The Correct Notion of Substructure in Phonology

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Overview

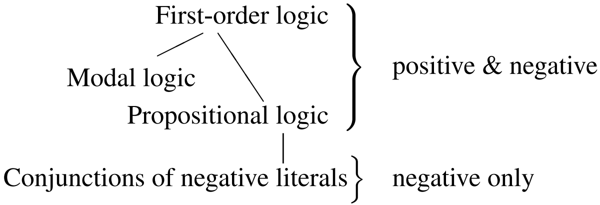
- Markedness (/output/surface) constraints constitute our theory of how grammars decide well-formedness of phonological structure
- The content of markedness constraints is not arbitrary (Eisner, 1997; de Lacy, 2011; Rogers et al., 2013)
- The most restrictive theory of markedness holds that constraints are entirely *negative*; meaning they can only forbid substructures (Jardine and Heinz, in press)

Overview

- However, there are instances of the *superstructure problem*, where some patterns cannot be captured using certain notions of substructure (Jardine and Heinz, in press; Jardine, 2016; Danis, 2017)
- We propose a strong definition of substructure that can capture these cases in a unified way and maintains a restrictive, *negative* conception of markedness
- We use *model theory*, which gives precise definitions of representations and constraints

Banned substructure constraints

- Many markedness constraints identify illicit pieces of a representation
  Ex., *NC̥, *CODA, *[voice]
- A restrictive theory of markedness *only* allows constraints of this type



(Rogers et al., 2013)

- How do we define ‘piece’?

Banned substructure constraints

- Jardine and Heinz (in press) and Jardine (2016) take the following definition from the notion of subgraph
- Fix a signature with elements D and (binary or unary) relations $R_1, ..., R_n$

$$\mathcal{S} = \langle D; R_1, R_2, ..., R_n \rangle$$

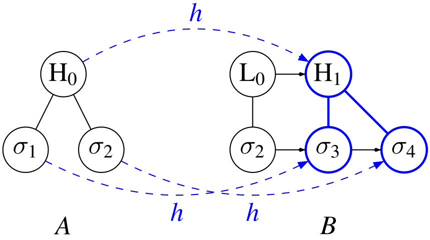
Definition (Weak substructure)

For two structures A and B in $\mathcal{S}$, A is a substructure of B iff there is a mapping h from D^A to D^B such that

- for every unary relation R_i, $d^A \in R_i$ in A implies $h(d^A) \in R_i$ in B, and
- for every binary relation R_j, $(d_1^A, d_2^A) \in R_j$ in A implies $(h(d_1^A), h(d_2^A)) \in R_j$ in B

Banned substructure constraints

"Hs should not be multiply associated"



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The superstructure problem

- The weak definition captures many markedness constraints, but not all (Jardine and Heinz, in press; Danis, 2017)
- There are markedness constraints that appear to *require* structure
- A variety of markedness generalizations cause what we call the *superstructure problem* under the weak definition, which we propose to solve by positing a stronger definition

The superstructure problem

Aghem (Hyman, 2014)

- When H tone is followed by L, it spreads to the right:
  a. /é - nòm/ → [é - nôm] ‘to be hot’
  b. /fú - kìa/ → [fú - kîa] ‘your sg. rat’
  c. e-nom → e-nom [é - nôm] ‘to be hot’

```
   e-nom    →    e-nom
   |   |         |/ |
   H   L         H  L
```

- Constraint: “H must spread to a following L-toned mora”

The superstructure problem

- We can't posit this as a banned substructure constraint using the weak definition

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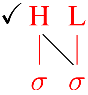

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$$* \quad \begin{array}{c} C \\ | \\ \text{place} \end{array}]_{\sigma}\, C \qquad\qquad \checkmark [CV\, \begin{array}{c} C]_{\sigma}\, C \\ \;|\;\;\, / \\ \text{place} \end{array} V$$

The superstructure problem

- These are just two examples, but the same issue arises elsewhere:
  - Ngbaka coocurrence restrictions on complex consonants (Danis, 2017)
  - Spreading in Tingrinya and other languages (Hayes, 1986)
  - Constraints like SPEC-T ("Syllables must be specified for tone"; Yip, 2002))

A strong definition of substructure

Definition (Strong substructure)

For two structures A and B in $\mathcal{S}$, A is a substructure of B iff there is a mapping h from D^A to D^B such that

- for every unary relation R_i, $d^A \in R_i$ in A **iff** $h(d^A) \in R_i$ in B, and
- for every binary relation R_j, $(d_1^A, d_2^A) \in R_j$ in A **iff** $(h(d_1^A), h(d_2^A)) \in R_j$ in B

A strong definition of substructure

- The strong definition requires that any relation between elements in the superstructure also belong in the superstructure

Definition (Strong definition of substructure)

...

- for every binary relation R_j, $(d_1^A, d_2^A) \in R_j$ in A **iff** $(h(d_1^A), h(d_2^A)) \in R_j$ in B

- This solves the superstructure problem both in Aghem and CODACOND:

Discussion

- Any structure A that is a substructure of B under the strong definition will also be a substructure under the weak definition
- Logic of the grammar is still the same, so negative markedness constraints are still computationally simple (Jardine and Heinz, in press)
- The two definitions are equivalent with respect to strings, but with non-string structures the stonger definition is strictly more expressive

Discussion

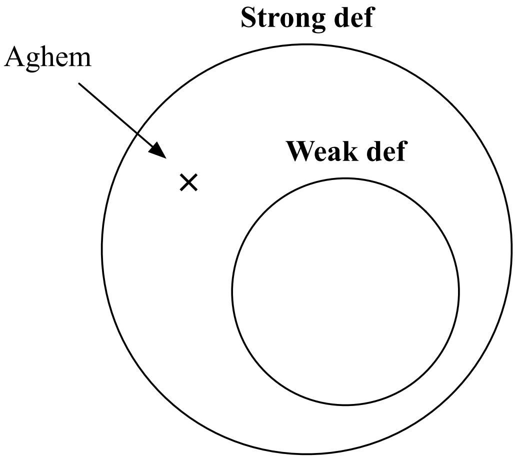

Figure: Graphsets captured by strong definition are a strict superset of those captured by weak definition

Discussion

- The strong definition does not, by itself, capture all cases of the superstructure problem
- Place restrictions in Ngbaka complex consonants (Danis, 2017) require assuming a spreading analysis
- Constraints like SPEC-T still require explicit marking of unspecified units

  SPEC-T: $*\textcircled{\sigma}$ (notation from Pulleyblank, 1986)

Conclusion

- An explicit theory of markedness requires an explicit definition of substructure
- The *strong* definition proposed here accounts for a wider range of markedness generalizations with negative constraints

Thank You

References I

Danis, N. (2017). *Complex place and place identity*. PhD thesis, Rutgers University.

de Lacy, P. (2011). Markedness and faithfulness constraints. In Oostendorp, M. V., Ewen, C. J., Hume, E., and Rice, K., editors, *The Blackwell Companion to Phonology*. Blackwell.

Eisner, J. (1997). What constraints should OT allow? Talk handout, Linguistic Society of America, Chicago. ROA#204-0797. Available at http://roa.rutgers.edu/.

Hayes, B. (1986). Assimilation as spreading in Toba Batak. *LI*, 17(3):467–499.

Hyman, L. (2014). How autosegmental is phonology? *The Linguistic Review*, 31:363–400.

Ito, J. (1986). *Syllable Theory in Prosodic Phonology*. PhD thesis, UMass Amherst.

Ito, J. and Mester, A. (1994). Reflections on codacond and agreement. *Phonology at Santa Cruz*, 3:27–46.

References II

Jardine, A. (2016). *Locality and non-linear representations in tonal phonology*. PhD thesis, University of Delaware.

Jardine, A. and Heinz, J. (in press). Markedness constraints are negative: an autosegmental constraint definition language. In *Proceedings of CLS 51*.

Pulleyblank, D. (1986). *Tone in Lexical Phonology*. Dordrecht: D. Reidel.

Rogers, J., Heinz, J., Fero, M., Hurst, J., Lambert, D., and Wibel, S. (2013). Cognitive and sub-regular complexity. In *Formal Grammar*, volume 8036 of *Lecture Notes in Computer Science*, pages 90–108. Springer.

Yip, M. (2002). *Tone*. Cambridge University Press.