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24.941J / 6.543J / 9.587J / HST.727J The Lexicon and Its Features
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24.941

The Lexicon and its Features

Contrasts and features

Phonological representations

The basic role of features in phonological theory:

- Constraints regulate the phonetic properties of words.
 - Marked configurations are characterized in phonetic terms.
 - Correspondence constraints assess phonetic similarity between representations.
- Features represent these phonetic properties.
- What phonetic properties are relevant to phonology?
 - What properties do constraints refer to?
 - How discriminating are phonological constraints?

Phonological representations

- Longstanding claim: Phonology is sensitive to a very limited set of properties (Jakobson, Fant & Halle 1952, Chomsky & Halle 1968, etc)
 - About 20-30 binary/primitive features.
 - Limited temporal resolution
- In particular it has been claimed that phonology is only sensitive to properties that can be contrastive.

On the other hand:

- We have seen evidence that phonology is sensitive to never contrastive features.
- There are proposals that many more than 20-30 features are needed, and finer temporal resolution (Flemming 1995, Kirchner 1997, Steriade 2000 etc).

The nature of phonological features

- The evidence for the relevance of never-contrastive features comes from their role in analyzing phonological processes - we need constraints that refer to these features.
 - E.g. the acceptability of *-ee* suffixation depends on the acceptability of stop release.
 - Correspondence constraint must refer to (properties of) stop releases.
- The arguments for restricting the size of the feature is based on the observation that the range of possible contrasts is limited.

Plan:

- Sharpen the issue by sketching an analysis that makes use of finer details.
- Show that generalization about contrasts are better accounted for in terms of constraints on the distinctiveness of contrasts rather than restrictions on representations.

pin-pen neutralization

- Southern US (and Bakersfield) accents:

$\varepsilon \rightarrow \mathbf{I} / _ [+nasal]$

– *pin-pen*, *him-hem* are homophonous, *pit-pet* contrast.

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Please see the Phonological Atlas of North America, the Telsur Project at the Linguistics Laboratory, University of Pennsylvania.

pin-pen neutralization

- Southern US (and Bakersfield) accents:

$\varepsilon \rightarrow \mathbf{I} / _ [+nasal]$

- *pin-pen*, *him-hem* are homophonous, *pit-pet* contrast.
- The process can be described with conventional features, but an analysis in terms of more detailed representations allows us to relate it to broader phenomena in English and elsewhere.
- Outline (cf. Padgett 1997)
 - vowels are nasalized before nasals
 - nasalization makes height contrasts less distinct perceptually, resulting in neutralization of /ɪ/, /ɛ/.
 - neutralization yields high [ɪ] because it is more distinct from [æ].

Effects of nasalization on vowel perception

- Perceptually, nasal vowels are less distinct from each other than oral vowels, both in terms of confusability (Bond 1975) and similarity judgements (Wright 1986).

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Effects of nasalization on vowel perception

- Perceptually, nasal vowels are less distinct from each other than oral vowels, both in terms of confusability (Bond 1975) and similarity judgements (Wright 1986).
- So although oral [ɪ]-[ɛ] are adequately distinct for contrast, nasalized [ĩ]-[ẽ] are not.
- Padgett (1997) cites examples of height neutralizations among nasalized vowels in Old Church Slavonic.

Nasalized vowels

- This analysis relates the *pin-pen* neutralization to the generalization fact that, in languages with contrastive vowel nasalization, the nasal vowel inventory is always the same as or smaller than the oral vowel inventory, never larger (Ferguson 1963, Ruhlen 1973).

Beembe (Congo)

i u î û
e o ě õ
 a ã

Dakota (Yankton-Teton)

i u î û
e o
 a ã

Portuguese (Continental)

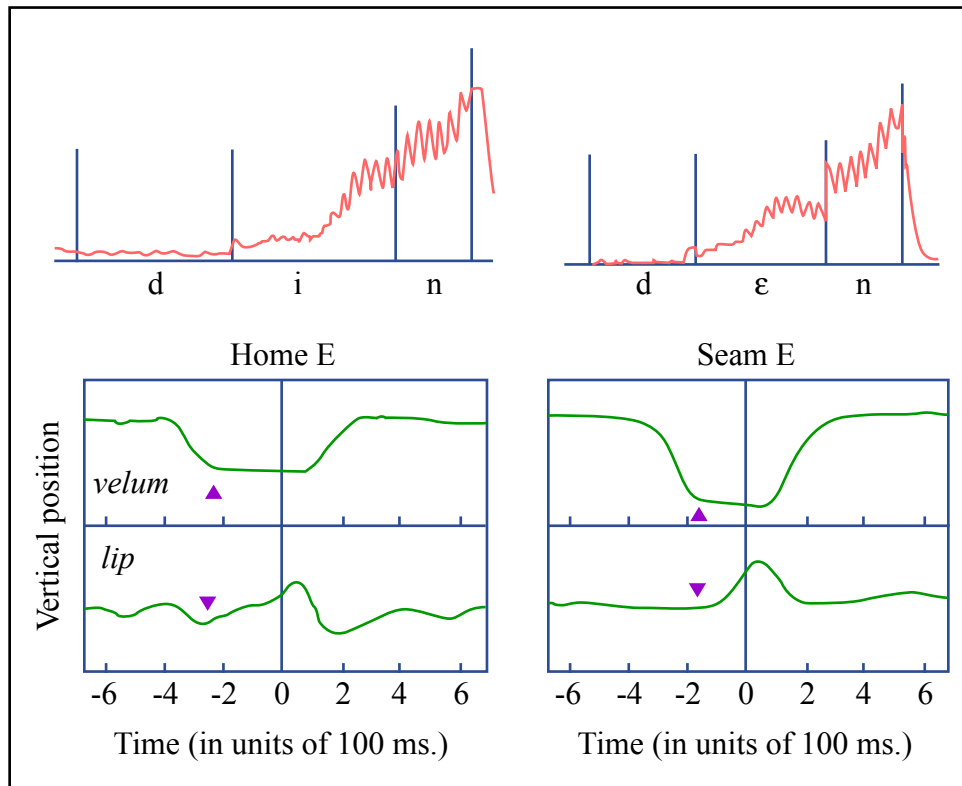
i u î û
e o ě õ
ε ɔ
 a ã

Ebrie (Niger-Congo)

i u
e o ě õ
 a ã

Vowel nasalization in English

- But it is not clear that the relevant vowels are [+nasal] in English - vowels are only partially nasalized before nasals.
 - velum lowers during vowel
 - about half of the tense vowel is nasalized
 - perhaps effect is greater in shorter lax vowel.



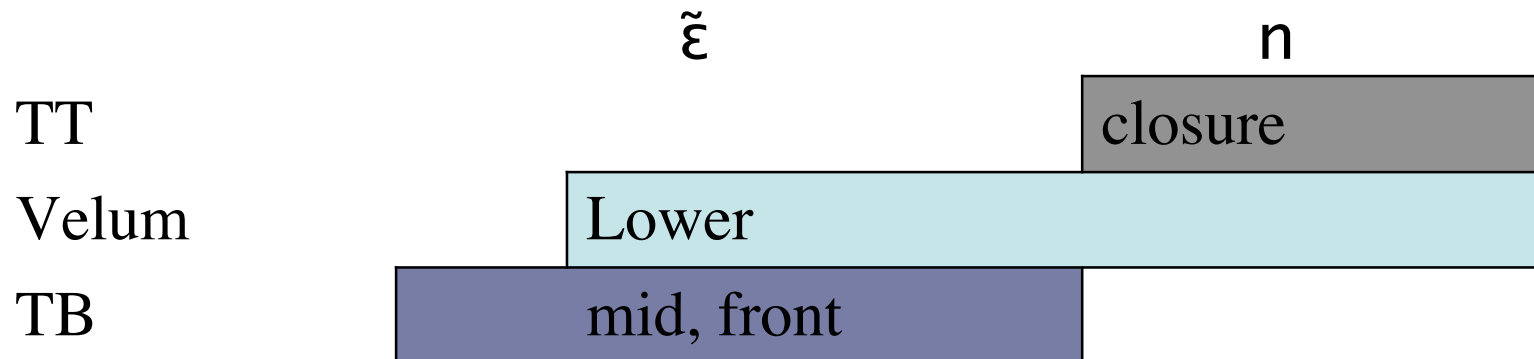
Cohn 1993
nasal airflow

Krakov 1993
velotrace

Figure by MIT OpenCourseWare.

Implementation

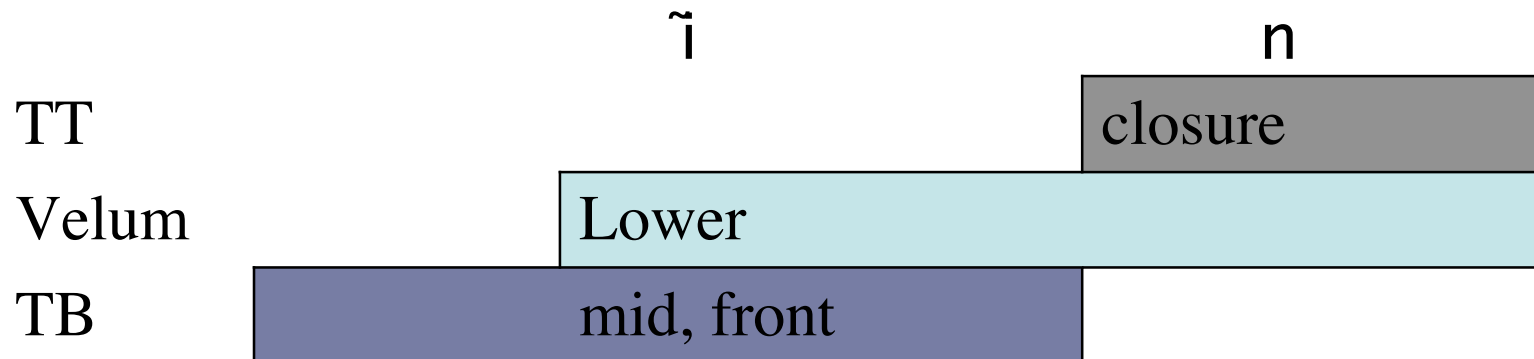
- Vowel nasalization: velum must be fully lowered ~50 ms before closure of nasal.



- I.e. some kind of specification of coordination of articulators, referring to subsegmental durations.
 - E.g. Browman & Goldstein's gestural score.

Implementation

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Neutralization due to indistinctness

- Pre-nasal [ɪ]-[ɛ] neutralize because they would be too similar perceptually and therefore too confusable.
- General principle: Maximize the distinctiveness of contrasts.
 - Contrasts can minimally distinguish words.
 - So if contrasting sounds are perceptually confusable, then listeners are more likely to be slow or inaccurate in identifying words.
- In OT terms: contrasts are more marked, the less distinct they are.
 - * $\tilde{\mathbf{I}}-\tilde{\mathbf{\epsilon}}$ >> * $\mathbf{I}-\mathbf{\epsilon}$
- Opposing constraint: Maximize the number of contrasts
 - More contrasting sounds allows speakers to differentiate words faster (i.e. increases the information content of each sound).
- * $\tilde{\mathbf{I}}-\tilde{\mathbf{\epsilon}}$ >> Maximize Contrasts >> * $\mathbf{I}-\mathbf{\epsilon}$

Neutralization due to indistinctness

- There are constraints on the distinctiveness of contrasts.
- Measuring distinctiveness: distance between sounds in perceptual space.
- Dimensions of the perceptual space for vowel quality correspond well to the frequencies of the first 2 or 3 formants.

F1	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7
	i			ɪ				ɛ		æ
				ĩ		ẽ		ã		



- Maximize distinctiveness: a hierarchy of constraints setting minimum distance requirements:

Mindist = F1:1 >> Mindist = F1:1.5 >> Mindist = F1:2 etc

Neutralization due to indistinctness

- Mindist = F1:1.5 >> Max Contrasts >> Mindist = F1:2

F1	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7
	i			ɪ			ɛ			æ
				ĩ		ẽ		æ̃		

		Mindist = F1:1.5	Max Contrasts	Mindist = F1:2
	 ɪ ɛ æ		3	**
	ɪ æ		2!	
/_N	ĩ ẽ æ̃	*!*	3	**
	 ã̃		2	
	ẽ æ̃	*!	2	*

Neutralization due to indistinctness

- Tense vowels are safe from neutralization due to greater duration (less nasalization?) and larger formant differences.
- Non-front lax vowels: F1 difference between [ʊ, ʌ] is larger than [ɪ, ɛ] (also rounding). Rarely contrast before nasals.

Phonetic detail in representations

- Rather than 20-30 binary features and coarse temporal segmentation we have articulatory and perceptual representations specified in terms of scalar dimensions, with much finer temporal resolution.
 - Partial nasalization of vowels
 - Evaluation of perceptual differences
 - stop releases
- The general objection to enriching phonological representations is based on the question: Why aren't most of these differences ever contrastive?

Constraining contrasts

- The argument for limiting the phonetic detail in phonological representations:
 - ‘...[Halle and Stevens] (and SPE) don’t simply have the wrong features in these instances; they will ALWAYS have TOO MANY features because they want to describe exactly how individual sounds are articulated. While we want the phonological features to have some phonetic basis, we also want to distinguish possible contrasts from possible differences.’ (Keating 1984:289)
 - ‘An adequate theory of phonological distinctive features must...be able to describe all and only the distinctions made by the sound systems of any of the world’s languages’ (McCarthy 1994:191)

Constraining contrasts

- The range of attested linguistic contrasts is much smaller than the range of phonetic differences.
- Analysis implicit in Keating, McCarthy:
 - All representable differences are possible contrasts.
 - So impossible contrasts must not be representable.
 - Implication: phonetic detail must be severely restricted to avoid over-predicting the range of possible contrasts.
- Response:
 - This is not the only conceivable theory of contrast.
 - It is an inadequate theory of contrast.

Constraint-based theories of contrast

- In OT it is more natural to derive restrictions on possible contrasts from constraints rather than from representations (cf. Kirchner 1997).
 - I.e. representations can encode unattested contrasts, but they are excluded by constraints.
- Dispersion Theory of Contrast (Flemming 2004, 2006):
 - Select an inventory of contrasts that best satisfies a ranked set of constraints:
 - Maximize the distinctiveness of contrasts (MinDist)
 - Maximize the number of contrasts.
 - Minimize Effort.

Dispersion Theory of Contrast - OT implementation

- Integration of differences on multiple dimensions is not well understood
 - here assume distance = largest distance on any dimension.

						F2											
						6	5	4	3	2	1						
F1	1	i	i	y	i	u	u										
	2		ɪ	ʏ			ʊ										
	3		e	ø		ø	ø										
	4		e	ø	ə	ɤ	o										
	5			ɛ	ɜ	ʌ	ɔ										
	6			æ	ɐ		ɑ										
	7				a	ɑ											

		MINDIST = 2	MINDIST = 3	MAXIMIZE CONTRASTS	MINDIST = 4	MINDIST = 5
a.	i u a			3!		
b.	i u e o a			5	***	*****
c.	i u e o ɛ ɔ a		*!*****	7	*****	***** *****
d.	i u e o a ɑ	*!	*	6	*****	*****
e.	i i u e o a		*!	6	*****	***** *
f.	i u e o a			5	***	*****!*

Constraint-based theories of contrast

- Preference for maximally distinct contrasts.
- Some distinctiveness constraints are undominated.
 - E.g. even if phonological representations distinguish 25% and 50% nasalized vowels, this may never be the sole basis for a contrast because it violates an inviolable Minimum Distance constraint.

Problems with the representational theory of contrast

- All theories allow for the representation of universally non-contrastive properties, e.g. syllable structure, prosodic structure (Steriade 1993).
- Real criterion: representational elements are justified by evidence that they play a role in the formulation of phonological rules/constraints.
- Non-contrastive features are necessary for the formulation of phonological generalizations. E.g. ejectives [t'] vs. (pre-)glottalized stops [ʔt].
 - Lombardi (1995) represents both as [+constricted glottis] because they never contrast minimally.

Problems with the representational theory of contrast

Ejectives [t'] vs. (pre-)glottalized stops [ʔt].

- Lombardi (1995) represents both as [+constricted glottis] because they never contrast minimally.
- But these sounds pattern very differently:
 - Ejectives commonly neutralize with plain stops in ‘coda’, e.g. Klamath, Shapsug, Peruvian Aymara, Maidu (Steriade 1997).

t'a ta at *at'

- Glottalized stops are commonly restricted to coda, e.g. English, Cantonese, Thai.

ta *ʔta aʔt *at

- These generalizations cannot be formulated if the two types of sounds are not distinguished.

Limitations of the representational theory of contrast

- The representational theory does not account for combinatorial restrictions on feature contrasts.
 - [nasal] can be contrastive on vowels and stops, but not on glottal stops or ejectives.
 - Front, central and back vowels can contrast [y ʉ u], but these differences are not contrastive as secondary articulations on consonants.
 - These restrictions plausibly follow from minimum distinctiveness requirements.

Possible vs. Preferred Contrasts

- The representational theory of contrast only seeks to distinguish possible contrasts from impossible contrasts.
- There are many generalizations about relative preferences for contrasts, e.g. [i] vs. [u] is less marked than [y] vs. [u].
- A theory of preferred contrasts can also account for restrictions on possible contrasts.

Backness and rounding in vowels

- Non-low vowels are generally front and unrounded or back and rounded (86% of the vowels in the UPSID database of phonological inventories).

i u
e o
a

- Every language has a front unrounded vowel.
- Every language has a back rounded vowel.
 - One reported exception: Jaqaru (Hardman 1966). Listen at: <http://www.quechua.org.uk/Eng/Sounds/Home/HomeWords.htm> and decide for yourself.
- Not every language has front rounded (y, ø, etc), central (ɨ, ə etc) or back unrounded (ɯ, ʏ etc) vowels.

Backness and rounding in vowels

- Explanation based on preference for maximizing distinctiveness of contrasts:
 - Covarying backness and rounding in this way maximizes the F2 difference between front and back vowels (Liljencrants & Lindblom 1972, Stevens, Keyser & Kawasaki 1986).

F2	14	13	12	11	10	9	8	7
	i		y	ɨ	ɯ			u

- MinDist = F2:6 >> Max Contrasts >> Mindist = F2:5
 - No non-peripheral vowels
- More distinct contrasts are preferred, some differences are insufficiently distinct to provide an adequate contrast.
- Representational theory has nothing to say about preferences - distinctiveness constraints also necessary.

Contrasts on multiple dimensions

- Consonantal contrasts are typically based on differences on multiple dimensions.
 - Stop place: quality of burst spectrum, F2 & F3 transitions (closure and release).
 - Stop voicing: VOT, preceding vowel duration, f0 in preceding and following vowels, burst intensity, etc.
- A contrast may be adequately distinct as a result of the combined contributions of multiple cues.
 - e.g. pre-pausal fricative voicing contrasts in English.
- A contrast may be neutralized because it is not possible to realize sufficient cues in the context (Steriade 1997 etc).
 - e.g. Lithuanian stop voicing contrasts are neutralized where VOT cannot be realized.

Natural Classes

- McCarthy (1994) asserts that an adequate theory of phonological features ‘must be able to characterize all and only the natural classes of sounds that recur in the phonological phenomena of different languages’
- Not clear how this is supposed to work. Perhaps every conjunction of feature values must specify a natural class.
- If so, increasing the number of features risks predicting too many natural classes.
 - Are [F2 12] or [F2 9, +coronal] natural classes?
- Not clear that standard small feature sets come anywhere near to meeting this criterion.
 - Does any constraint need to refer to [+high tone, +round]?

Natural Classes

- An alternative approach to possible natural classes:
 - Possible natural classes are those that are mentioned in the universal set of constraints.
 - There is no reason why any particular combination of features has to be mentioned in a constraint - depends on the theory of constraints.
- There are distinct constraint families that regulate different aspects of phonological form:
 - Perceptual distinctiveness (MinDist)
 - Articulatory effort
 - Correspondence

Natural Classes

- Each constraint family refers to different aspects of phonological representation in particular ways:
 - Distinctiveness constraints refer to perceptual distance only - not to articulatory features, and not to particular values of perceptual features.
 - Effort constraints refer to (certain aspects) of articulatory representations.
 - Correspondence constraints may also refer to perceptual distance (cf. Steriade 2001).
- I.e. strong restrictions on reference to features.
- Examining the set of features independently of the constraint families with which they are associated is uninformative.

Summary

- The fundamental criterion for proposing that a feature (or representational distinction) is part of phonological representation is evidence that a constraint is sensitive to that difference.
- The evidence suggests that constraints can be sensitive to phonetic differences that never serve as the sole basis for a contrast.
 - E.g. correspondence to burst strength.
- Limitations on possible contrasts derive from constraints on what constitutes a good contrast - particularly distinctiveness constraints.

End