24.963 Linguistic Phonetics
Fall 2005

24.963

Linguistic Phonetics

The position of phonetics in grammars

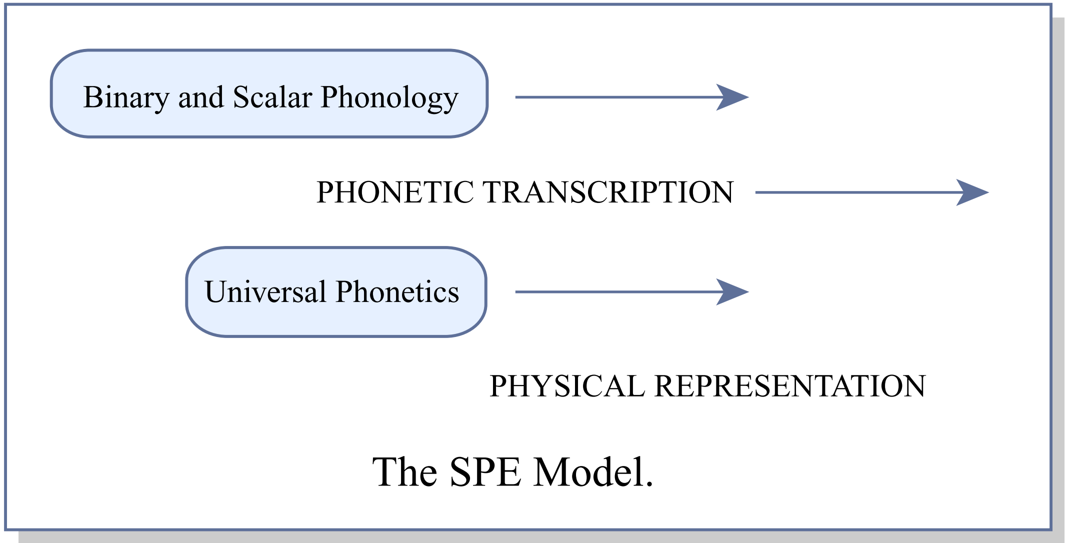


Image by MIT OpenCourseWare. Adapted from Keating, P. "Universal Phonetics and the Organization of Grammars." In *Phonetic Linguistics*. Edited V. Fromkin. Indianapolis, IN: Academic Press, 1985, pp. 115-32.

- Reading for next week: Johnson chapters 5&6

- beats
- aliasing

Phonetic and phonological representations

- The study of linguistic sound patterns is traditionally divided into two sub-fields: phonetics and phonology.
- Phonology specifies the sounds that a language uses, the distribution of those sounds, and alternations in the realization of morphemes (among other things).
- What is left for phonetics?
- If the ‘sounds’ whose distribution is specified in the phonology are characterized in sufficient physical detail, then phonology should describe all aspects of the sound structure of a language.
- But phonology traditionally operates in terms of rather coarse-grained descriptions of sounds, so a lot of detail is left out.

Phonetic and phonological representations

- Example – phonological representations in Chomsky and Halle (1968):
  - strings of segments, essentially as in IPA-style transcription.
  - each segment is specified as a matrix of binary feature specifications.
  - Features are defined phonetically, but in rather broad terms.

Phonetic and phonological representations

E.g. Halle and Clements (1983):

Feature	Definition of the + value
[syllabic]	'Constitute syllable peaks'
[consonantal]	'Sustained vocal tract constriction at least equal to that required in the production of fricatives'
[sonorant]	'Air pressure inside and outside the mouth is approximately equal
[coronal]	'Raising the tongue blade towards the teeth or the hard palate'
[anterior]	'Primary constriction at or in front of the alveolar ridge'
[labial]	'With a constriction at the lips'
[distributed]	'With a constriction that extends for a considerable distance along the midsaggital axis of the oral tract'
[high]	'Raising the body of the tongue toward the palate'
[back]	'With the tongue body relatively retracted'
[low]	'Drawing the body of the tongue down away from the roof of the mouth'
[round]	'With protrusion of the lips'
[continuant]	'Allowing the air stream to flow through the midsaggital region of the oral tract'

Image by MIT OpenCourseWare. Adapted from Halle, M., and N. Clements. *Problem Book in Phonology: A Workbook for Courses in Introductory Linguistics and Modern Phonology*. Cambridge, MA: MIT Press, 1983

Phonetic and phonological representations

[lateral]	'With the tongue placed in such a way as to prevent the air stream from flowing outward through the center of the mouth, while allowing it to pass over one or both sides of the tongue'
[nasal]	'Lowering the velum and allowing air to pass outward through the nose'
[advanced tongue root]	'Drawing the root of the tongue forward'
[tense]	'With a tongue body or root configuration involving a greater degree of constriction than that found in their lax counterparts'
[strident]	'With a complex constriction forcing the air stream to strike two surfaces (sic), producing high-intensity fricative noise'
[spread glottis]	'With the vocal folds drawn apart, producing a non-periodic (noise) component in the acoustic signal'
[constricted glottis]	'With the vocal cords drawn together, preventing normal vocal cord vibration'
[voiced]	'With a laryngeal configuration permitting periodic vibration of the vocal cords'

Image by MIT OpenCourseWare. Adapted from Halle, M., and N. Clements. *Problem Book in Phonology: A Workbook for Courses in Introductory Linguistics and Modern Phonology*. Cambridge, MA: MIT Press, 1983.

Phonetic and phonological representations

- So standard phonological representations can characterize speech to about the same level of detail as a broad phonetic transcription. The remaining detail is generally held to be the subject matter of phonetics.
- Chomsky and Halle proposed an intervening step: phonetic detail rules convert binary feature specifications into scalar values.
- The remaining detail is supposed to be a matter of universal phonetics, and therefore not really part of grammar
- However, hardly anybody has actually adopted phonetic detail rules in the sense of SPE.

Phonetics and phonology

- The question that Keating (1985) addresses is how much phonetic detail can be supplied by ‘universal phonetics’.
- Another important question: Why should phonological representations exclude so much phonetic detail?

Keating (1985)

- The grammar must account for all language-specific aspects of sound structure.
- How much can universal phonetics account for?
- Short answer: not much.

Mechanical physiological effects

Case study: Intrinsic vowel duration

- Lower vowels are longer, other things being equal.
- Hypothesized explanations:
  i. Low vowels involve greater movement. Thus, if velocity is constant, low vowels will be longer (Lehiste 1970)
  ii. If only the magnitude, but not duration, of force input to jaw varies, low vowels will be longer (Lindblom 1967).

- Test: Electromyographic (emg) study of muscle activity in jaw lowering.
  - Lower jaw position is correlated with longer duration in English
  - But low vowels show longer and higher amplitude of muscle activity
  - i.e. the variation in duration is under the control of the speaker.

Widespread tendencies are subject to language-specific variation

Case study: Voicing effects on vowel duration.

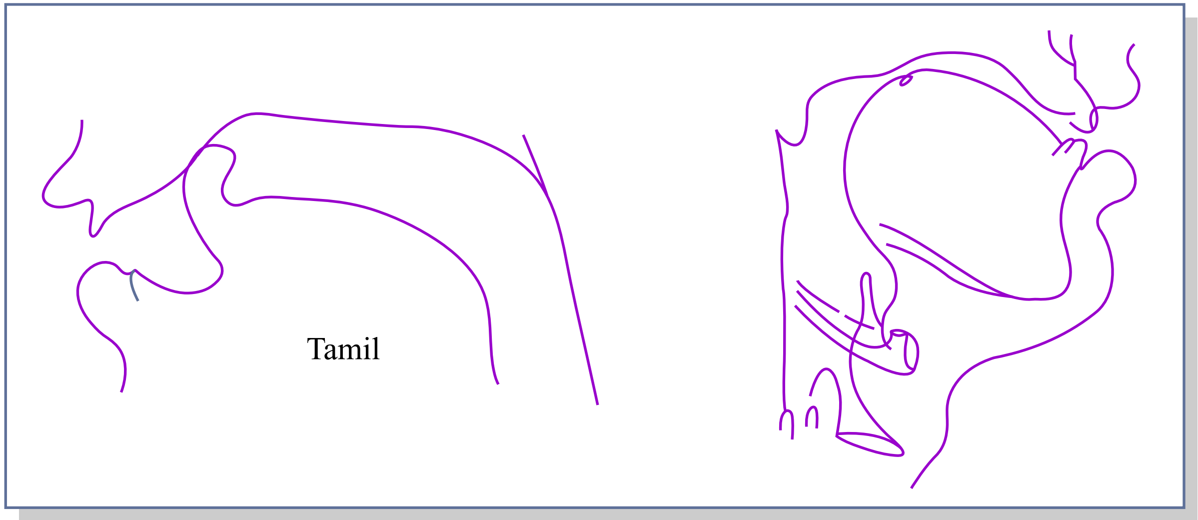
- Vowels are shorter before voiceless obstruents than before voiced obstruents or sonorants in many languages (Chen 1970)
  - E.g. English [ɛ] is shorter in longer in ‘bet’ than in ‘bed’ and ‘ben’ (ratio is approx. 0.8).
- Language-specific variation:
  - Effect is greater in English
  - No effect in Polish, Czech, Saudi Arabic
  - Effect conditioned by underlying voicing in Russian, German, English

Widespread tendencies are subject to language-specific variation

- The effect of obstruent voicing on vowel duration is very widespread and never reversed, so there must be some universal factor favouring this pattern, but languages may counteract the effect, or exaggerate it.

The nature of phonetic universals

- The failure of phonetic universals to place hard constraints on cross-linguistic variation is unsurprising. E.g:
- Phonetic universal: full retroflexion is not compatible with a high front tongue position [i]. (The tongue tip/blade and tongue body cannot simultaneously form constrictions with the hard palate).



Images by MIT OpenCourseWare. Left figure adapted from Ladefoged, Peter, and Ian Maddieson. *The Sounds of the World's Languages*. Malden, MA: Blackwell, 1996. Right figure adapted from Stevens, Kenneth N. *Acoustic Phonetics*. Cambridge, MA: MIT Press, 1999.

The nature of phonetic universals

- This constraint has a variety of consequences in front vowel/retroflex sequences:
  - Kodagu (Emeneau 1970) - vowels are retracted preceding retroflexes.
  - Gugada (Platt 1972) - partial backing and lowering of vowel [iəɖ] (cf. English).
  - Mantjiltjara (Marsh 1969) - retroflexion is ‘very weak’ after [i].
  - Gujarati - reduced retroflexion following [i] observable in palatograms in Dave 1977.
- Physics and physiology place constraints on linguistic systems, but they do not determine them.

Evidence for language-specific phonetic detail - Cross-linguistic variation in the realization of phonological categories

- Voiceless aspirated and unaspirated stops (Cho and Ladefoged 1999, Ladefoged and Cho 2001).

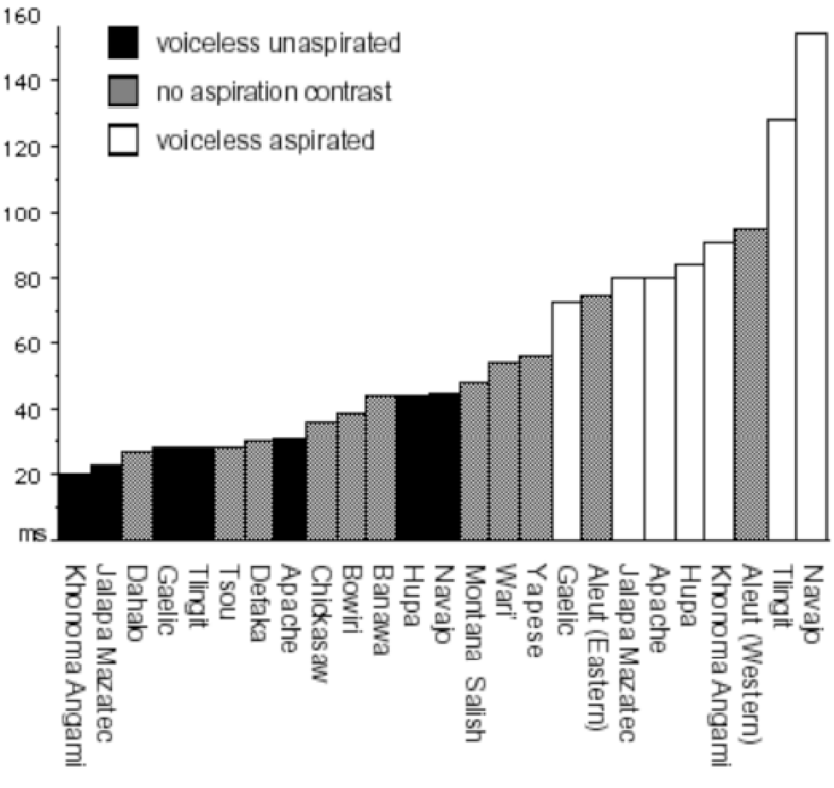


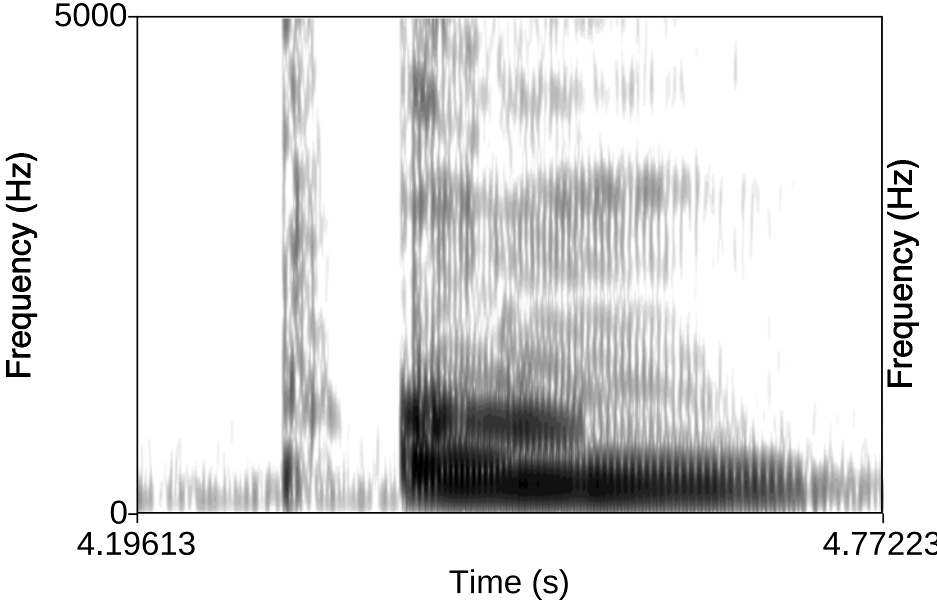
Figure 1. Mean VOTs (ms) for voiceless velar stops in 18 languages. (Values for voiced velar stops are not shown.)

Ladefoged, Peter, and Taehong Cho. "Linking linguistic contrasts to reality: The case of VOT." *UCLA Working Papers in Phonetics* 98 (2001): 1-9.

Cho, Taehong, and Peter Ladefoged. "Variations and universals in VOT: evidence from 18 languages." *Journal of Phonetics* 27 (1999): 207-229

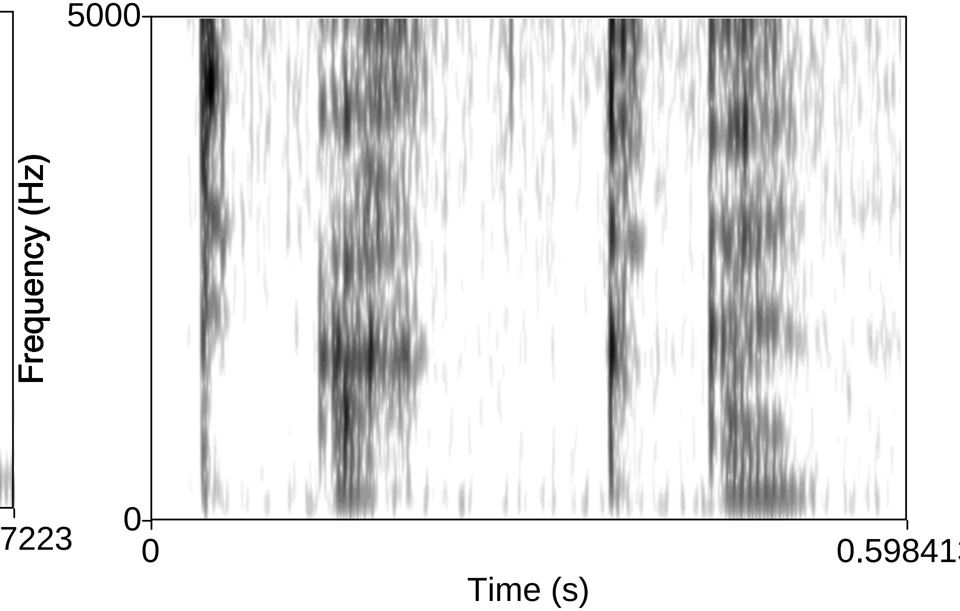
Cross-linguistic variation in the realization of phonological categories

- ‘VOT’ in ejectives
- Examples: Montana Salish



p’úm

[Audio clip 1]



t’áq’ən

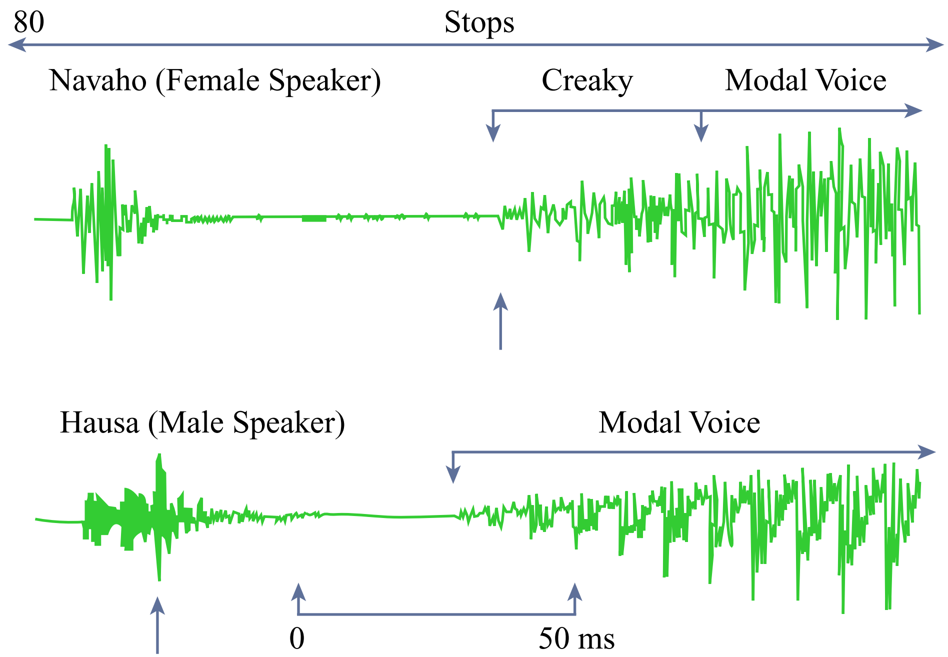
[Audio clip 2]

VOT in ejectives

- Navaho [k’aːʔ] vs. Hausa [k’aːràː]
- Navajo 94ms vs. Hausa 33ms

For the sound files, please see Peter Ladefoged’s *A Course in Phonetics*
http://hctv.humnet.ucla.edu/departments/linguistics/VowelsandConsonants/course/contents.html

Specifically:
Chapter 11: Navajo
Chapter 6: Hausa



Waveforms illustrating differences between Navajo and Hausa ejectives. The arrows indicate the releases of the glottal closures.

Image by MIT OpenCourseWare.

VOT in ejectives

- Cho and Ladefoged (1999)

Voice Onset Time (ms) for Ejectives in Six Languages				
Language	Bilabial	Alveolar	Velar	Uvular
Apache		46	60	
Hupa		93	80	89
Montana Salish	81	65	86	81
Navajo		108	94	
Tlingit		95	84	117
Yapese	60	64	78	

Glottalized stops

- Ejectives vs. Korean ‘fortis’ stops vs. English coda stops.
- Phonologically: All [+constricted glottis] stops?

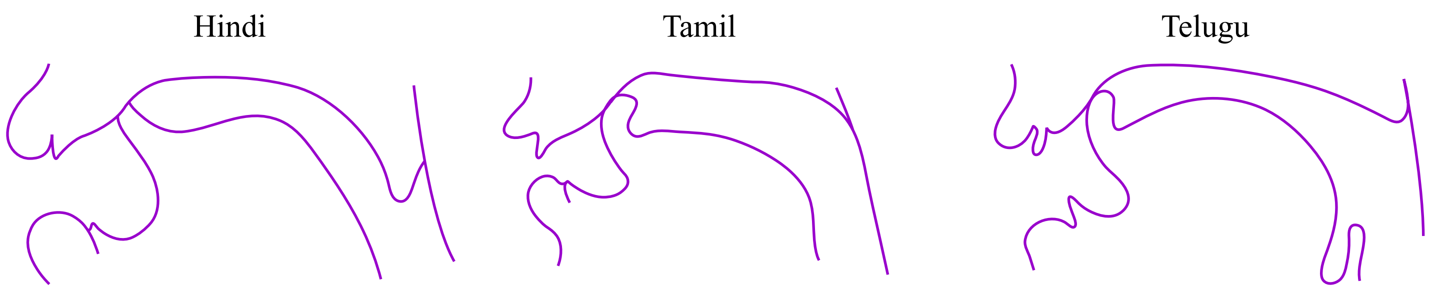
Korean (Seoul Dialect)		
Unaspirated	Fortis	Aspirated
pul 'fire'	p*ul 'horn'	p^hul 'grass'
tal 'moon'	t*al 'daughter'	t^hal 'mask'
kɨn 'weight or measure'	k*ɨn 'rope'	k^hɨn 'large'
tʃa 'ruler'	tʃ*a 'salty'	$tʃ^h$a 'tea'
sal 'flesh, fat'	s*al 'uncooked rice'	

Please see UCLA Phonetics Lab data: Korean for sound samples.

Degrees of retroflexion

Two (or more) degrees of retroflexion

- Apical post-alveolar, e.g. Hindi, vs. Sublaminal post-alveolar, e.g. Telugu (Ladefoged and Bhaskararao 1983)
- Phonologically: both [+coronal, -anterior, -distributed]?



X-ray tracings of the apical retroflex ɖ in Hindi and the sub-apical retroflex ɖ in Tamil and Telugu.

Image by MIT OpenCourseWare. Adapted from Ladefoged, Peter, and Ian Maddieson. *The Sounds of the World's Languages*. Malden, MA: Blackwell, 1996. Based on Ladefoged, Peter, and Peri Bhaskararao. "Non-quantal Aspects of Consonant Production: A Study of Retroflex Consonants." *Journal of Phonetics* 11 (1983): 291–302.

Vowel quality

- Similar front vowels of Danish (dotted) and English (solid) (Disner 1978, 1983).
- Danish vowels are systematically higher than their English counterparts.

Disner, S. (1978) "Vowels in Germanic Languages." *UCLA Working Papers in Phonetics* 40.

Disner, Sandra F. (1983). "Vowel quality: The relation between universal and language-specific factors." *UCLA Working Papers in Phonetics* 58. Ph.D. dissertation, University of California, Los Angeles.

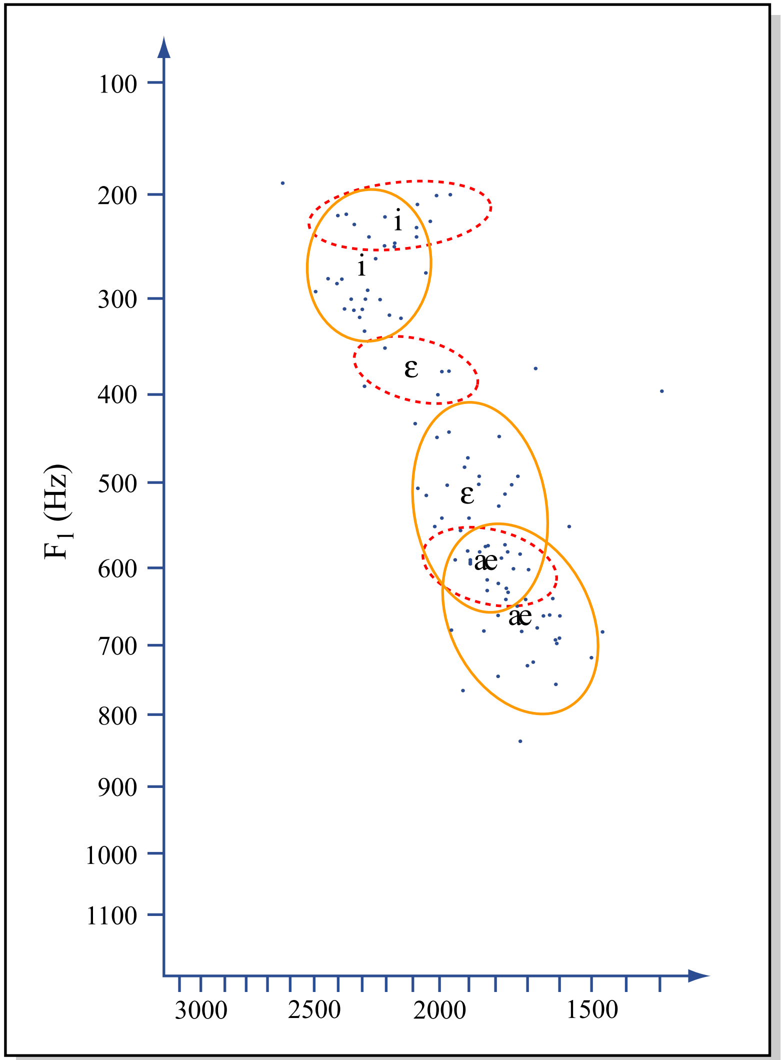


Image by MIT OpenCourseWare. Adapted from Disner (1983).

Cross-linguistic variation in contextual phonetic effects

- Vowel shortening before voiceless obstruents (above).
- Coarticulation
  - e.g. Nasalization adjacent to nasals (Cohn 1990, 1993).

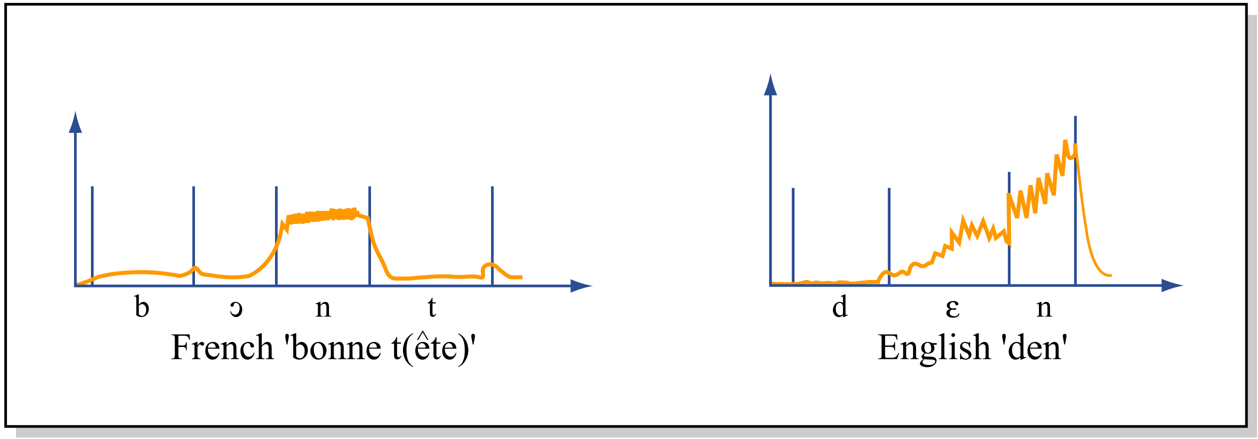
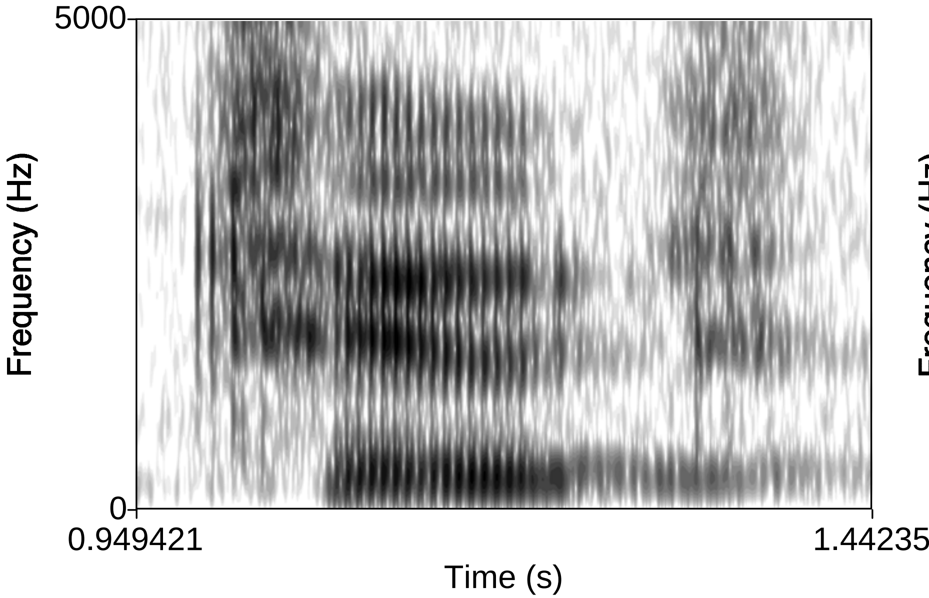


Image by MIT OpenCourseWare. Adapted from Cohn, A. “Nasalization in English: Phonology or Phonetics?” *Phonology* 10 (1993): 43-81.

Language-specific variation in coarticulation

- Fronting of vowels adjacent to alveolars and dentals.



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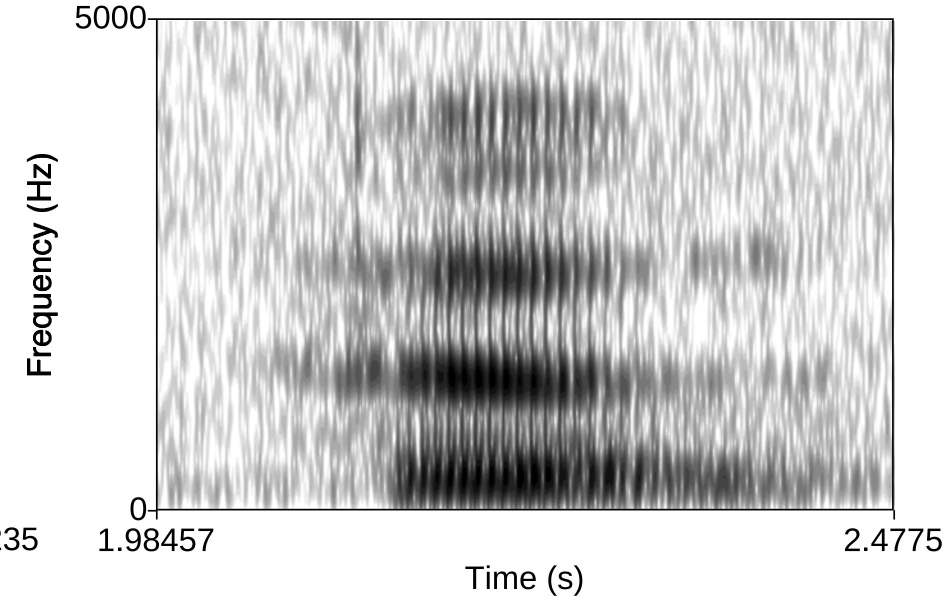
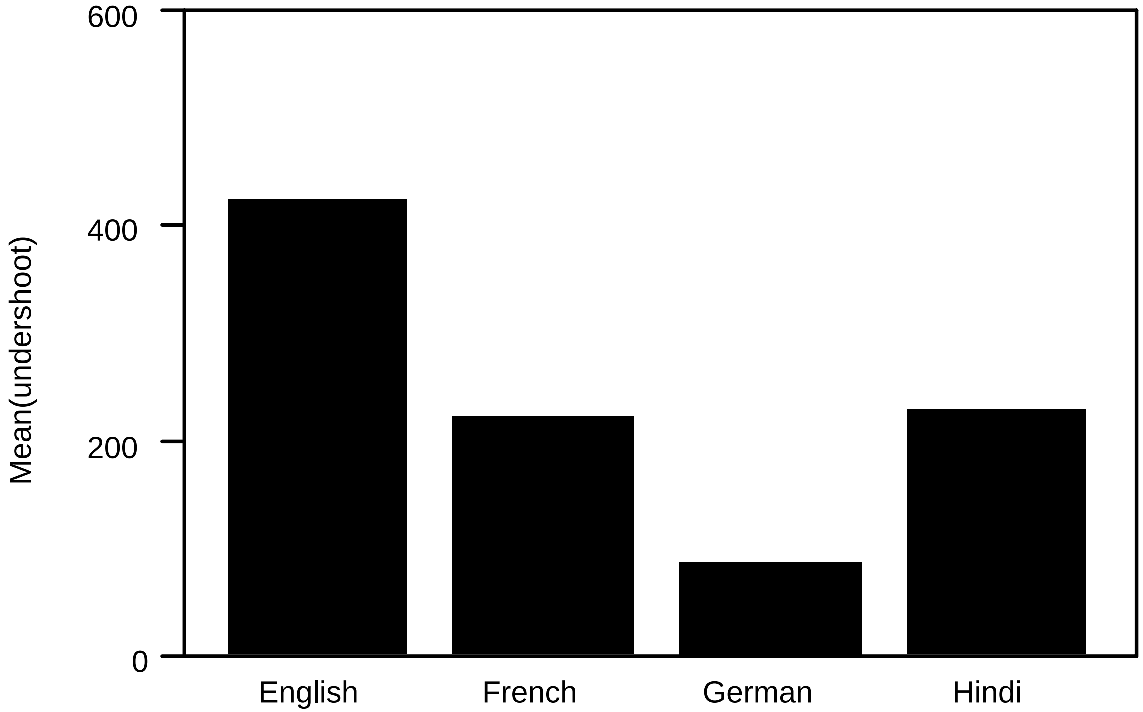


who

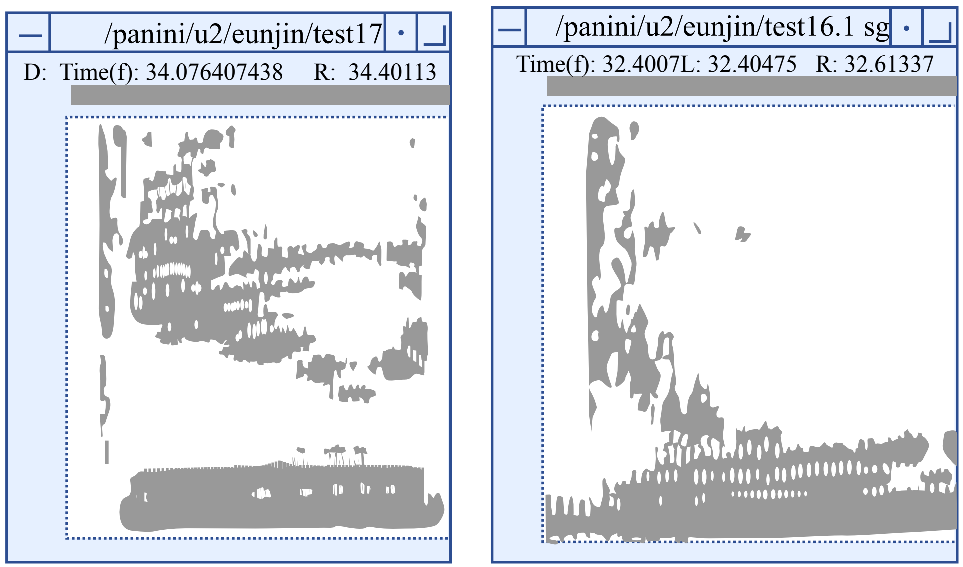
Language-specific variation in coarticulation

- Fronting of vowels adjacent to alveolars and dentals.



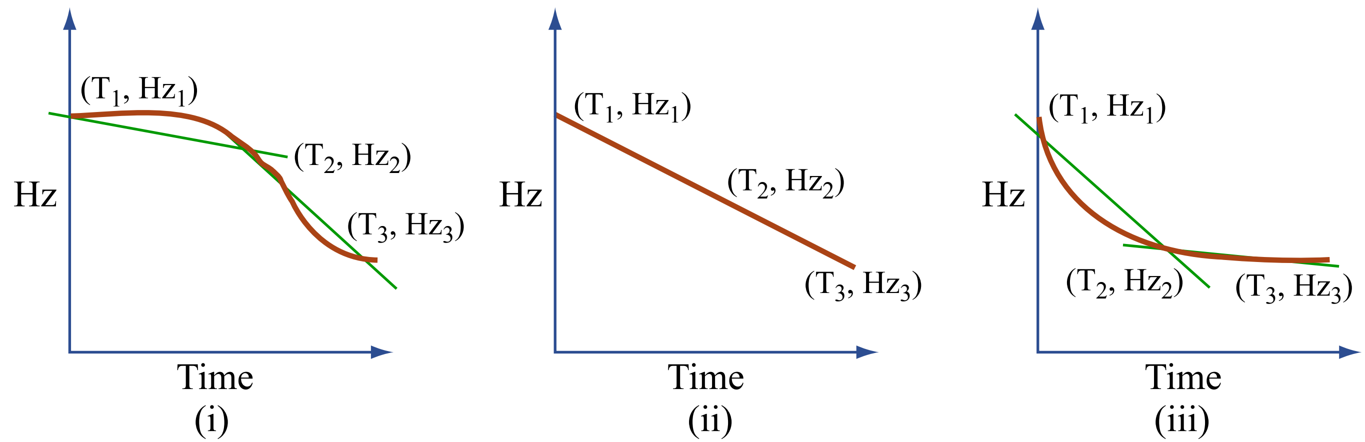
Language-specific variation in coarticulation

- The shape of the F2 trajectory in /du/ sequences (Oh 2000).



Sample spectrograms of [du] in native English (left) and French (right) speech.

The shape of the F2 trajectory in /du/ sequences (Oh 2000).



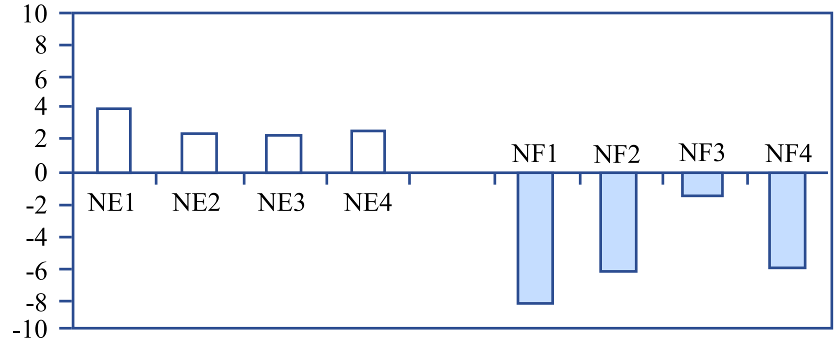
Quantifying the distinct trajectory shapes: Slope change values.

$$\text{(i)} \quad \left(\frac{Hz_2 - Hz_1}{T_2 - T_1}\right) - \left(\frac{Hz_3 - Hz_2}{T_3 - T_2}\right) > 0$$

$$\text{(ii)} \quad \left(\frac{Hz_2 - Hz_1}{T_2 - T_1}\right) - \left(\frac{Hz_3 - Hz_2}{T_3 - T_2}\right) = 0$$

$$\text{(iii)} \quad \left(\frac{Hz_2 - Hz_1}{T_2 - T_1}\right) - \left(\frac{Hz_3 - Hz_2}{T_3 - T_2}\right) < 0$$

The shape of the F2 trajectory in /du/ sequences (Oh 2000).



Slope change values in native speech.

Image by MIT OpenCourseWare. Adapted from Oh, Eunjin. “Non-native Acquisition of Coarticulation: The Case of Consonant-vowel Syllables.” Ph.D. dissertation, Stanford, 2000.

Vowel duration (Zhang 2001)

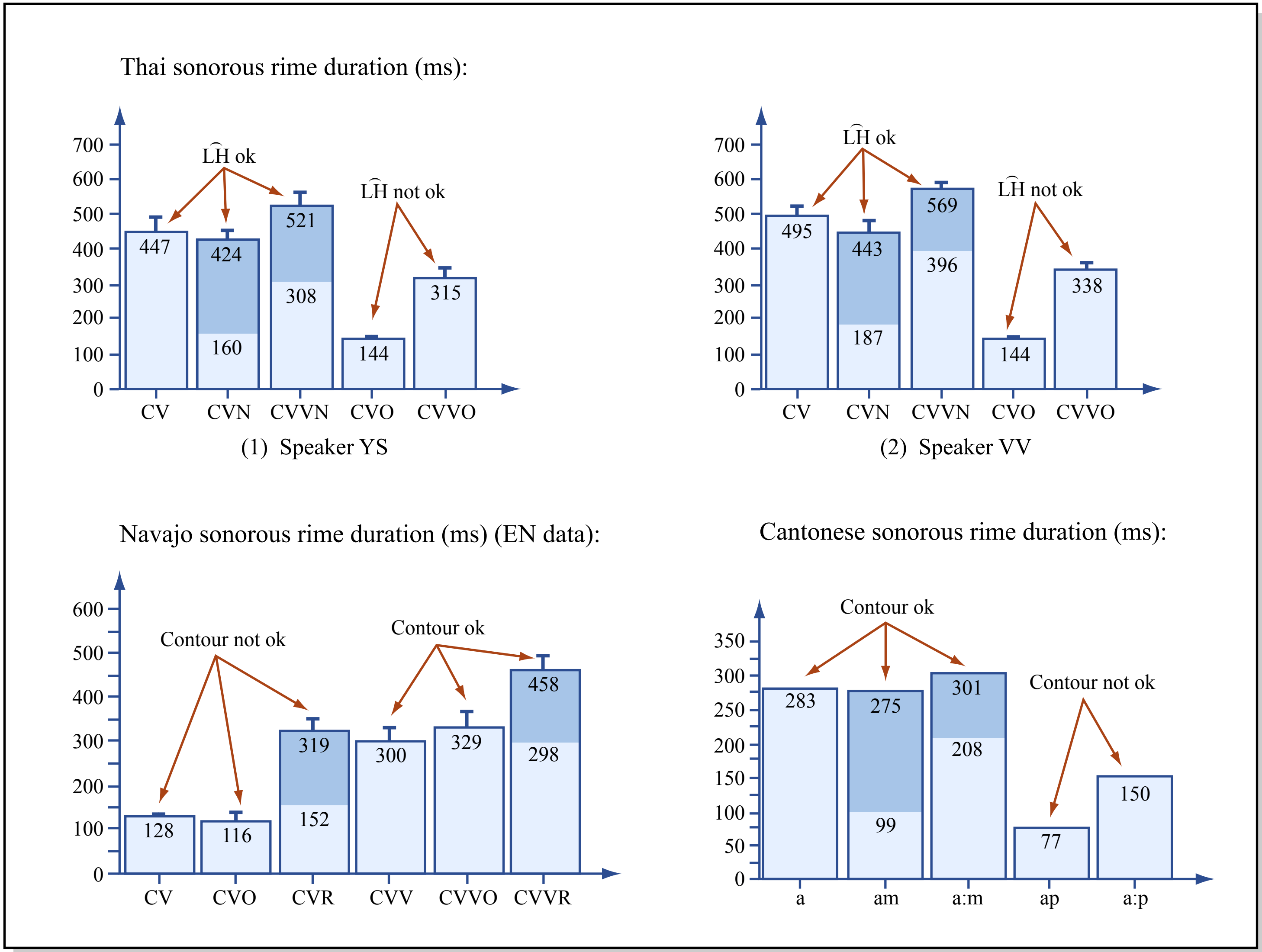


Image by MIT OpenCourseWare. Adapted from Zhang, J. "The Effects of Duration and Sonority on Contour Tone Distribution." Ph.D. dissertation, University of California, Los Angeles, 2001.

Summary

- There is language-specific variation in matters of relatively fine phonetic detail.
- Standard phonological representations cannot encode all of this detail.
- Therefore - either:
  - phonological representations need to be enriched, or
  - we should posit a language-specific phonetic component of grammar, or
  - the mapping from phonological representations to phonetic realization depends on language-specific phonological properties, e.g. the system of contrasts.
- Phonetics is as much a part of grammar as phonology or syntax.
- Phonetics is not just a matter of physics and physiology.

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