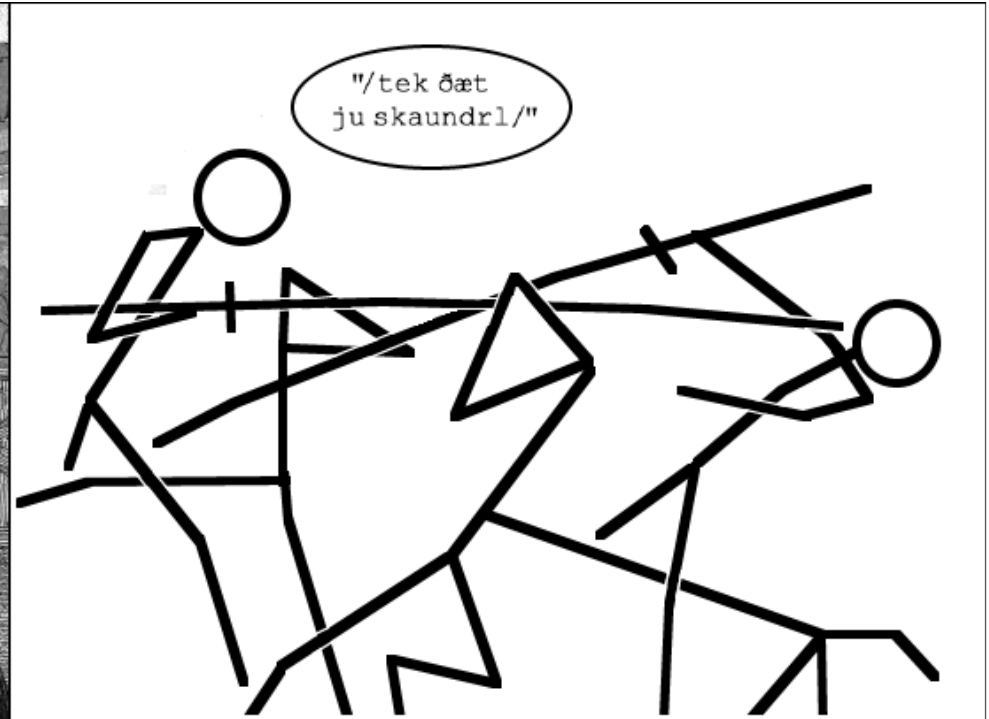
Phonetics and Phonology

- Different levels of linguistic description or artificial separation of disciplines? Consider:

  - describing the vowel system of a language

  - "Auslautverhärtung" (neutralized voicing contrast)

  - universal vs. language-specific properties of speech

  - methods: experiments, measurements, statistics

  - mental representations

  - relation between linguistic organization and physical events

  - organization of university institutes

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Neutralization

- Some pairs of sounds established as phonemes in a context A cannot enter a contrast in context B

- E.g. neutralization of the voicing contrast in German (and a number of other languages)

    - stops and fricatives in word-final position, e.g.:

        - "bunt" and "Bund" [bʊnt]

        - "lies" and "ließ" [li:s]

Interdisciplarity

- Phonetics and Phonology have many connections with other scientific disciplines

- communication theory, philosophy of language, logic

- sociology, psychology

- acoustics and signal processing

- clinical research and applications; language and speech disorders, speech therapy, logopedics, early diagnosis

- cognition, reading and writing, orthography

- communications technology, dialog systems: automatic speech recognition, speech synthesis, speech-to-speech translation

Phonology

- Scientific study of the *sound system* of a language

- Inventory and organization of speech sounds in a specific language

- **Classification of speech sounds by** *distinctive features*

Distinctive features

- Aims of using distinctive features

  - describing of all speech sounds in all languages by means of a universal set of features

  - describing phonemes/allophones of a language in terms of a vector of (mostly binary) features

    - each phoneme is distinct from all others by its specific constellation of feature values

    - the function of phonemes to distinguish meaning is actually achieved by distinctive features

  - capturing regularities in sound systems

  - forming natural classes of sounds with common properties

Distinctive features

- Historical development of sets of distinctive features

  - Trubetzkoy (1939), Jakobson (1939)

  - Jakobson, Fant and Halle (1952) [articulatory, acoustic]

  - Chomsky and Halle (1968) [SPE, Generative Phonology]

  - Fant (1973) [purely acoustic]

  - Ladefoged (1982) ["traditional"]

  - Clements (1985) [feature geometry]

  - ...

- No definitive universal feature set yet

- Usually a mix of articulatory, acoustic, auditory features

German consonants (Wiese, 2000)

		p	t	k	f	s	ʃ	ç	x	χ						h	?
voice	−																
voice	+	b	d	g	v	z	ʒ	j	ɣ	ʁ	m	n	ŋ	l	R		
consonantal		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
obstruent		+	+	+	+	+	+	+	+	+	−	−	−	−	−	+	+
continuant		−	−	−	+	+	+	+	+	+	−	−	−	−	+	+	−
nasal		−	−	−	−	−	−	−	−	−	+	+	+	−	−	−	−
spread glottis		−	−	−	−	−	−	−	−	−	−	−	−	−	−	+	−
constricted gl.		−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	+
labial		+			+						+						
dental					+												
coronal			+			+	+					+		+			
dorsal				+				+	+	+			+		+		
d. front				−				+	−	−			−		−		
tongue pos.		+	+	+	+	+	+	+	+	+	+	+	+	+	+		
high t.p.		−	−	+	−	−	+	+	+	−	−	−	+	−	−		
low t.p.		−	−	−	−	−	−	−	−	+	−	−	−	−	+		

German vowels (Wiese, 2000)

	iː	ɪ	eː	ɛː	ɛ	aː	a	oː	ɔ	uː	ʊ	yː	ʏ	øː	œ	ə	ɐ
cons.	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−	−
high	+	+	−	−	−	−	−	−	−	+	+	+	+	−	−	−	−
low	−	−	−	−	−	+	+	−	−	−	−	−	−	−	−	−	+
front	+	+	+	+	+	−	−	−	−	−	−	+	+	+	+	−	−
back	−	−	−	−	−	−	−	+	+	+	+	−	−	−	−	−	−
round	−	−	−	−	−	−	−	+	+	+	+	+	+	+	+	−	−
ATR	+	−	+	−	−	−	−	+	−	+	−	+	−	+	−	−	−
long	+	−	+	+	−	+	−	+	−	+	−	+	−	+	−	−	−

cf. tables for American English in Fromkin et al. p. 244f.

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- **Combinatorics of speech sound:** *phonotactics*

Syllable structure, Phonotactics

- Complex syllable structure of German (and English and ...)
"(du) strumpfst"   [ʃtʁʊmpfst]   /CCCVCCCCC/

- Anything goes?

  - [ʃtʁoː], aber *[ʁʃtoː]

  - [aʁm], aber *[amʁ]

- Language-specific:

  - Georgian: [.tsvkl] [.mkr]

- German and English each have at least 12,500 distinct syllables –
cf. Japanese: ~110

Syllable structure, Phonotactics

- Phonotactics: systematic description of combinatorics of speech sounds, thereby forming larger constituents

- Constraints imposed by syllable boundaries

- No universally valid definition of "syllable (boundary)"

- Syllable boundaries are difficult to determine, but counting syllables is easy (really?)

    - how many syllables in "Fenster", "Papst", "schrumpfst"?

    - syllable boundary in "Fenster": [fɛn.stɐ] or [fɛns.tɐ]?

Syllable structure in German

- General structure: C*VC* (obligatory vowel, optionally surrounded by consonants)

- Max: CCCVCCCCC ("strumpfst" [ʃtʁʊmpfst])

- Sonority hierarchy: syllable nucleus maximally sonorous, decreasing sonority with increasing distance from nucleus
  → concept much disputed

- Syllable constituents

  - ONC - onset, nucleus, coda (flat)

  - OR – onset, rhyme (hierarchical)

- Logatomes: phonotactically possible but non-existant syllables or words

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- Combinatorics of speech sound: *phonotactics*

- **Suprasegmental units and features**

Phonetics/Phonology: Prosody

- Prosody comprises properties of spoken language beyond single sounds

    - intonation: accenting, phrasing, sentence mode

    - ambiguities

        - "Ja zur Not geht's auch am Samstag"

        - "Flying planes can be dangerous."

    - discourse and information structure

        - Carter called Nixon a Republican, and then he offended him.

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Suggested exercises, readings, online resources

- Apply the minimal pair and distribution tests to establish the phoneme inventory of (British or American or …) English

- Exercises 10a-c, 13, 14, 24, 25 (incl. text p. 227ff.) in Fromkin et al. p. 273ff.

- Richard Wiese (2000): The Phonology of German. Oxford Univ. Press.

- Vowels and consonants in the world's languages [http://www.phonetics.ucla.edu/]

Thanks!