Phonetics-phonology mismatches

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Overview

- The phonetics-phonology interface: basic assumptions
- Laryngeal features and their phonetic interpretation
- No universal mapping between phonetics and phonology
- Three cases of mismatches:
  1. Vowel fronting: a purely phonetic change
  2. Vowel merger: still a phonetic change?
  3. Change in contrast from voicing to tone: a phonetic change??
- A remaining issue
- Conclusion

The phonetics-phonology interface

- ... is only possible in a grammar theory with two independent modules of phonetics and phonology,
- with abstract symbolic representations (underlying and surface forms) in one and continuous phonetic representations (auditory and articulatory) in the other.
- The interface is the mapping between these two.
- The phonological surface form can map either onto the articulatory form (many featural approaches), the auditory form (Boersma 1998), or both (Hale & Kissock 2007). This mapping can be assumed to be universal or learnt.
- Phonological features can be viewed as constituting the interface with phonetics, because one of their functions is to ensure a direct phonetic realisation/interpretation.

Laryngeal features and their phonetic interpretation

Jakobson, Fant & Halle (1952): **[voiced] vs. [unvoiced]**

- provided articulatory, acoustic and impressionistic perceptual definitions of each of their features (focus on acoustics)

Halle & Stevens (1971): **[± stiff vocal folds], [± slack vocal folds], [± spread glottis] , [± constricted glottis]**

- each with its own articulatory definition

Lieberman (1977), Keating (1984): **[± voice]**

- referring to different regions on the single acoustic dimension of Voice Onset Time (VOT)

Laryngeal features and their phonetic interpretation II

Harris (1994), Iverson & Salmons (1995), Honeybone (2005), Beckman, Jessen & Ringen (2013) (and more):

[voice] vs. [spread glottis] (or equivalents)

- Both are directly observable from the phonetics:
  - negative VOT (and active vocal fold vibration): [voice]
  - positive VOT (glottal abduction): [spread glottis]
- and show different phonological behaviour, e.g.:
  - [voice] triggers voicing assimilation in obstruent clusters
  - [spread glottis] triggers devoicing in the same cluster

Transparency between phonetics and phonology (based on the assumption of a universal, one-to-one mapping between phonetics and phonology).

Challenging the assumptions underlying this transparent mapping

Assumption 1:

The mapping between the phonetics module and the phonology module is language specific and learnt, "arbitrary" (Boersma 1998, Mielke 2008 for features).

Advantage: it allows mismatches.

Assumption 2:

The phonological surface form maps onto an auditory form (and vice versa) (Boersma 1998, Reiss 2007): "primacy of perception",

because spoken languages are acquired on the basis of the auditory input.

Transparent mappings for free

- If phonological categories (features or segments) are learnt on the basis of the auditory input, they often simply mirror input distributions on auditory dimensions.
- E.g., in a language with two high vowels, a front one (with high F2 values) and a back one (with low F2 values), the learner will create two categories that are distinguished along the auditory dimension of F2, thus constructs something like [±high F2] or [±front],
- recall the simulations of feature emergence by {Boersma, Chládková, (Benders)} (this conference).
- Transparent mappings are by-products of perceptual learning, not a stipulated universal property of the grammar or the acquisition device.

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Transparent mappings for free: Example voicing feature(s)

[voice] - [spread glottis] and VOT:

- VOT is insufficient for languages with a four-way laryngeal contrast, e.g. Hindi, where VOT values for the plain voiced and the breathy voiced categories largely overlap.
- VOT is an acoustic measure, not an auditory dimension.
- Lisker & Abramson (1964) acknowledged this problem: "it seems likely that the voiced aspirates are distinguished from the other voiced category by the presence of low amplitude buzz mixed with noise in the interval following release of the stop" (p.403)

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Transparent mappings for free: Example voicing feature(s)

Better to use two independent auditory dimensions:

- presence vs. absence of periodicity in the signal,
- presence vs. absence of aspiration noise in the signal.

Languages with a two-way laryngeal contrast usually use one or the other (but see Swedish).

The fact that the presence of the cue is more salient than its absence can explain the prevalence of phonologically active privative features:

- [voice] is a direct consequence of the saliency of periodicity (versus its absence),
- [spread glottis] of the presence of aspiration noise (versus its absence).

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Transparent mappings for free: Example voicing feature(s)

Further auditory dimensions involved in voicing contrast:

- amplitude of the burst,
- lowering of the pitch in the vowel following a voiced plosive (F0 perturbation),
- shortening of the preceding vowel duration by a voiceless plosive (pre-fortis clipping),

... ({Abramson, Lisker})

There is no one-to-one mapping.

Listeners and learners use whatever is there in the auditory form!

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Learning a voicing feature on the basis of the auditory input

Study by Narayan, Gorman & Swingley (2008, BUCLD) using large corpora:

- Acquisition of the voicing distinction (in plosives) by AE infants,
- Motherese shows larger overlap in VOT than normal (adult-directed) speech, but enhancement of the pitch cue (F0 perturbation).
- Conclusion that there are "multiple cues to relevant features".

Infants start off with pitch as most reliable cue to voicing contrast.

AE Motherese could be considered a case of mismatch between phonetics and phonology in a universal-mapping approach.

Problematic since they didn't distinguish the perceptual cues of aspiration noise and periodicity (to be fair, they called their study "the acoustics of [voice]...").

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Phonetics-phonology mismatches

- Where a language has phonological processes that are not in line with the phonetics of the segments involved.
- These can only be detected by looking at the phonological behaviour (not at the phonetics).
- How can such mismatches be learned?
- Children learn features not only from the perception, but also from phonological alternations.

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Case 1: Vowel fronting

- /uː/-fronting in Standard English of Southern England (e.g., Henton 1993, Harrington et al. 2009): is realized as [ʉː] or [iː], or even [iː] (Uffmann 2010)
- Phonological behaviour of fronted /uː/: It still triggers insertion of a [+back] glide (Uffmann 2010)

  see [j] *it*
  do [w] *it* (irrespective of realization of /uː/)
- /uː/ and /w/ share a feature, so do /iː/ and /j/.
- This is a classical case of a Neogrammarian sound change, where

  /uː/ changed to /uː/
  | |
  [uː] [ʉː]

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Case 1: Vowel fronting

- Other vowel cues than F1/F2 values at midpoint:
- Both tense high vowels show diphthongization, i.e. pronunciation of /iː/ as [ii] and of/uː/as [ʊʉ], also used as cue in perception (Chládková & Hamann 2011),
- and transfer of diphthongization cue from high vowels to other vowels (Chládková, Hamann & Williams 2014).
- It is possible that diphthongization is a better cue for the high vowel contrast than F2 midpoint values, which could lead to the start of another Great Vowel Shift (Jespersen 1909)

[ii]	>	[əɪ]	>	[aɪ]	*time*
[ʊʉ]	>	[əʉ]/[əʊ]	>	[aʉ]/[aʊ]	*house*

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Case 2: One vowel, two functions

- The Chukchi vowel system has two high mid vowels [e] that are phonetically identical (Dunn 1999, Muravyova et al. 2001) but show different phonological behaviour:
- /e_1/ is recessive, i.e. it is lowered in vowel harmony (like /i, u/)
- /e_2/ is dominant, i.e. it triggers vowel harmony (like /o, a, (ə)/)

[te]	affix (comitative)	
[mere]	'tear'	[mereta] 'by a tear'
[miɬute]	'hare'	[miɬutete] 'by a hare'

- [e] → /e/ → |e_1|
  → |e_2|
- (Here, one could also assume that the information "dominant" or "recessive" is stored with the whole morpheme)

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Case 3: Voicing and tone

Hyman (1976) and Jakobson (1931):

- Pitch lowering/F0 perturbation is an automatic effect when articulating sequences of voiced plosives and vowels (a)
- This pitch lowering can be enlarged language-specifically (b)
- Learner's of this language can then interpret the movement in the pitch of the following vowel as rising tone (c)
- Might lead to the loss of the voicing contrast (as in Chinese dialects, various South-Asian languages)

	phonology	*phonetics*
a)	/pā/ – /bā/	[pā] – [bā]
b)	/pā/ – /bā/	[pā] – [bā]
c)	/pā/ – /bá/	[pā] – [bá]
	/pā/ – /pá/	[pā] – [pá]

Note: Necessary for Hyman to assume this phonological change due to the change in the phonetics

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Summary
Phonetics-phonology mismatches

An arbitrary mapping between phonetics and phonology is necessary to be able to distinguish between

- a purely phonetic sound change (Neogrammarian change), which results in a phonetics-phonology mismatch,
- and a phonological change.
- The question emerges then: when does a phonetic change become a phonological change?
- Or: When do we move up in the life-cycle of change?

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Where does the articulatory form come in?

- The articulatory form is dependent on the auditory representation (and only relevant in the process of speech production).
- There is a "many-to-one relationship between vocal tract shape and sound shape" (Ohala 1981: 178); well-known example: bunched and retroflex /r/ in AE.
- We saw already that automatic effects of articulation influence the auditory form (F0 perturbation).
- Articulatory restrictions can influence all representations higher-up through parallel evaluation: searching for one optimal path through the whole grammar.

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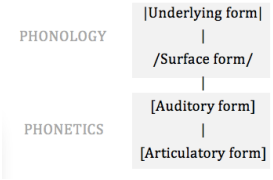
Part of the grammar model with phonetics and phonology modules



For a formalization of parallel evaluation with OT constraints, see the BiPhon model by Boersma (2007)

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Summary and conclusion

Assuming an arbitrary mapping between phonetics and phonology and primacy of perception

- gives us a transparent mapping between phonetics and phonology for free
- and at the same time allows for changes in the phonetic form without concomitant changes in the phonology (Neogrammarian sound changes).

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Take-home messages

There is no one-to-one mapping between phonology and phonetics:

- one phonological feature can have (and usually has) several phonetic (auditory) cues,
- which can be language-specific.
- Acoustics is not an auditory form!

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Thank you!

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