# Issues in Feature Theory

## Day 2: Revenge of the Phoneticians

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## Ladefoged (1980)

- Peter Ladefoged (1980). 'What Are Linguistic Sounds Made of?' Language 56, 485-502.
- Attempt to give a state-of-the-art (1980) account of what we know about how sounds are produced and what the relevant acoustic properties are,
- with some thoughts about how this links up to phonological features.
- Spoiler: It doesn't very well, actually, and this has been known for 40 years, and everything that came afterwards only added more evidence.
- But let's look at the evidence.



## The structure of the paper

- Articulatory parameters of language, and a discussion of how they match up with SPE features
- Acoustic parameters and how they match up with features
- A few thoughts on the mapping to features
- Some thoughts on attested and attestable contrasts (hi Dave)
- Some thoughts on fine-grained cross-linguistic differences



## Intro

- Take-home message:
  "[P[honological features are certainly not sufficient for specifying the actual sounds of a language; nor are they in a one-to-one relationship with the minimal sets of parameters that are necessary and sufficient for this purpose." (485)
- The rest is explication.

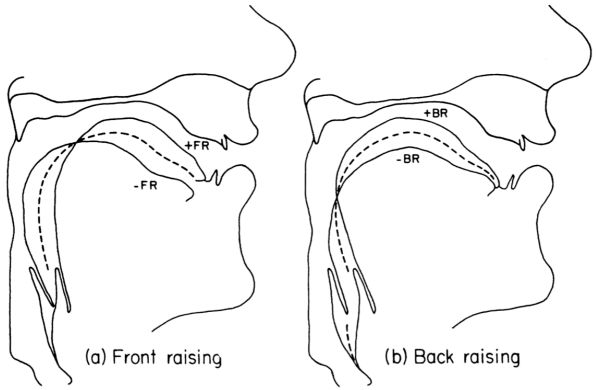
## The articulatory parameters

1. Front raising
2. Back raising
3. Tip raising
4. Tip advancing
5. Pharynx width
6. Tongue bunching
7. Tongue narrowing
8. Tongue hollowing
9. Lip height
10. Lip width
11. Lip protrusion
12. Velic opening
13. Larynx lowering
14. Glottal aperture
15. Phonation tension
16. Glottal length
17. Lung volume decrement

LIST 1.



## Front raising and back raising



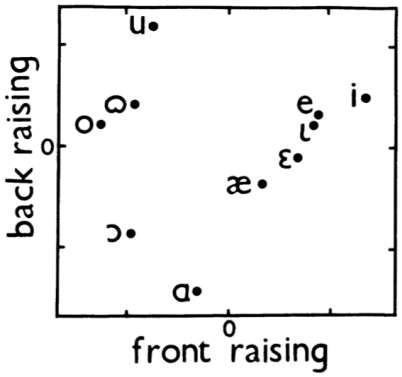



## Front raising and back raising

- Ladefoged: These are the main articulatory parameters for the description of vowels (ignoring the lips).
- Looks different from the classic features [±high] (raise tongue body) and [±back] (retract/front tongue body).
- Front vowels all involve some front raising — UFT feature [coronal] for front vowels seems more justified than the “articulator-based” traditional features.
- Nevertheless not a good match between features and gestures.
- Back raising kinda correlates with vowel height but also with backness.



## Front/back raising and vowels



## And the muscles?

- Ideally, features should correspond to motor commands given to specific muscles or pairs of muscles.
- "[T]he front raising-lowering parameter corresponds in great part to the actions of the genioglossus, and of opposing muscles such as the glossopharyngeus and other pharyngeal constrictors. The back raising-lowering parameter effectively summarizes the opposing actions of the styloglossus and the hyoglossus. However, there are many possible compensatory actions of the jaw and the tongue muscles, and it is probably not too profitable to consider either parameter as simply specifying the action of a group of muscles" (488).
- We should not try "to interpret each feature in terms of a single physical scale" (491).



## Summary

- "But by now it should be clear that the necessary and sufficient set of articulatory parameters required for characterizing linguistic contrasts is not identical with the set of features required for characterizing phonological patterns. A sim be made by reference to the acoustic parameters of speech." (493)



## Acoustic parameters

1. Voice source frequency
2. Voice source amplitude
3. Frequency of formant one
4. Frequency of formant two
5. Frequency of formant three
6. Bandwidth of formant one
7. Bandwidth of formant two
8. Bandwidth of formant three
9. Amplitude of nasal formant
10. Frequency of nasal formant
11. Amplitude of aspiration
12. Amplitude of fricative source
13. Frequency of lower fricative pole
14. Frequency of upper fricative pole
15. Relative amplitude of fricative poles

List 2.



## Some discussion

- Some phonetic features correspond quite nicely to one acoustic parameter, e.g. vowel height and F1 frequency.
- Most, however, are in many-to-many relationships.
- Mapping between acoustic and articulatory parameters — generally works quite well but
  - different articulatory settings can create the same acoustic effect
  - there are compensatory articulations
- For most sounds variability is rather limited, but for some it is big, e.g. American /r/, which can be produced in many different ways.
- Acoustics no good link to features either!

## Mappings

- Mappings between features and phonetic parameters — only for feature groups, in many-to.many relationships.
  - (This feature combo corresponds to these settings …)
- Necessary to separate phonetic and phonological description. Consequences:
- There are “fewer guiding principles as to what defining limits can be set on phonological features” (495).
- “Phonological rules may be stated in terms of much more abstract units” (496).



## How adequate are the sets?

- Section 4 discusses briefly the adequacy of the set of suggested articulatory and acoustic parameters.
- Conclusion: all attested contrasts seem to be covered.
- But: a far larger range of speech sounds could be contrastive.
- Also muses about attestable contrasts not covered by system so far — lateral movement of tongue between lips, ‘buccal’ fricatives … but: shouldn’t be disregarded.
- There could be many more sounds than are in the IPA — as phonologists we also should keep an open mind.



## Language-specific differences

- Ladefoged notices what is treated as the same by phonologists can be phonetically quite different, across languages.
  - Already seen: different spacing of height contrasts in English and Danish.
  - Velar ejectives in Hausa and Navajo are quite distinct.
  - Same goes for implosives in Hausa and Kalabari. Etc.
- One claim: This shows the “inadequacy of phonological theories”. But this seems to be based on the idea that phonological theories should strive for phonetic accuracy, already debunked.
- Conclusion: phonetic detail should be included in description of languages. But: Is this phonology? Ladefoged remains ambivalent.



## And now for something completely …

- John Kingston and Randy L. Diehl (1994). ‘Phonetic knowledge’. *Language* 70, 419–454.
- This paper argues explicitly — and at times in lot of technical detail — that phonetics is not automatic (like Hale & Reiss’s transducers) but instead controlled.
- It only seems automatic because it is “thoroughly overlearned” — highly controlled but well-practised.
- Evidence from discussing the phonetic realisation of [±voice] contrasts.

## Different models

- Kingston & Diehl discuss three models of the phonetics-phonology interface (421ff):
- a “literal and inflexible phonetics”: automatic translation of features into phonetics; identified with Hallean models of phonology but dismissed as “naïve” in a short paragraph.
- “Flexible but automatic phonetics”: recognises variation but still considers everything predictable:
  - Recognises gestural overlap and coarticulation effects
  - Recognises speaker accommodation, e.g. employment of additional strategies to induce voicing on stops
  - Recognises physiological dependencies, e.g. high vowels raise F0



## A controlled phonetics

- The third model: speakers have independent control over the phonetic realisation of phonological units.
- “Constraints that determine what a speaker (or listener) can do but not what thzey must do; that is, the constraints limit phonetic behavior rather than predicting it”.
- This also predicts variability, between speakers, styles, languages — which K&D argue is actually found.
- But it also helps optimise phonetic behavior (some functionalist ideas here; ease of articulation vs contrast maximisation for listeners) — and this implies **phonetic knowledge**.



## The phonetics/phonology divide

- So how much can be controlled?
- Recall HKR: any non-random difference = phonology
- K&D allow phonetics more leeway, generally treat allophonic variation as phonetic (all of it???).
- Main point: Not every language-specific process is phonological. Contrastiveness is main criterion.
- Phonology regains a level of abstractness appropriate to stating categorical processes.
- Phonetic properties are not distinctive but differ in reliably they occur and how salient listeners find them as cues to contrast.



## Variation in the realisation of [voice]

| | [+voice] | [−voice] |
|---|---|---|
| UTTERANCE-INITIAL OR PRETONIC; | short lag VOT<br>$F_1$ lower<br>$F_0$ lower<br>weaker burst | long lag VOT<br>$F_1$ higher<br>$F_0$ higher<br>stronger burst |
| INTERVOCALIC OR POSTTONIC | closure voicing<br>shorter closure<br>longer preceding vowel<br>$F_1$ lower<br>$F_0$ lower | no closure voicing<br>longer closure<br>shorter preceding vowel<br>$F_1$ higher<br>$F_0$ higher |
| UTTERANCE-FINAL AND POSTVOCALIC | longer preceding vowel<br>closure voicing possible<br>shorter closure<br>$F_1$ lower | shorter preceding vowel<br>no closure voicing<br>longer closure<br>$F_1$ higher |

## Explaining variation

- Quite a few positional differences in English (but not only there).
- Partially explicable by automatic processes. Word-initially it's hard in stops to initiate voicing, but postvocalically it's harder to stop it.
- But: evidence for different strategies by speakers, e.g. some don't seem to even attempt to produce voicing (closing of glottis) if it's hard anyway, some don't even seem to target a phonetically voiced articulation, or they develop compensatory strategies.
- This also implies a considerable amount of variation between speakers.
- Presence and amounts of aspiration in different positions are not automatic but controlled.



## $F_0$ and voicing

- General finding: Voicing also has an effect on depressing F0. Is this part of an automatic phonetics? It looks uniform, also across languages.
- K&D: no. In English F0 depression regardless of actual glottal closure and vocal fold vibration — manipulated independently as cue for voicing.
- Although actual phonetic voicing varies across languages, this is a stable phenomenon [kinda surprising me a bit, actually].
- Variable effect in sC clusters where contrast is neutralised, also speaker-dependent = more evidence for control.
- Tamil: phonetic voicing effect of underlying length contrast. 3/4 speakers don't lower F0 at all even though it's phonetically voiced.



## Phonetic redundancy

- K&D discuss cases of 'phonetic redundancy' that serve to enhance contrast, thus are possible listener-oriented. 3 types:
- Multiple independent correlates of one feature, e.g. [voice] correlates with low frequency energy, shorter C duration, longer preceding V, aspiration on [+voi] etc.
- Multiple subproperties, e.g. low frequency energy of [+voice] stops conspiracy of lowered F0, lowered F1 and vocal fold vibration
- Multiple uses of subproperties: e.g. perception of voicing in stop closure perceptually shortens the closure; lowering F0 during closure also causes perceptual shortening.



## Where are we now?

- The simplistic transducer mapping by Hale & Reiss does not seem to be supported by phonetic evidence.
- Ladefoged: phonological features and phonetic parameters are in indirect many-to-many relations.
- K&D: Speakers can control very fine-grained aspects of their phonetics.
- Both agree that phonology should be more abstract and not try to seek a close match with the phonetics.
- Both also seem to agree that there is some link, though.
- Tomorrow: look at some phenomena suggesting a looser fit, with a focus on rhotics and interactions between "low" sounds.