Situating phonological contrast: Distinctive feature theory

Daniel Currie Hall

Saint Mary's University

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§1

Introduction

Introduction

- What theories of distinctive features (and elements) agree on:
  - Phonological segments are composed of smaller units.
  - These units serve to distinguish contrasting segments.
  - They can be manipulated by the grammar.
- Two questions they don't all agree on:
  1. Are features innate/universal?
  2. Do features have phonetic content?

Introduction

Agenda for this talk:

- Outline an approach to features in which contrast plays a central role
- Propose answers to these questions:
  1. Are features innate/universal? **No.**
  2. Do features have phonetic content? **Yes.**

§2

Distinctive features and the Contrastivist Hypothesis

- As Mielke (2011: §2.3) has pointed out, distinctive features have three functions:
  1. Features define segmental contrasts.
  2. Features identify sets of segments that participate in alternations (natural classes).
  3. Features identify structural changes in alternations.
- Using a single mechanism for all three of these purposes makes predictions about how phonology works, particularly if the features are restricted in interesting ways.

A theory of features has things to say about how much information the phonological component of the grammar has access to.

- If features define segmental contrasts, then there must be **at least** enough features specified to distinguish all lexically contrastive segments from one another.
- If features are drawn from a finite universal set, then there can be **at most** as much information as provided by full specification of all segments for all features in that set.

The **Contrastivist Hypothesis** (Hall 2007; Dresher 2009) posits that feature specifications are minimal:

Contrastivist Hypothesis

- The contrasting segments of the underlying inventory are assigned just enough features to give each of them a representation distinct from the others.
- Non-contrastive features are not visible to the phonological computation.

Dramatization of Elan Dresher (played by Stanley Tucci)
explaining the principle of contrast to two skeptics (Ian Holm and Tony Shalhoub):

Note: The embedded video stopped working at the end of 2020, when Adobe ended support for Flash. The longer clip from which this excerpt is taken is available on YouTube at `https://www.youtube.com/watch?v=d3hs2M_0vLE`.

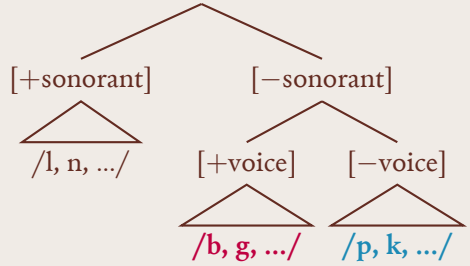
Motivations for the Contrastivist Hypothesis:

Methodological: If we hypothesize minimal feature specifications, it should be relatively easy to see if we need more features. If we start with richer representations, we might not notice whether it's possible to simplify them.

Empirical: We can see examples of non-contrastiveness correlating with phonological inactivity.

E.g., a typical voicing assimilation pattern (Lithuanian data from Odden 2013: 130–131):

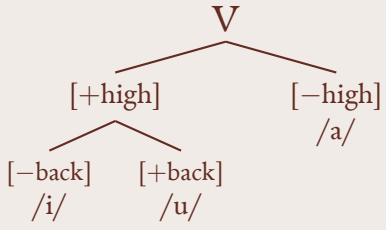
1	at-praʃi:ti	'to ask'
2	at-ko:pti	'to rise'
3	ad-bekti	'to run up'
4	ad-gauti	'to get back'
5	at-likti	'to complete'
6	at-neʃti	'to bring'



How do we know which features are contrastive? The Successive Division Algorithm (SDA; Dresher 2009: 16):

Successive Division Algorithm

1. Begin with *no* feature specifications: assume all sounds are allophones of a single undifferentiated phoneme.
2. If the set is found to consist of more than one contrasting member, select a feature and divide the set into as many subsets as the feature allows for.
3. Repeat step (2) in each subset: keep dividing up the inventory into sets, applying successive features in turn, until every set has only one member.



Properties of the SDA:

- No feature is assigned unless it serves to mark some phonemic contrast that has not already been encoded.
- The ordering of features is not stipulated, and can vary from one language to another. (See Mackenzie 2009, 2011, 2013 for examples.)
- Unlike specification by minimal pairs (Archangeli 1988: 192), the SDA will always provide enough features to tell all the phonemes apart.
- Features do not have to be ordered in such a way as to minimize the total number of specifications, or the total number of different features used. Specifications are minimal only in the sense that no non-contrastive features are assigned.

§3

Two questions

Two questions

Features of theories of features

Universality	Phonetic content		
+	+	Jakobson, Fant & Halle (1952) Chomsky & Halle (1968) Clements & Hume (1995) Halle, Vaux & Wolfe (2000) Hale & Reiss (2000, 2003)	} ‘substance-free’
–	–	Blaho (2008); Odden (2019) Fudge (1967)	
–	+	**this talk**	
+	–	unattested (?)	

Question 1: Are features universal?

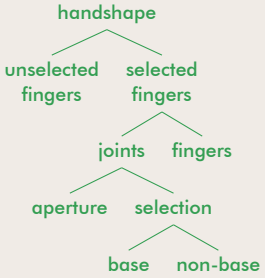
- The Contrastivist Hypothesis and the SDA say that a segment's feature specifications depend on the system of contrasts in which it participates.
- This means we can't determine what features a segment has just by knowing what it sounds like and how to produce it (contra Hale & Reiss 2003).
- But we could still have features specified by the SDA that are drawn from a master list provided by UG.

Two questions

Are features innate/universal?

Against innate universal features:

- **Spoken and signed languages use features with very different phonetic correlates.**
- Mielke (2008: §1.5.1) considers three possible responses to this:
  1. Features are universal, but have disjoint phonetic correlates in different modalities.
     - But feature geometries proposed for spoken languages (e.g., Clements & Hume 1995; Halle, Vaux & Wolfe 2000) don't map readily onto ones proposed for signed languages.
       E.g., handshape geometry from Brentari (2011: 204):



  2. UG provides a superset of features, and signed and spoken languages use disjoint subsets.
  3. Or features are acquired, not innate.

Two questions

Are features innate/universal?

Against innate universal features:

- **The 'same' feature may have different boundaries between its + and − values in different languages.**
  - E.g., are /ɛ/ and /ɔ/ [−low] or [+low]?
    - Calabrese (1998): They're [−low] (in Italian)
    - Mateus & d'Andrade (2000): They're [+low] (in Portuguese)
    - Chomsky & Halle (1968): /ɛ/ is [−low] and /ɔ/ is [+low] (in English)
  - Similarly, Mielke (2005) points out that laterals and nasals sometimes pattern as [−continuant] and sometimes as [+continuant].
- Maybe UG provides multiple versions of features like [±continuant] and [±low]?
- More plausibly, maybe the features provided by UG don't come with fixed cutoff points, just identifiable phonetic dimensions: [+low] just means 'lower than [−low]', not 'below a certain tongue height' or 'above a certain F1 frequency'.
- Either of these options weakens the predictive power of innate features.

Against innate universal features:

- **Morphosyntax gives independent reason to posit a feature-learning mechanism.**
- E.g., Tsez has four noun classes (Gagliardi *et al.* 2009; Plaster *et al.* 2013):

  Class I: male persons (human or supernatural)
  Class II: female persons (human or supernatural), paper items, stone items, berries
  Class III: animate non-persons, vehicles, various other inanimates
  Class IV: abstract nouns derived using suffixes *-ni* or *-λi*, various other inanimates

- These classes are involved in agreement:

∅-igu uži	*j-igu kid*	*b-igu k'eʦ'u*	*r-igu čorpa*
I-good boy	II-good girl	III-good cat	IV-good soup
'good boy'	'good girl'	'good cat'	'good soup'

- If agreement is feature-driven, learners must be able to acquire features that encode essentially arbitrary classes, and that can't be innate.
- If UG includes a feature-learning mechanism, why should it also have a list of features?

Two questions

Are features innate/universal?

Instead of innate universal features:

- Blaho (2008: 40): "Features are not innate, but the ability to make generalisations over data and posit categories is."
- Cowper & Hall (2014): The two key components of this are **contrast** and **correlation**.
- Learners look for correlations between contrasts in different types of structure:
  - Semantic contrast aligned with morphological contrast:

    English: *the rack* vs. *the racks*
  - Lexical contrast aligned with phonetic contrast:

    English: [læk] *lack* vs. [ɹæk] *rack*
  - Semantic contrast aligned with displaced morphological contrast:

    English: *This sheep is black* vs. *These sheep are black*
  - Lexical contrast aligned with displaced phonetic contrast:

    Nupe: [ēgā] 'stranger' vs. [ēgʷā] 'hand' (Hyman 1970: 62)
  - Lexical contrast aligned with phonetic contrast *and* displaced phonetic contrast:

    English: [ɹæks] *racks* vs. [ɹeɪgz] *rags*

Question 2: Do features have phonetic content?

- Radically Substance-Free Phonology:
  - "Features are indicators of the way members of an inventory behave, but they don't necessarily have any consistent phonetic characteristics even within the same system" (Blaho 2008: 22–23).
  - "Phonological theory does not require or allow features to have any substantive definition at all" (Odden 2019: 2).
- Let's go back to Mielke's (2011) list of what features do:
  1. Features define segmental contrasts.
  2. Features identify sets of segments that participate in alternations (natural classes).
  3. **Features identify structural changes in alternations.**
- How do features do (3) if they don't have phonetic substance?

Two questions

Do features have phonetic content?

- Suppose that a feature identifies a class of sounds that triggers lip-rounding on adjacent segments.
- Formally, this is implemented as feature spreading (or the equivalent).
- Then we can say that the phonetic content (or correlate) of that feature is lip-rounding (even if members of the triggering class are not always rounded themselves).

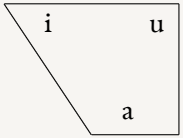
  Nupe: /ēgā/ [ēgā] ‘stranger’ vs. /ēgɔ̄/ [ēg^{w}ā] ‘hand’ (Hyman 1970)
  (see also Smith, this workshop, on Bemba)

- If features have *no* substance, or even just no *consistent* substance, though, then the same feature could do different things to different segments.
- This allows for spurious formal unification of disparate processes.

Spurious formal unification: A hypothetical example

Hypothetical inventory

	LABIAL	CORONAL		DORSAL	
STOP	p	t		k	
AFFRICATE		ʦ			
FRICATIVE	f	s	ʂ	x	x^w
NASAL	m	n		ŋ	
LIQUID			r		



The 16 segments of the inventory can be efficiently specified using four arbitrary binary features with no phonetic substance:

Hypothetical feature specifications

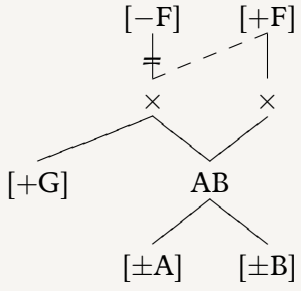
	ʂ	r	s	f	x^w	u	x	a	ŋ	k	n	p	ʦ	i	t	m
A	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−
B	+	+	+	+	−	−	−	−	+	+	+	+	−	−	−	−
F	+	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−
G	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−

And here's a hypothetical rule: A [+G] segment assimilates to the [+F] feature of a following segment that shares its values for [±A] and [±B].

SPE notation

$$\begin{bmatrix} \alpha\ \mathrm{A} \\ \beta\ \mathrm{B} \\ +\mathrm{G} \end{bmatrix} \rightarrow [+\mathrm{F}]/\_\_ \begin{bmatrix} \alpha\ \mathrm{A} \\ \beta\ \mathrm{B} \\ +\mathrm{F} \end{bmatrix}$$

Autosegmental spreading



Recap: Features and rule

	ʂ	r	s	f	x^w	u	x	a	ŋ	k	n	p	ʦ	i	t	m
A	+	+	+	+	+	+	+	+	−	−	−	−	−	−	−	−
B	+	+	+	+	−	−	−	−	+	+	+	+	−	−	−	−
F	+	+	−	−	+	+	−	−	+	+	−	−	+	+	−	−
G	+	−	+	−	+	−	+	−	+	−	+	−	+	−	+	−

$$\begin{bmatrix} \alpha\,\mathrm{A} \\ \beta\,\mathrm{B} \\ +\mathrm{G} \end{bmatrix} \rightarrow [+\mathrm{F}]/\_\_ \begin{bmatrix} \alpha\,\mathrm{A} \\ \beta\,\mathrm{B} \\ +\mathrm{F} \end{bmatrix}$$

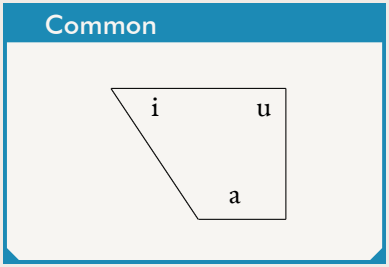
This rule produces phonetically natural results...

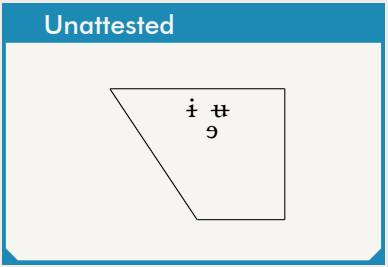
- s → ʂ / __ r
- x → x^w / __ u
- n → ŋ / __ k
- t → ʦ / __ i

...just not ones that have much in common.

Here's a more positive reason to believe features have phonetic content:

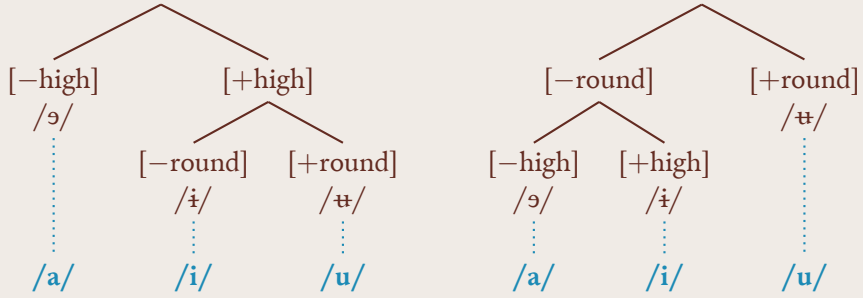
- Phonological inventories tend to have robust phonetic contrasts.





- Dispersion Theory (Liljencrants & Lindblom 1972; Padgett 2001, 2003b,a; Flemming 2002, 2004) explains this by saying that surface distinctness is an explicit desideratum.
- But Hall (2011) argues that it can be understood as an epiphenomenon of contrastive specification combined with phonetic enhancement (Stevens *et al.* 1986; Stevens & Keyser 1989, 2010; Keyser & Stevens 2001, 2006).

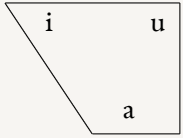
- Contrastive specification (by the SDA): Features are specified only if they serve to mark a contrast.
- So any phonetically meaningful set of features that can be assigned to */ɨ ɔ ʉ/ could also represent /i a u/:



- Enhancement: Non-contrastive phonetic properties tend to reinforce specified features.
- So specifications that *could* be /i a u/ or /ɨ ɔ ʉ/ are more likely to be realized as [i a u]:
  - [−high] can be enhanced by lowness (reinforcing high F1).
  - [−round] can be enhanced by frontness (high F2).
  - [+round] can be enhanced by backness (low F2).
- There are differences between languages (and speakers—see Harper, this workshop) in exactly which features get enhanced and how, but enhancement of some sort is the overwhelming norm.
- If the input to enhancement consists only of contrastive specifications, we get dispersed inventories without any need to explicitly compare sounds—we just have to amplify the properties that are already there.
- But this does depend on the assumption that phonological features have some phonetic substance for enhancement to amplify.

- The contrast-and-enhancement approach can also explain why inventories are not *more* dispersed than they are.

Common



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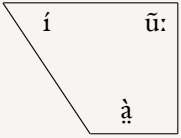

- Once the SDA has assigned enough features to distinguish all the contrasting underlying segments, it stops. It can't specify additional dimensions of contrast.
- And enhancement only reinforces what's specified; it doesn't add new contrasts on other dimensions.

§4

Conclusions

Conclusions

- So, where is contrast?
  - **Phonological contrast** is in the underlying inventory, and fundamentally constrains how detailed phonological representations can be.
  - **Phonetic contrast** follows from the interaction of phonological contrast with phonetic enhancement.
- And how do phonology and phonetics interact?
  - **Phonological representations** contain limited amounts of phonetic information, through contrastively specified, phonetically interpretable features (substance use in moderation).
  - **Phonetic implementation** builds on phonological representations, amplifying features' content through enhancement, but it doesn't directly concern itself with contrastiveness.

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