

## Distinctive Feature Theory

### Part 2: Underspecification

Christian Uffmann

## German umlaut

- We saw yesterday that even a fairly simple and straightforward looking process can raise questions w.r.t what features we are using.
- General process [+bk] -> [-bk] with certain suffixes.
- But: /ɑ/ -> /e/. Also change in [±low]?
- One option: Additional raising rule to repair ill-formed output [æ], which is not a phoneme of German.
- Or could we specify [e] as [+low]? You didn't like that ...
- Or we leave out [±low] — not a contrastive feature. Topic of Underspecification discussed today and tomorrow.

## Further complications

- No need to discuss in detail now, but there are a few extra wrinkles to German umlaut.
- /au/ umlauts as [ɔɪ], e.g. H[au]s — H[ɔɪ]schen 'house' or B[au]m — B[ɔɪ]mchen 'tree'. How many repairs?
- And a point about phonetic accuracy: For some speakers /ɑ/ is actually phonetically front [a].
- The alternation persists, however! So is [a] phonologically [+back] even though it phonetically isn't? Or should we propose a different alternation to account for this? (Umlaut as raising)

## A few thoughts

- A few thoughts to keep in mind for the next 1 1/2 weeks:
- The same feature may have different phonetic correlates in different environments.
- There is no clear one-to-one relation between features and articulatory parameters/gestures.
- What is phonologically the 'same' may be articulatorily diverse.

## One feature — different correlates

- Consider [+voice] in English. Always vocal fold vibration?
  - In codas also lengthening of preceding vowel (difference *cot-cod*)
  - and drop in F0 (fundamental frequency)
  - while vocal fold vibration is optional.
- Experimental evidence that these are actually the salient cues for [voice] in codas. Listeners perceive a sound as voiced if vowel is lengthened and/or F0 drops.
- Then what exactly is [+voice]?

## Other complications

- Features may correspond to diverse gestures or cues.
- Voicing may be achieved by a variety of articulatory settings, for example.
- Ladefoged (1980): What we call ‘ejectives’ may be phonetically quite distinct objects — but never contrastive.
- The ‘same’ phonological segment may have different phonetic realisations, e.g. types of /r/ in German, French, or Norwegian.
- And this isn’t even taking into account sociophonetic variation or ongoing shifts, e.g. /u/-fronting in English.
- (More on all this in Week 2!)

## A radical alternative?

- Should we just throw out the phonetic component of the feature? Or would that be throwing out the baby with the bathwater?
- Could any set of segments be a phonological class?
- Where and how does the translation to phonetics happen?
- For example, the infamous Vowel Shift Rule in SPE.
  - Alternations like [ɪ — αɪ] (*divine-divinity*), [ɛ — i:] (*obscene-obscenity*), [æ — eɪ] (*sane-sanity*).
  - Chomsky & Halle: complex rule to derive alternation.
  - What if it’s just a length difference ([+long] or VV or extra mora)?
  - But: rule is lexicalising, barely productive, and can we really be that arbitrary?

## Underspecification: Intro

- What we learned in Part 1: There’s a whole lot of features.
- Do we always need all of them? Is every segment in a language exhaustively specified?
- Example from Turkish: we only need [high, back, round]. What would adding [ATR, low] buy us, other than full phonetic specs?
- Same in German: does just forgetting about [low] not buy us a simpler umlaut rule?
- Ideas of underspecification

## Underspecification

- Idea as old as the feature: are segments underspecified for features, when these features don't provide important info?
- But then what is this important info? How much can/should be removed?
- What are reasons for or against underspecification?
- At what level are segments underspecified?
- Are 'missing' specifications filled in later? At what level?

## Redundant specifications

- Feature specifications are redundant if the feature value can be recovered independently, from other feature specifications.
- In other words, some specification  $[\alpha X]$  may imply the specification  $[\beta Y]$ .
- Given a universal set of features, redundancy relations may be **universal**, that is, they hold in any system.
- Or they are **language-specific**, based on the phoneme system of a language.
- We can express a redundancy relation using a double arrow:  $[\alpha X] \Rightarrow [\beta Y]$

## Universal redundancy relations

- Given the phonetic content of features, some feature specifications may be mutually incompatible.
- For example because they require antagonistic movements of an articulator.
  - Segments cannot be [+high] and [+low] simultaneously
  - Segments cannot be [+s.g.] and [+c.g.] simultaneously
- Or they require impossible combinations of articulatory gestures
  - [+lateral] segments require the tongue as an active articulator
  - [+nasal] is incompatible with pharyngeals — why?

## Language-specific redundancy

- In addition to such universal redundancy relations, they can be language specific as well.
- e.g. in English all sonorants are [+voice]
- e.g. in Polish and Italian all front vowels are [–round]
- e.g. in Polish all coronal fricatives are [+strident] (no  $[\theta, \delta]$ )
- Think of some more implicational relations between feature specifications in your pet language!

## Exercise

5-vowel system, full specifications

	[i]	[e]	[a]	[o]	[u]
[consonantal]	-	-	-	-	-
[high]	+	-	-	-	+
[low]	-	-	+	-	-
[back]	-	-	+	+	+
[round]	-	-	-	+	+
[ATR]	+	+	-	+	+
[nasal]	-	-	-	-	-

## Underspecification: the beginnings

- The idea of underspecification is as old as the idea of the feature.
- Central idea of structuralism: phonemic oppositions. Features express such oppositions (see Trubetzkoy 1939).
- Take the set of labials /p, b, m/ (see also Dresher (2009)).
  - /p/ is distinct from /b/ because it is [-voice].
  - /p/ is distinct from /m/ because it is [-nasal].
- So /p/ is [-voice, -nasal]. But wait – is it?
  - If /m/ is also [+voice], it [ $\pm$ nasal] distinguishes it from /b/!
- Then we can / should leave /p/ underspecified for [ $\pm$ nasal]. Underspecification can take different routes.

## Two ways of underspecifying /p b m/

	[p]	[b]	[m]
[nasal]	-	-	+
[voice]	-	+	

	[p]	[b]	[m]
[voice]	-	+	+
[nasal]		-	+

## Underspecification and variation

- A second point mentioned by Trubetzkoy (and taken up by Dresher): lack of contrast can give rise to phonetic variation.
- He mentions German /r/: Standard [ʀ] but also [r, r̥, R, ʀ ...] (similar rhotic variation also found in other languages).
- Reason: Lack of oppositions. /r/ is a sonorant that is neither nasal, nor lateral. The rest is phonetic freedom.
- In other languages, /r/ shows less variation because it is embedded in a different system of contrasts.
- This link between contrast and phonetic variation was all but forgotten in (early but not only) generative phonology.

## Underspecification in SPE

- SPE maintains underspecification (and abandons it in a footnote). What is Chomsky & Halle's motivation for underspecification?
- Model: rules-only. But where does it say what a possible segment/phoneme is?
- How does the grammar know that there is no /θ/ in Polish? Or that there is no distinction between /ɸ/ and /s/ in English?
- And why is *blink* a possible word, but *\*bnick, lbick* aren't?
- The early generative answer: underspecified inputs, predictable feature fill-in.

## Morpheme Structure Rules

- Idea going back to Halle (1959): rules provide predictable features, given the phoneme inventory and phonotactic constraints.
- **Blank-filling rules** (Harms 1968); non-contrasts are not provided.
  - In English, contrast between /θ/ and /s/: segments must be specified as [±strident].
  - In Polish no such contrast, only /s/: Leave [strident] unspecified, blank-filling rule provides value ([+strident]). (From where? Wait ...)
- **Sequential constraint rules**: further feature values can be provided by rule taking into account phonotactic restrictions.
- Let's look at this for a second ...

## Sequential constraint rules

- Consider the word *street*. Initial cluster /str/. What is predictable?
- First step: what are possible CCC-clusters?
  - C1 always /s/, thus all is needed is [+cons]
  - C2 must be one of /p t k/, so all we need is place of articulation
  - C3 must be /r/ because /str/ is the only CCC cluster starting with /st/
- Thus, all we need to say is  
[+cons] [+cons, +coronal] [+cons]
- And then we need (quite a lot of) very specific fill-in rules.

## Filling in rules

- Some of these rules may be language-specific, learned.
- The other origin of rules: linking rules and universal marking conventions.
- For example, the unmarked value for obstruents is [-voice], for sonorants it is [-voice].
- Idea in SPE: At underlying level, replace [±X] with values *u* and *m*. Segments can be specified as [*u* voice], for example.
- Values are translated into + and - at the beginning of a derivation; missing values are also inserted at the beginning.
- Underspecification: only in the lexicon. You don't ever 'see' it.

## Morpheme Structure Conditions

- Stanley's (1967) way out of this mess: **MSCs**
- = statements of what is and isn't a possible morpheme (phoneme inventory, phonotactic constraints, etc.).
- Generalisations are stated directly.
- Stanley also points out some additional formal problems with underspecification, for example that it introduces ternary contrast into a supposedly binary system (features can be +, – or  $\emptyset$ ).
- Chomsky & Halle recognise this in a footnote and quietly abandon their own proposal — as did the rest of the field.
- Underspecification was dead for the next 15 years.

## The return of underspecification

- In the mid-1980s there was renewed interest in underspecification.
- Reasons:
  - Representational economy
  - Markedness relations
  - Phonological activity
- Two main 'schools': Radical and Contrastive Underspecification.

## Radical Underspecification

- Foundational work by Kiparsky (1982, 1985), developed in detail by Archangeli (1988a, b).
- Basic idea: get rid of as many feature specs as possible.
- Along the way, capture markedness statements (e.g. un marked segments as featureless and thus ideal epenthetic segments).
- Some idea that there is a link to phonological activity but not particularly developed; general notion that missing values need to be inserted before the first rule applies that references the feature value.
- Let's look at the formal details, however briefly.

## Radical Underspecification

- First principle: only one value '+' or '-' can be specified underlyingly for a feature (avoids ternarity problem).
  - Complement rules fill in the opposite value.
- Second principle: markedness is captured by rules.
  - Default rules provide unmarked feature values.
  - e.g. [+low] -> [-high], [+son] -> [+voice]
- Complement rules and default rules are 'cost-free', can be complemented with language-specific rules, but these carry some 'cost' and are therefore avoided.

## Example

	/i/	/e/	/a/	/o/	/u/		/i/	/e/	/a/	/o/	/u/
[high]		-		-			+				+
[low]			+						+		
[back]				+	+					+	+

(a)

[+low] → [-high]  
 [+low] → [+back]

[ ] → [-low]  
 [ ] → [+high]  
 [ ] → [-back]

(b)

[+low] → [+back]

[ ] → [-low]  
 [ ] → [-high]  
 [ ] → [-back]

## Contrastive underspecification

- The basic idea behind contrastive underspecification was first formulated in Kiparsky (1985): non-contrastive feature values may also be inactive — invisible to the phonology.
- Example: We already established that [+sonorant] implies [+voice] — all sonorants are voiced (in English, German, Polish ...).
- Now processes that involve the feature [±voice] typically ignore sonorants, e.g. final devoicing in German, voicing assimilation in Polish.
- Kiparsky: Underspecified segments stay underspecified throughout the lexical phonology; missing values are inserted postlexically, can be affected by postlexical rules.

## Some evidence

- Lateral dissimilation in Latin  
 men-alis      dent-alis      nas-alis  
 stell-aris      pol-aris      vel-aris
- /l/ in suffix unless /l/ in stem — then [+lat] → [-lat]
- plur-alis      flor-alis      later-alis
- No dissimilation, blocked by intervening /r/.
- Why does /r/ block it? It's the [-lat] liquid.
- But: Given full specification, all segments bar /l/ should be [-lat]; why does only /r/ block it?
- Laterality only contrastive for /l – r/. All other segments underspecified

## Some more evidence

- Additional evidence comes from transparent segments in vowel harmony systems.
- e.g. Hungarian (see Dave's class). Back harmony. Harmonic pairs /u-y, o-ø, a-e/. Seventh vowel /i/ unpaired, is ignored by harmony — harmony skips across intervening /i/
  - stem      dative      ablative      gloss  
 ház      háznak      háztól      'house'  
 föld      földnek      földtől      'ground'  
 radír      radírnak      rádirtól      'eraser'
- Solution: /i/ is underspecified for [back], as there is no contrast.

## How to underspecify?

- How do we know which feature values should be left out? No really clear underspecification algorithm.
- Archangeli attempts a formalism based on pairwise comparison. Idea: identify all pairs that are distinguished by one feature specification: These are contrastive pairs, their values are protected.
- Then remove all values that are 'unprotected' = not marked as contrastive. Archangeli: doesn't always work.
- Note: Both radical and contrastive underspecification are 'subtractive' — starting point is full specification, then values are taken away, to be added later again, in the derivation.

## Example

	[i]	[e]	[a]	[o]	[u]	
[high]	+	-		-	+	{i-e}; {o-u}
[low]			+	-		{a-o}
[back]	-	-		+	+	{i-u}; {e-o}

## Surface underspecification?

- So far the assumption has been that all feature values are inserted in the course of a derivation. Are they?
- Keating (1988): maybe not. Evidence from phonetics.
- Segments may lack clear articulatory targets. For some articulatory parameters, production seems to be interpolated from flanking segments.
- For example no oral features for /h/, lip rounding on /t/.
- Choi (1995) on Marshallese — 3 vowel phonemes, different heights. Backness and rounding follow from flanking consonants, which can be labialised, palatalised, or velarised.
- How about cases of reduced / non-contrastive / variable gestures?

## Feature privativity

- Touched upon yesterday: features may be privative, not binary.
- Formalises idea that one value of a feature may never be phonologically active. Reason: it doesn't exist.
- (Also takes up point in Radical Underspecification where only one value is specified underlyingly.)
- Argument for place features — made yesterday.
- Same holds for [nasal]. Non-nasals don't seem to be a class.
- Could make argument for [voice] as well but under the assumption of additional structure, to be discussed on Friday.
- Could all features be privative?



## Some consequences

- There is no such thing as a fully specified segment.
- Every segment bears a certain number of privative features, but number of features is different; one may bear none (everything [-F] in binary model).
- Also leaves phonetic targets partially unspecified. Does privativity require a more autonomous phonetic interpretation module?
- Some evidence that there is greater phonetic variability in unspecified segments, e.g. German [s.g.] stops are predictably aspirated, while the other stops show variable and gradient voicing effects.
- Do features only mark salient phonetic properties with additional properties added in phonetics?

## Additive or subtractive?

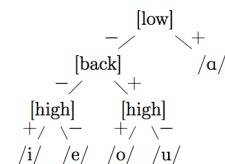
- Original assumption: start fully specified, then remove predictable feature values (subtractive approach).
- Then put the missing values back in in the course of the derivation.
- Alternative: Build representations bottom-up, on the basis of contrast.
- Outputs remain variably 'underspecified'. There is no fully specified matrix.
- Approach supported by privativity, though it can also be done with binary features.

## The Contrastive Hierarchy

- Most recent systematic approach to underspecification; Dresher (2009) and the 'Toronto School'.
- (By the way, yes, underspecification was dead again for a while, because OT. Should we talk about that?)
- Idea that there is a contrastive hierarchy of features — segments are divided up along the hierarchy until all segments are contrastively specified. And then it stops.
- This is known as the **Successive Division Algorithm** (SDA). Let's see how it works, with the 5-vowel system.

## Examples

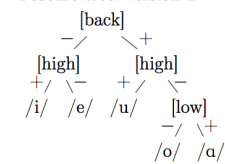
Feature tree: version 1



Feature matrix

	/i/	/e/	/a/	/o/	/u/
[high]	+	-	-	-	+
[low]	-	-	+	-	-
[back]	-	-	-	+	+

Feature tree: version 2



Feature matrix

	/i/	/e/	/a/	/o/	/u/
[high]	+	-	-	-	+
[low]	-	-	+	-	-
[back]	-	-	+	+	+

## Full specification?

---

- Should we add redundant features later? Not fully clear in Drescher's original proposal, but later proposal by Hall (2011): no.
- Hall takes original idea of enhancement from Stevens & Keyser (1989) — that some features are there for basic contrasts, while others are there to enhance them.
- But he pushes it into phonetic implementation. Additional gestures/cues are added to enhance and stabilise contrasts, but these can be gradient, optional — not phonology.
- Consequence: a more complex and 'smarter' phonetic implementation module. No universal phonetics, but phonetics interpreting features and freely adding stuff on dimensions that are underspecified — more next week!

## Summary

---

- Underspecification is an old concept. Reasons for it have changed, though, as well as the level, at which it holds.
- Originally, only lexicon is underspecified, then it persists into the derivation, now it can persist on the surface.
- Reasons also shifted from lexical economy and markedness to expressing contrast and phonological activity: underspecification becomes 'visible'.
- My suggestion: We can also use it to get a clearer idea of gradient vs. categorical distinctions. Gradient phonetic phenomena emerge where segments are un(der)specified. Stay tuned ...

## Questions?

---