Realizational Morphology in a Modular Minimalist Grammar

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- **Modular minimalist grammars with realizational morphology are briefly motivated and defined**

  modular = relatively independent components separated

  realizational = atoms of syntax not pronounced words

- **Captures generalizations missed by previous MGs and many other generative grammars**

Paper, slides, code: https://github.com/epstabler/mol25

Something generative grammars systematically miss?

Chomsky&Lasnik'77, Lasnik'00: "*Syntactic Structures* makes the claim that there could be another language just like English but where Affix Hopping is optional. The theory we're looking at now . . . makes the claim that there couldn't be any such language.

Affix Hopping and DO-Support. . . describe but don't capture the. . . generalization: *A stranded affix is no good*. "

Bresnan'00: "To counter the fact that DO is ungrammatical elsewhere, there must be a constraint that penalizes its presence"

Grimshaw'97, Sag'11: "[DO is] necessary whenever it is possible"

Non-lexicalist, late insertion, realizational theories

Kayne'93: "There is no auxiliary selection rule"

Bjorkman'11: "BE is not directly selected for, but is instead inserted to support inflectional material that was unable to combine with a main verb"

Olivier'25: "HAVE and BE are allomorphs"

Kalin&Weisser'25:
"Combining all the evidence. . . the most adequate model:"
non-lexicalist (syntactic word-building),
post-syntactic (syntactic atoms have no phonology),
phonology 'realizes' features but not in lexical increments

Modular vs monostratal

Let **monostratal** = each rule application builds one piece of structure

Examples: CFG, MCFG, CG, CCG, TAG, 1990's MG,...

Let **modular** = each piece of structure respects a number of relatively independent, separately stated constraints

Examples: Most of theoretical linguistics

Here: A (simple, preliminary) modular formulation of MG, with realizational morphology, close to recent Chomskian proposals

A modular grammar

mrg:	accepts/transduces binary trees over finite set of atoms
sel:	checks match of selection features
agr:	checks match of agreement features
hm:	move heads to highest accessible 'strong' positions
lin:	linearize
vi:	vocabulary insertion

The derived **(tree) language** is the range of the composition g

$$g = vi \circ lin \circ hm \circ agr \circ sel \circ mrg$$

1. mrg

mrg: an identity trandsuction on binary trees

$$\text{mrg t} = \begin{cases} \text{t} & \text{if t is an atom} \\ \text{S (mrg x) (mrg y)} & \text{if t} = \text{S x y} \end{cases}$$

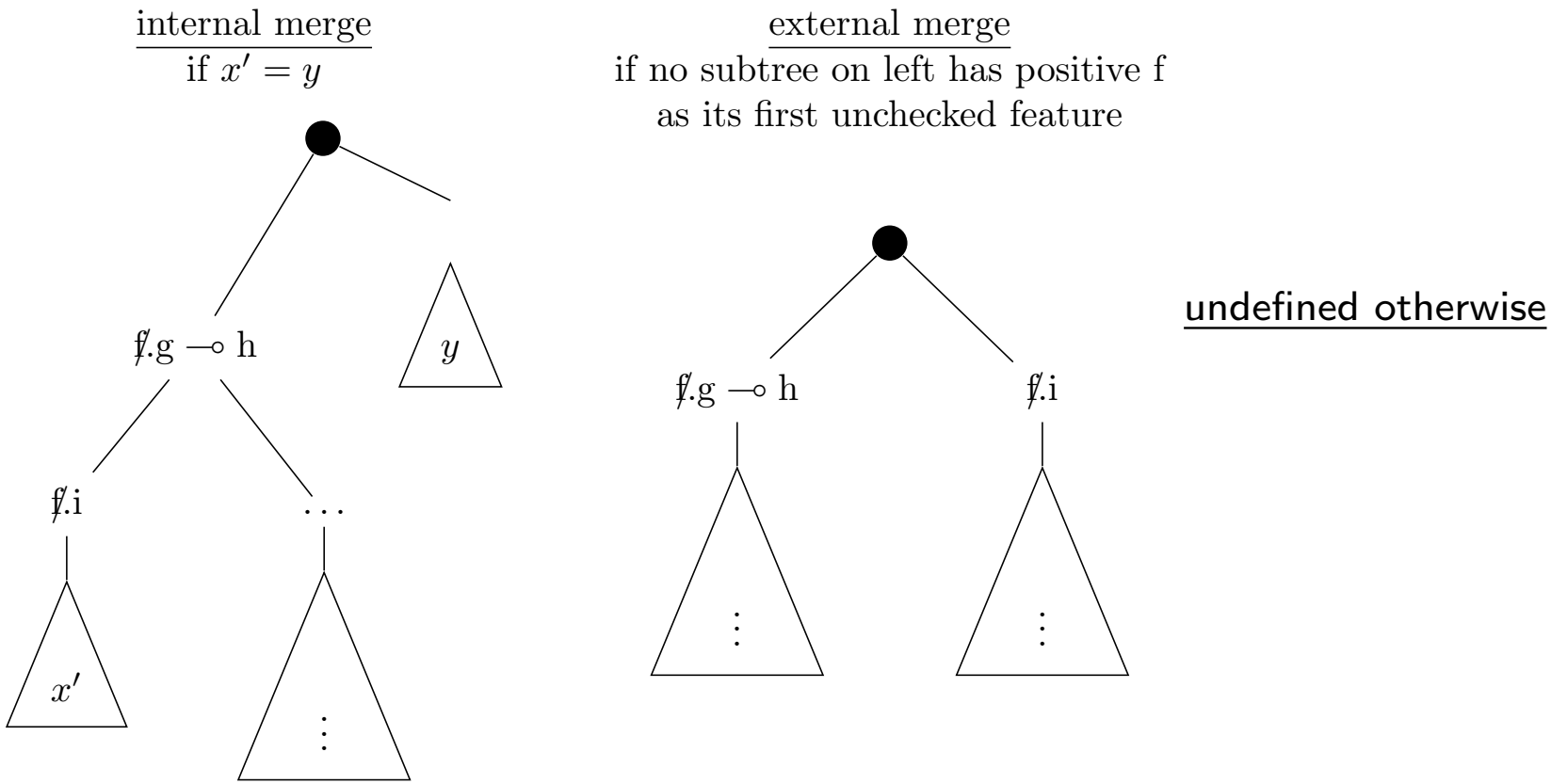
where the atoms have the form:

$$\begin{array}{lcll} \surd\text{destroy} & : & \text{D.D} & \multimap \quad \text{V} \\ \surd\text{destroy} & : & & \quad \text{N} \end{array}$$

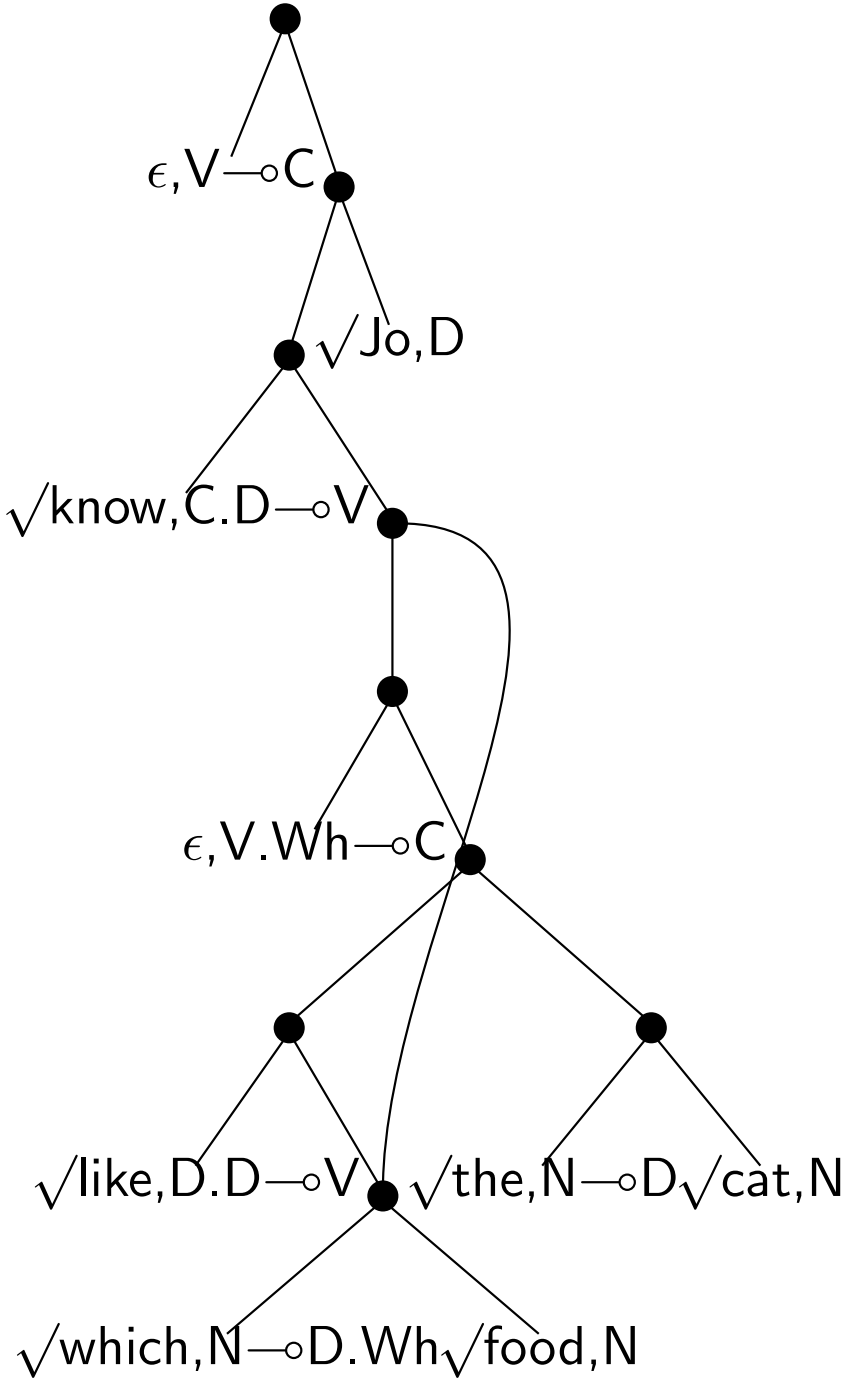
2. sel

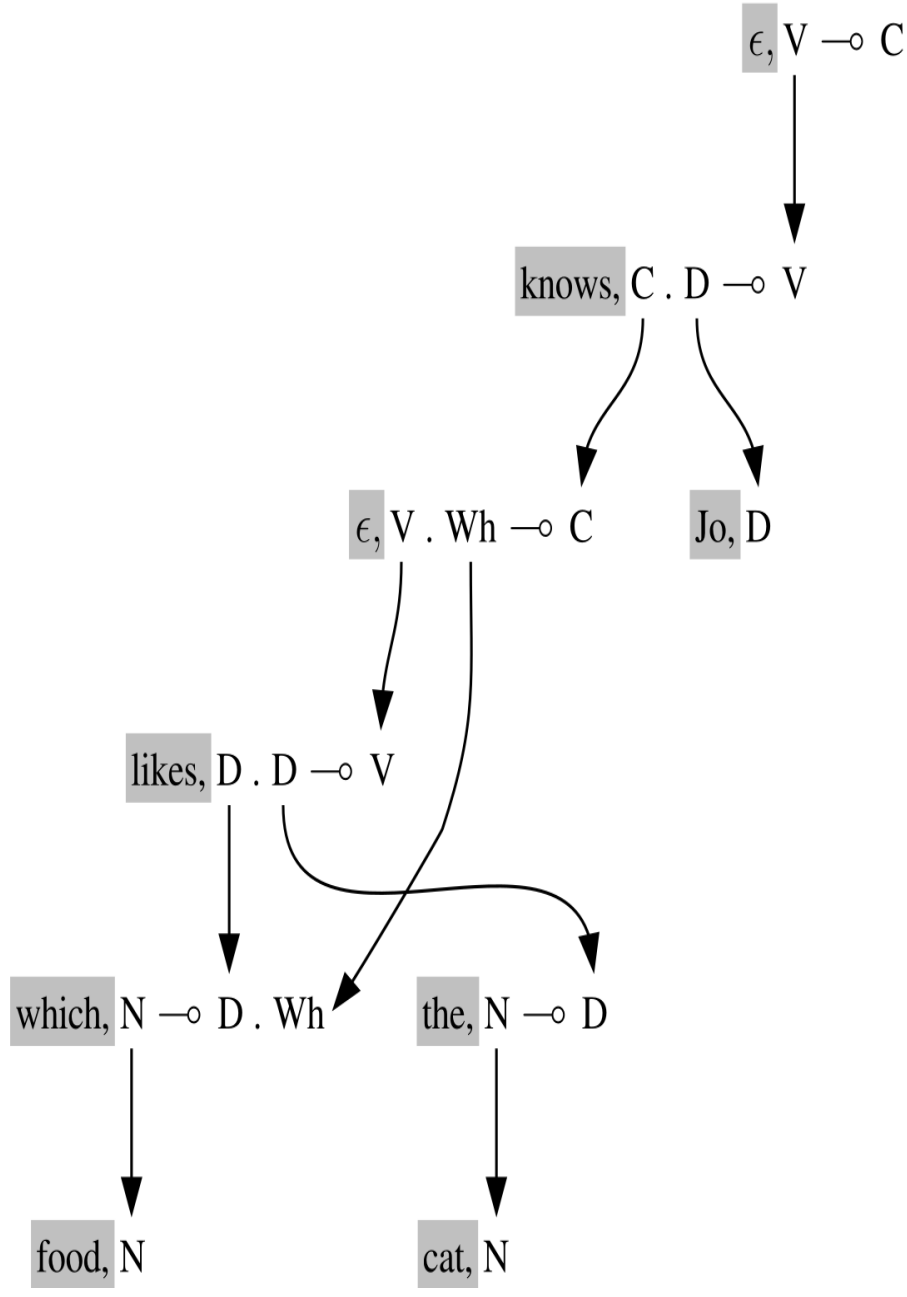
$$\text{sel } x = \begin{cases} x & \text{if } x \text{ is labelable} \\ \text{undefined} & \text{otherwise} \end{cases}$$

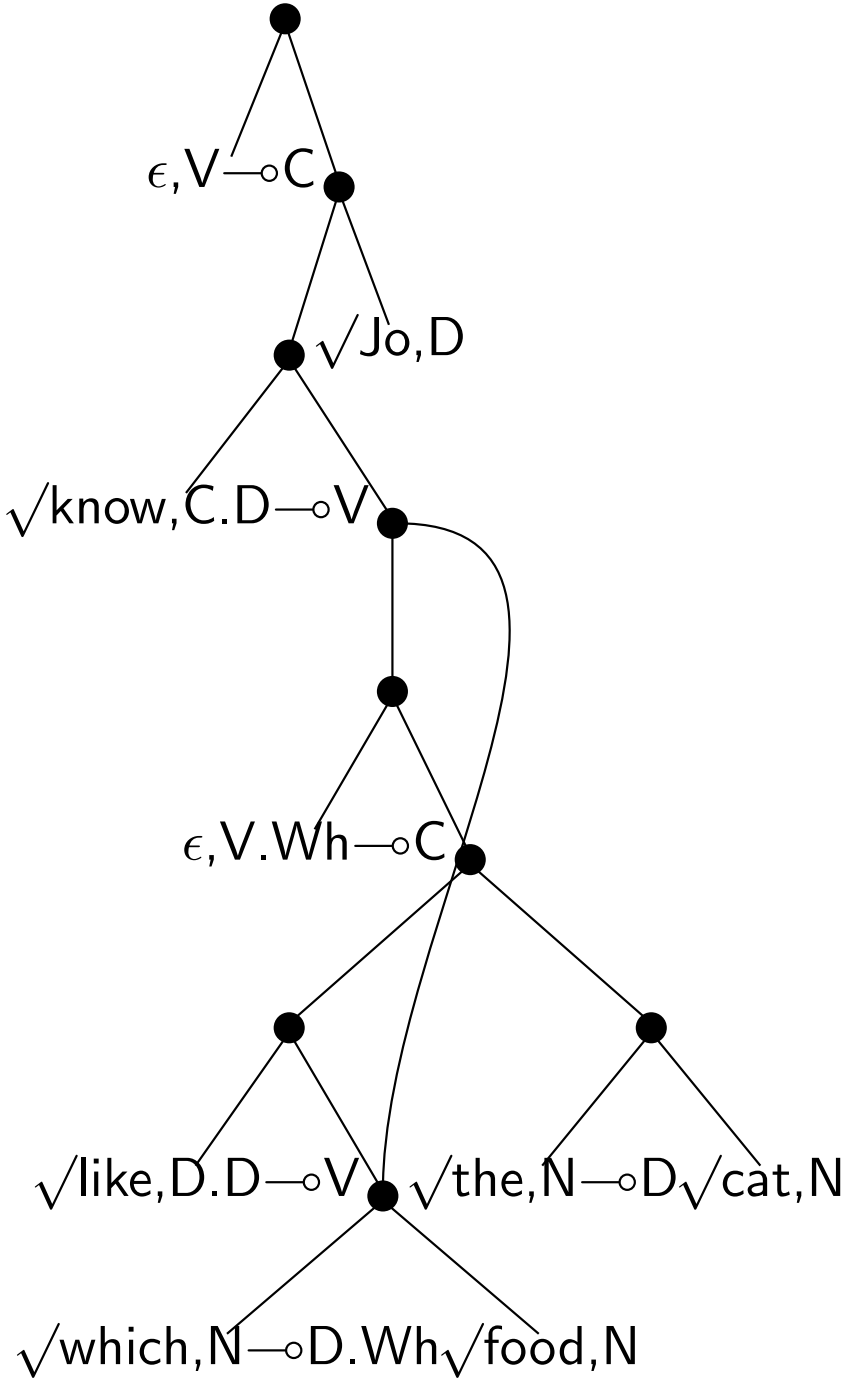
- Labeling checks features of opposite polarities, in order. . .

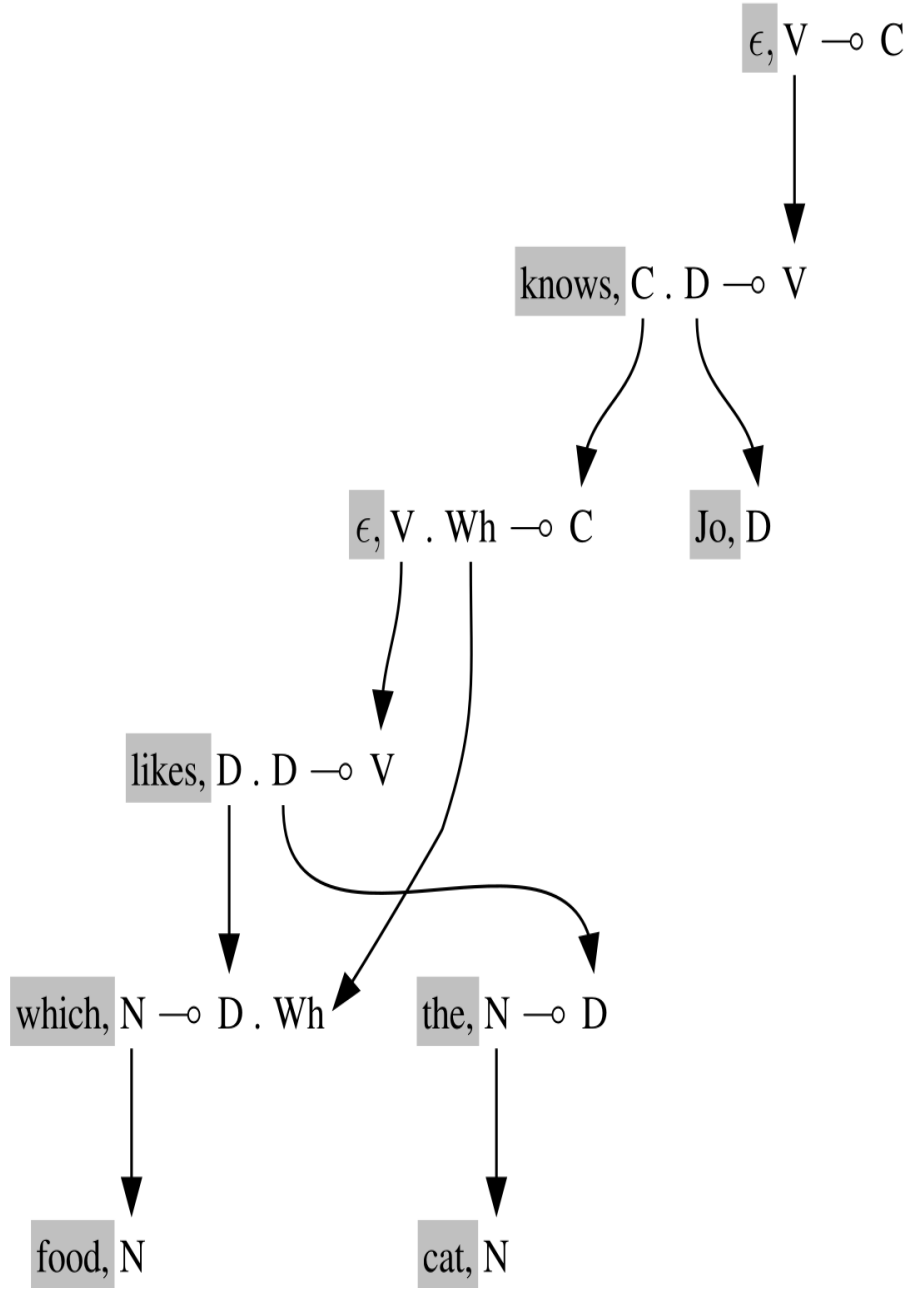


if (smc) no two subconstituents have same first unchecked feature.


ϵ,V—∘C
√Jo,D
√know,C.D—∘V
ϵ,V.Wh—∘C
√like,D.D—∘V
√the,N—∘D
√cat,N
√which,N—∘D.Wh
√food,N


ϵ, V —∘ C
knows, C . D —∘ V
ϵ, V . Wh —∘ C
Jo, D
likes, D . D —∘ V
which, N —∘ D . Wh
the, N —∘ D
food, N
cat, N



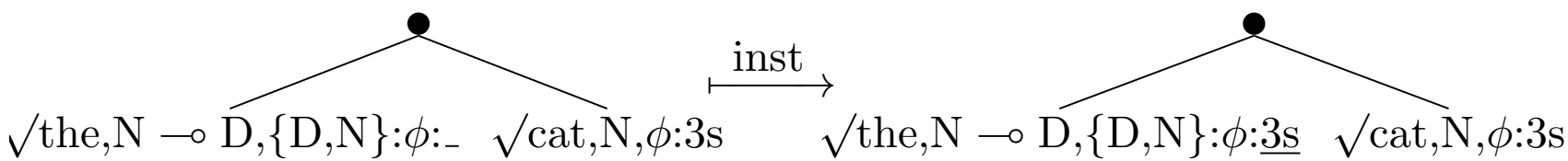


note: labeling is efficient, but smc blocks multiple wh extraction – too strict

3. agr

$$\text{agr t} = \begin{cases} \text{t} & \text{if t can be instantiated} \\ \\ \text{undefined} & \text{otherwise} \end{cases}$$

- Atoms given set of type:value features, each with a tier, where tier $\approx$ features of visible heads on spine
- 'probe' ϕ:_ or ϕ:$\underline{\text{3s}}$ instantiated by 'goal' ϕ:3s, in bottom-up order, in 'tier-adjacent' head (Béjar&Rezak'09) (Hanson'23)



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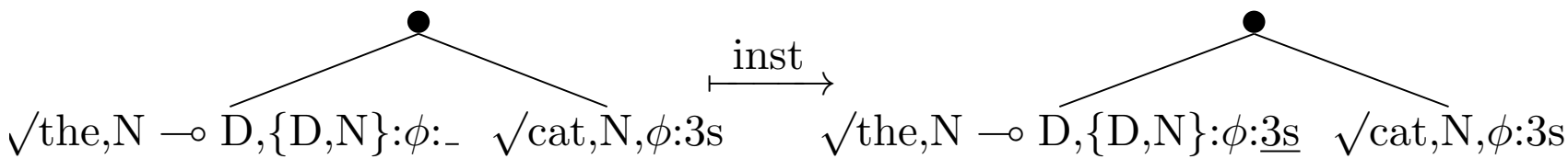
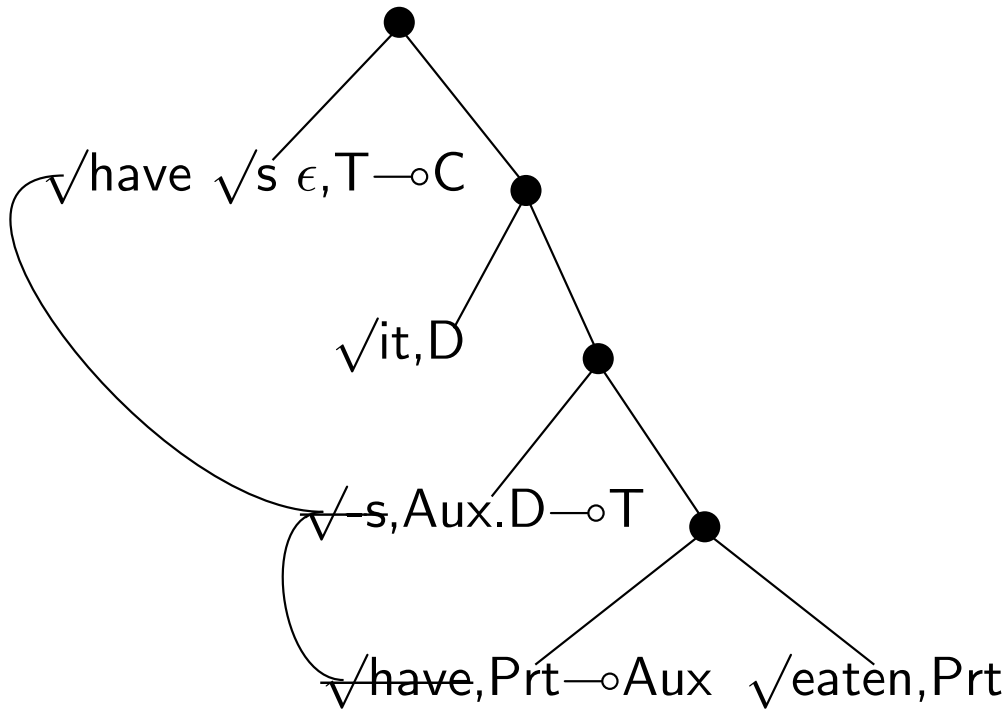


Conjecture: adapting Ermolaeva&Kobele'22, instantiated trees are MCF

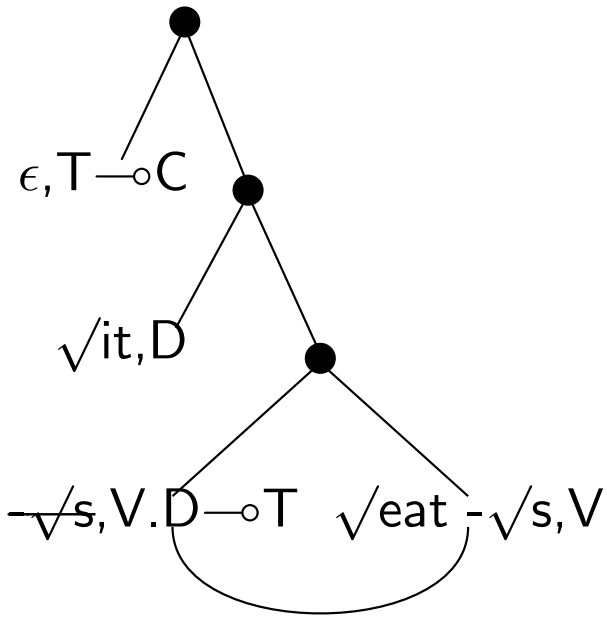
4. hm

Heads can be raised from the phrases they form



4. hm

Heads can also be lowered from the phrases they form



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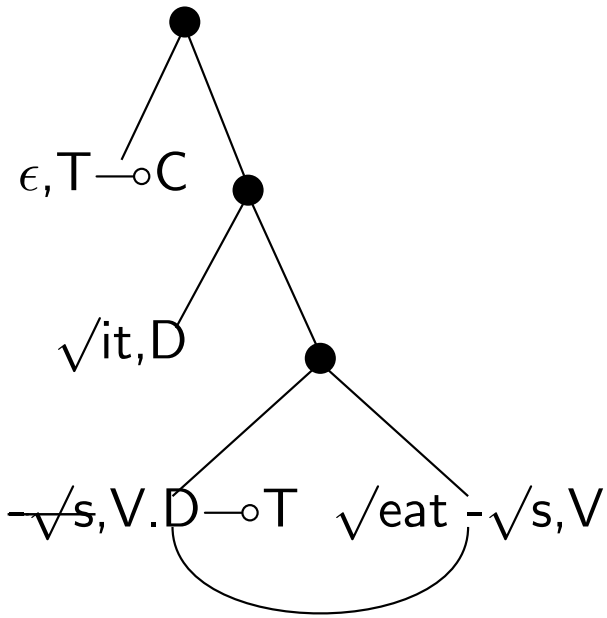

Stabler'01: Folded in with mrg, sel, and lin: 5 MG rules $\Rightarrow$ 13

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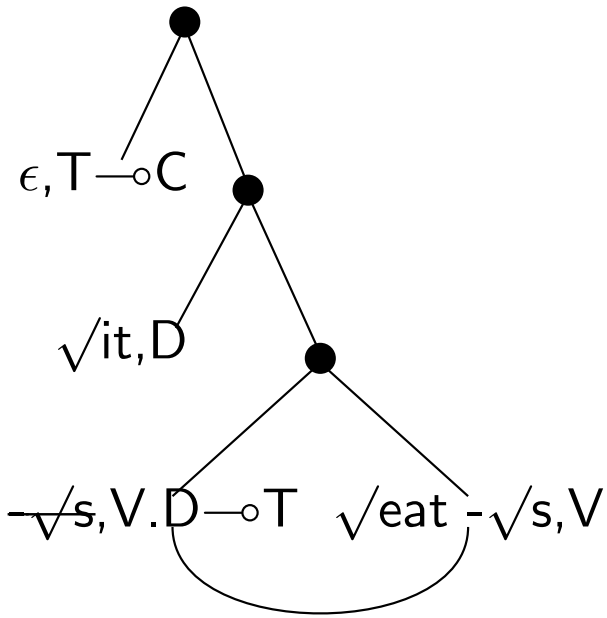

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Chomsky'01: There are some reasons to suspect that a substantial core of head-raising processes. . . may fall within the phonological component.

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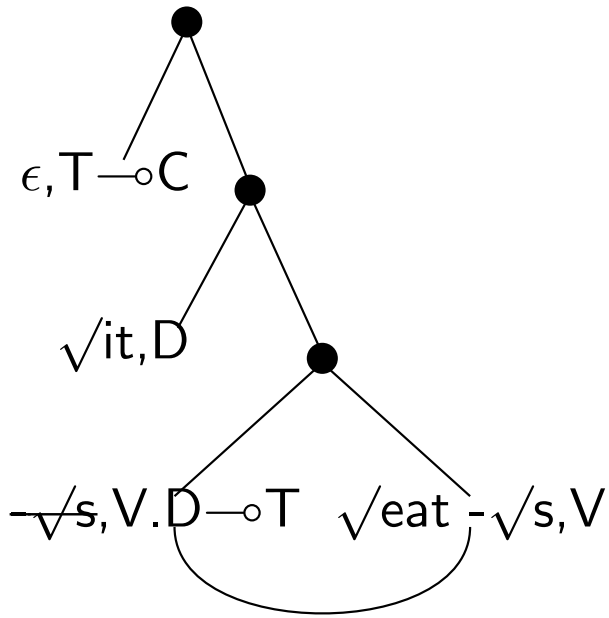
Heads can also be lowered from the phrases they form



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Chomsky&al'23: 'Head Movement' (or at least a subset of phenomena going under that name) may . . . be a post-syntactic operation,. . .

4. hm

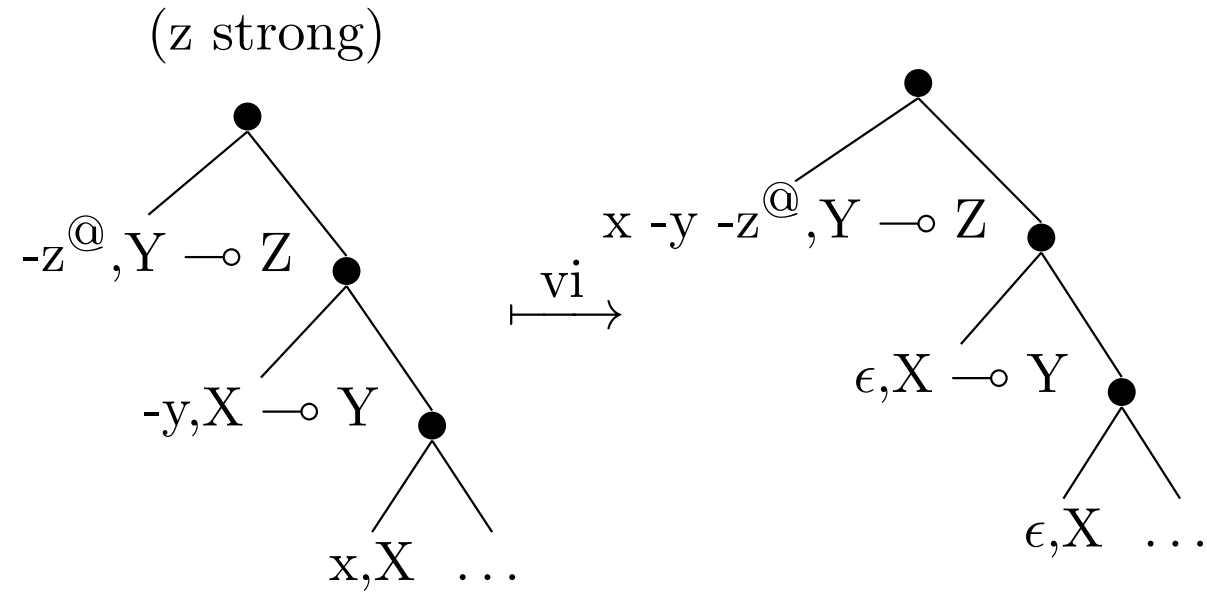
Head movement determined by 2 diacritics (Arregi&Pietrazko'21)

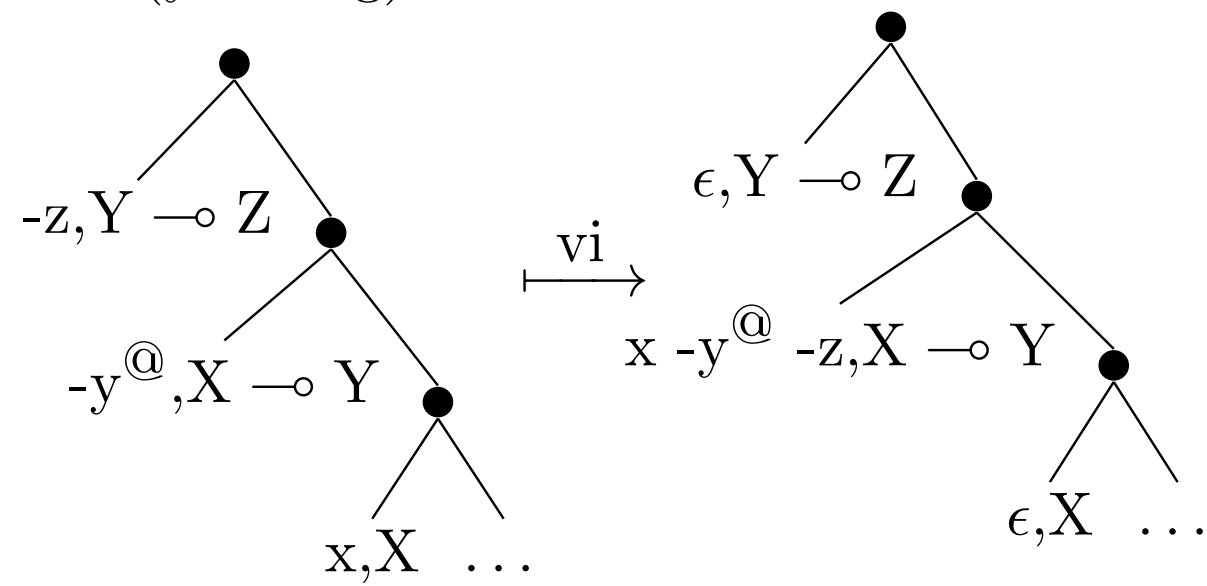
- Diacritics: -$\sqrt{}$root is 'dependent', $\sqrt{}$root$^{@}$ is 'strong'
- In a maximal, non-recursive sequence of first-merged heads:

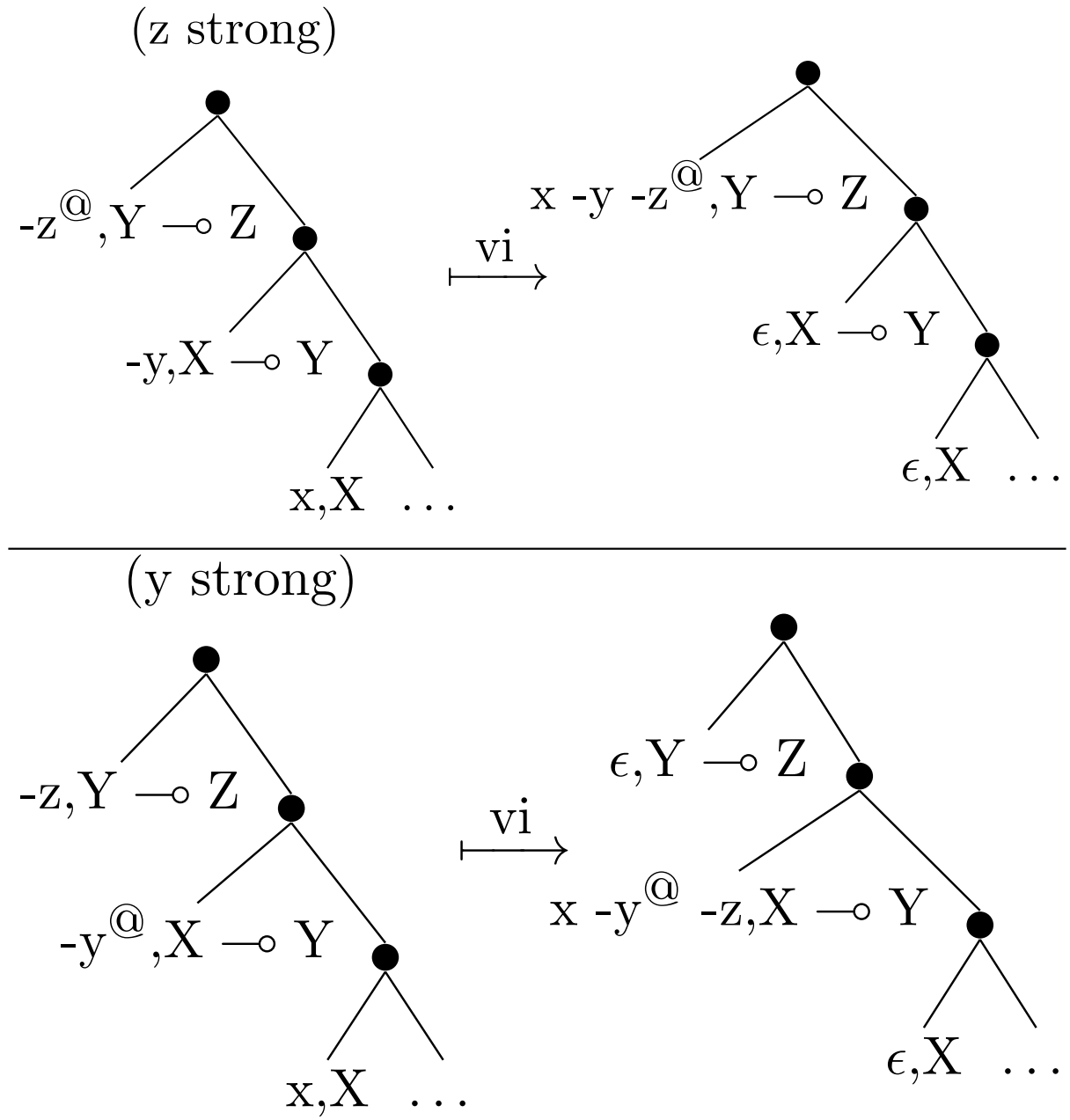
  $$\text{-}h_0,\ \text{-}h_1,\ldots\ \text{-}h_{n-1},\ h_n$$

  – Heads 'roll up', left-adjoining to form $h_n,\ldots$ -h_0.
  – If no head marked @, heads placed in highest position, h0
  – Else: the complex attaches to highest @-marked head

(cf. Brody'98, Svenonius'16, Harizanov&Gribanova'19, Branigan'23,...)


(z strong)
-z@,Y ⊸ Z
-y,X ⊸ Y
x,X …
vi
x -y -z@,Y ⊸ Z
ϵ,X ⊸ Y
ϵ,X …


(y strong)
-z,Y ⊸ Z
-y@,X ⊸ Y
x,X …
vi
ϵ,Y ⊸ Z
x -y@ -z,X ⊸ Y
ϵ,X …



Conjecture: adapting Michaelis'98, Kobele'02, head moved trees are MCF

5. lin

- (ord) Put first merges head-first, else head-final.
  (Kayne'94,'20, Chomsky'95, Cinque'23)

  (del) Delete non-final internally merged elements

  $\text{lin} = \text{ord} \circ \text{del}$

* del is too simple –
  e.g. Yuan'25: deletion of non-final copies blocked when those copies are needed to host affixes, etc

6. vi

- Vi rules phonologially instantiate roots, based on context

$$\sqrt{\text{cat}} \quad \rightarrow \quad \text{cat}$$
$$\phi\text{:3p} \quad \rightarrow \quad \text{-s}$$

  So we transform the leaf

$$(\sqrt{\text{cat}},\text{N},\phi\text{:3p}) \quad \Rightarrow \quad (\text{cat -s},\text{N},\phi\text{:3p}).$$

- More specific rules take precedence, 'blocking' simpler ones:

$$\sqrt{\text{mouse}},\phi\text{:3s} \rightarrow \text{mice}.$$

- vi rules can apply to a complex formed by head movement:

$$\sqrt{\text{chase}}\ \sqrt{\text{past}} \quad \rightarrow \quad \text{chase -ed}.$$

- vi rules can also target spans – sequences of first-selected heads, not marked 'dependent' but in the domain of a vi rule:

$$(\sqrt{\text{de}})\ (\sqrt{\text{el}}) \quad \rightarrow \quad \text{del}.$$

(Halle&Marantz'93,Embick&Marantz'08,Svenonius'16,Haugen&Siddiqi'16,i.a.)

6. vi

- defaults are negative conditions –

  new in MGs, but not new in grammars

  (Buszkowski'95, Groenink'95, Boullier'98, Kracht'98,...)

- MCFGs lack negative conditions –

  so expressible in Horn clauses, parsable in Datalog

  (Kanazawa)

- But here, the competition domains for defaults are finite in number and scope, so still: vi instantiated trees MCF

The modular grammars

mrg:	accepts binary trees over finite set of atoms
sel:	check match of selection features
agr:	check match of agreement features
hm:	move heads to highest accessible 'strong' positions
lin:	linearize
vi:	vocabulary insertion

$$\mathbf{g} = \mathbf{vi} \circ \mathbf{lin} \circ \mathbf{hm} \circ \mathbf{agr} \circ \mathbf{sel} \circ \mathbf{mrg}$$

Each particular g specified by atoms and vi rules

Nominalization

Chomsky'70: common underlying form $\rightarrow$ different pronunciations

The barbarians destroy the city

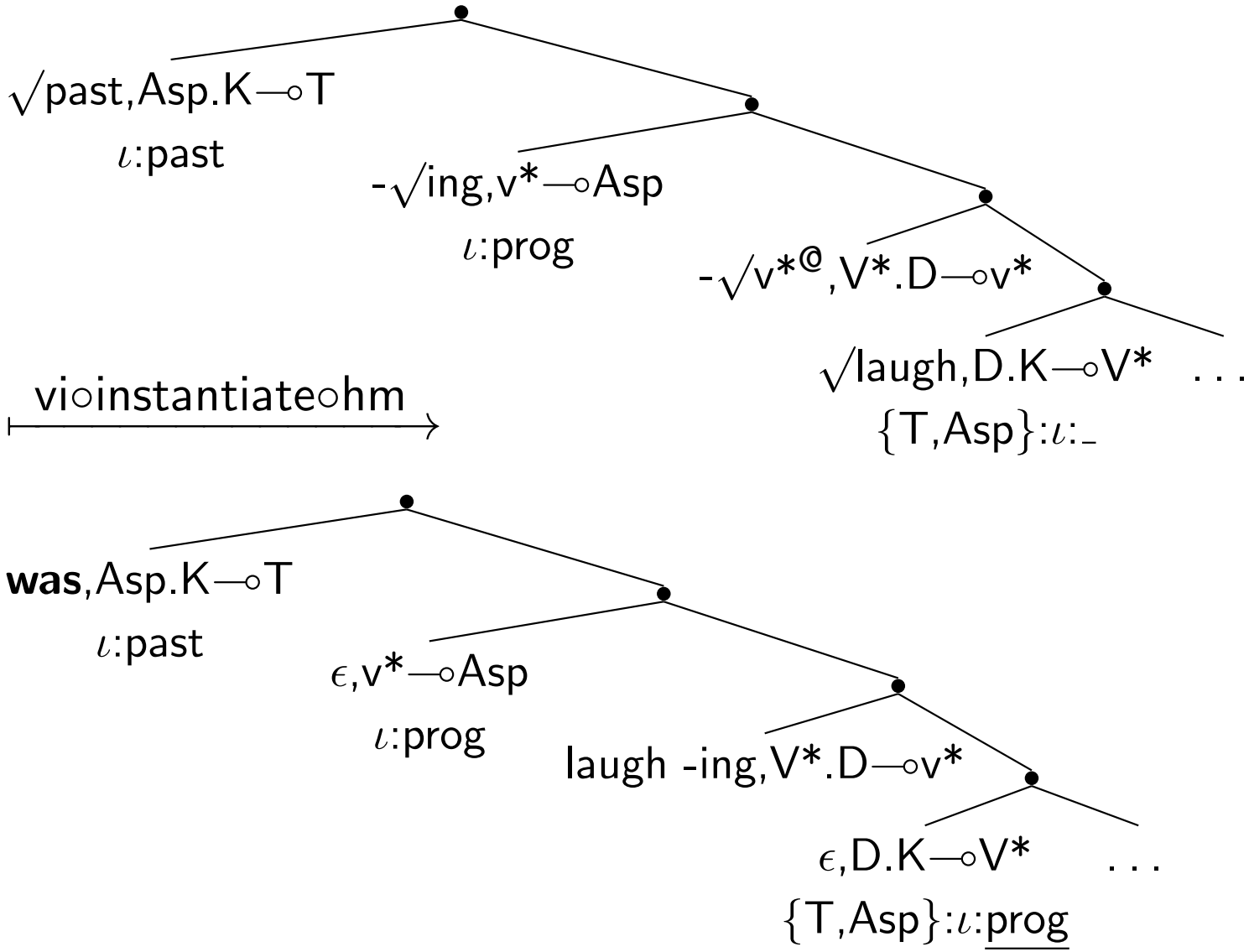
The destruction of the city by the barbarians

The oligarchs capture the markets

The capture of the markets by the oligarchs

$$\begin{array}{rcl} (\sqrt{\text{capture}}) & \rightarrow & \text{capture} \\ (\sqrt{\text{destroy V}}) & \rightarrow & \text{destroy} \\ (\sqrt{\text{destroy N}}) & \rightarrow & \text{destruction.} \end{array}$$

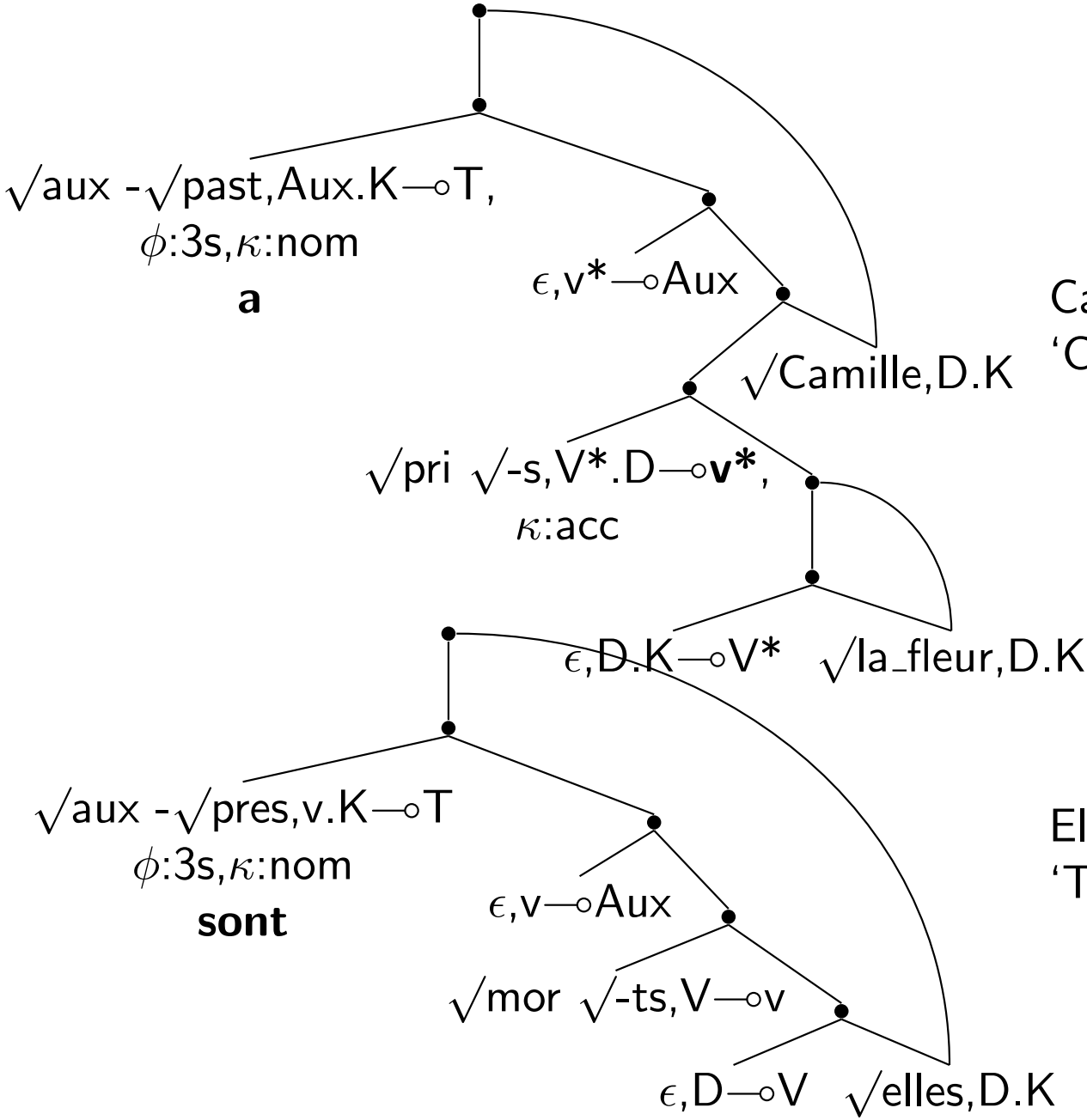
Auxiliaries: English



(Bjorkman'11, Arregi&Klecha'15, Fenger'19, Cruschina&Calabrese'21, i.a.)

Auxiliaries: French

(Olivier'25, Bjorkman'11)

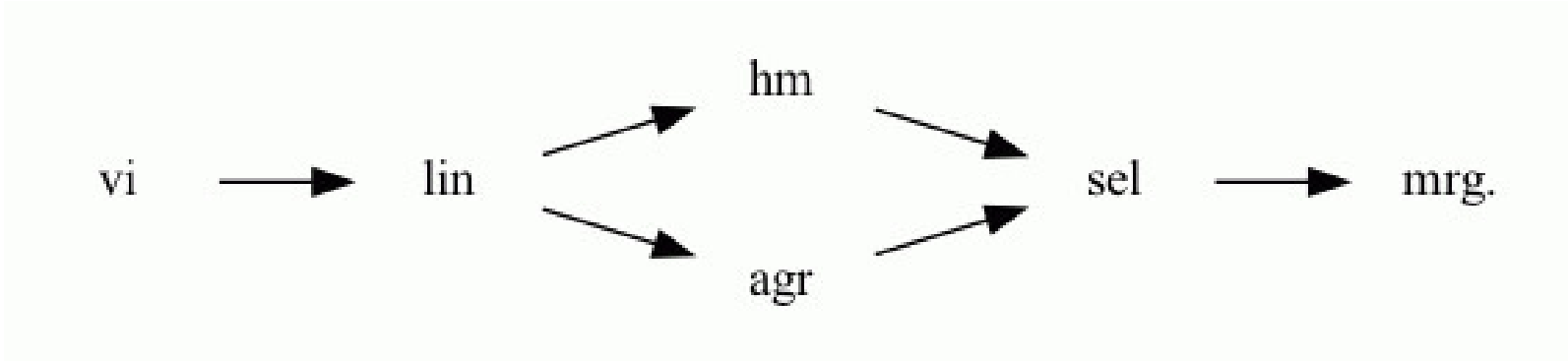


Camille a pri-s la fleur
'Camille took the flower'

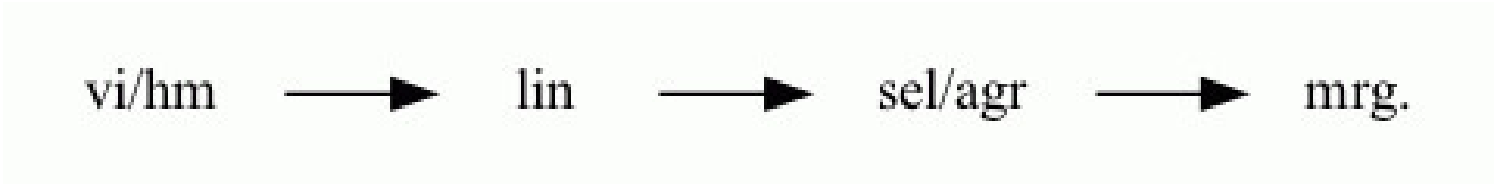
Elles sont mor-ts
'They have died'

Dependencies among modules

- Dependencies more explicit than in rule-based MGs:



- Future work: unify sel/agr in labeling; vi/hm in interface



  – lin is structurally trivial, so dependency arguments weak

Conclusions

MG properties adjusted

- modular; roots; word-forming hm, vi are post-mrg, post-lbl

MG properties preserved: Two conjectures

- Modular grammars (with smc,del) weakly MCF
  - major components already treated (sel, agr, lin)
- MCF parsing/learning may extend easily to del, smc replacements
  - re del: easy extension from MCFGs to 'parallel' MCFGs
  - re smc: distinct, stipulated condition can be replaced

New capture of prominent generalizations

- Halle&Marantz: roots, allomorphy, last-resorts
- Chomsky&Lasnik, Bjorkman, Olivier: 'overflow' auxiliaries
- But not: 'Stray affixes are no good'

Alexiadou&Borer'20 Introduction, Nominalization: 50 Years on from Chomsky's Remarks
Bjorkman'11 BE-ing Default: The Morphosyntax of Auxiliaries
Branigan'23 The Grammar of Multiple Head Movement
Brody'98 Projection and phrase structure
Bruening'18 The lexicalist hypothesis: Both wrong and superfluous
Boullier'04 Range concatenation grammars
Buszkowski'96: Categorial grammars with negative information
Chomsky'57 Syntactic Structures
Chomsky'70 Remarks on nominalization
Chomsky'01 Derivation by phase
Chomsky&al'23 Merge and the Strong Minimalist Thesis
Chomsky&Lasnik'77 Filters and control
Collins'02 Eliminating labels
Collins&Kayne Towards a theory of morphology as syntax
Engelfriet,Lilin&Maletti'09 Extended multi bottom–up tree transducers
Ermolaeva&Kobele'22 Agree as information transmission over dependencies
Giannoula'25 Deciphering mirror principle violations
Goto&Ishii'25 Seeking an optimal design of search and merge
Graf'22 Typological implications of tier-based strictly local movement
Graf'23 Subregular tree transductions, movement, copies, traces, and the ban on improper movement
Graf&Kostyszyn'21 Multiple wh-movement is not special
Grimshaw'97: Projection, heads, and optimality
Groenink'95: Literal movement grammars
Halle&Marantz'93 Distributed morphology and the pieces of inflection
Halpert&Zeijlstra'24 Off phases: It's all relative(ized)
Hanson'25 Tier-based strict locality and the typology of agreement
Harizanov&Gribanova'19 Whither head movement?
Haugen&Siddiqi'16 Towards a restricted realization theory
Holmberg'17 The final-over-final condition and linearization in generative grammar

Kalin&Weisser'25 Minimalism and morphology
Kanazawa'07 Parsing and generation as Datalog queries
Kanazawa'09 The pumping lemma for well-nested multiple context-free languages
Kanazawa'17 Parsing and generation as Datalog query evaluation
Kayne'93 Toward a modular thoery of auxiliary selection
Kayne'20 Antisymmetry and externalization
Ke'24 Can agree and labeling be reduced to minimal search?
Keine'25 Φ feature sharing
Kobele&Liu'25 Formalizing feature inheritance
Kracht'98 Strict compositionality and literal movement grammars
Lasnik'00 Syntactic Structures Revisited
Marantz'98 No escape from syntax
Olivier'25 A syntactic account of auxiliary selection in French
Sag'10 Sex, lies, and the English auxiliary system. Stanford
Sag&al'20 Lessons from the English auxiliary system
Stabler'97 Derivational minimalism
Stabler'01 Recognizing head movement
Stabler'11 Computational perspectives on minimalism
Stanojević'19 On the computational complexity of head movement and affix hopping
Vanden Wyngaerd&al'15 Late insertion and root suppletion
Yuan'25 Morphological conditions on movement chain resolution