Grammar Size and Quantitative Restrictions on Movement

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SCiL 2018
Jan 4–7, 2018

Outline

Minimalist Grammars (MGs)

- Minimalist grammars (MGs) are a formalization of Chomskyan syntax (Stabler 1997, 2011)
- Succinct formalism for defining MCFGs
- Operations: Merge and **Move**
- Grammar is just a finite list of feature-annotated lexical items (LIs)

Chemistry	Syntax
atoms	words
electrons	features
molecules	sentences

Merge

Merge combines subtrees to encode **head-argument dependencies**.

category feature N^- , V^- , ...

selector feature N^+ , V^+ , ...

the	men	like	which	men
N^+ D^-	N^-	D^+ D^+ V^-	N^+ D^-	N^-

- *the* and *men* have matching features, triggering Merge
- same steps for *which men*
- *like* merged with *which men*
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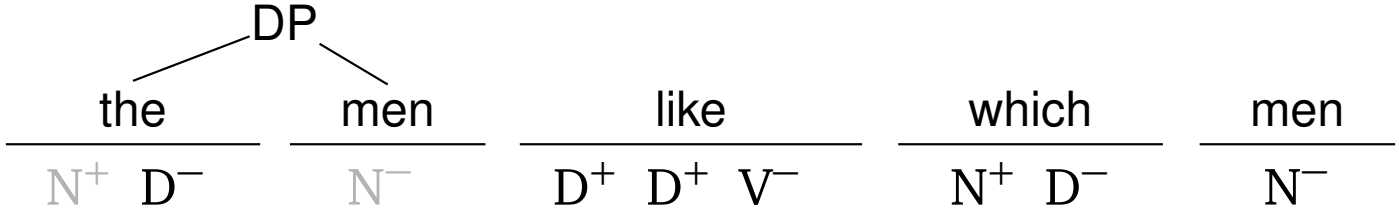

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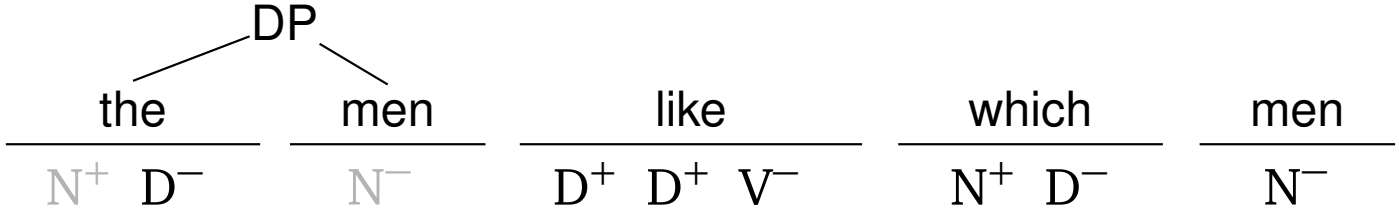

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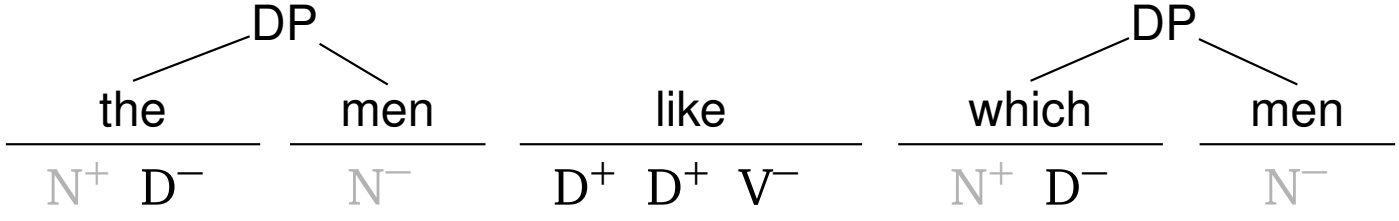

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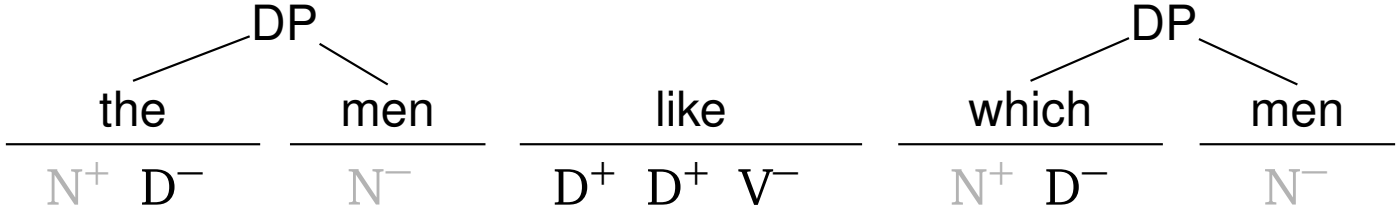

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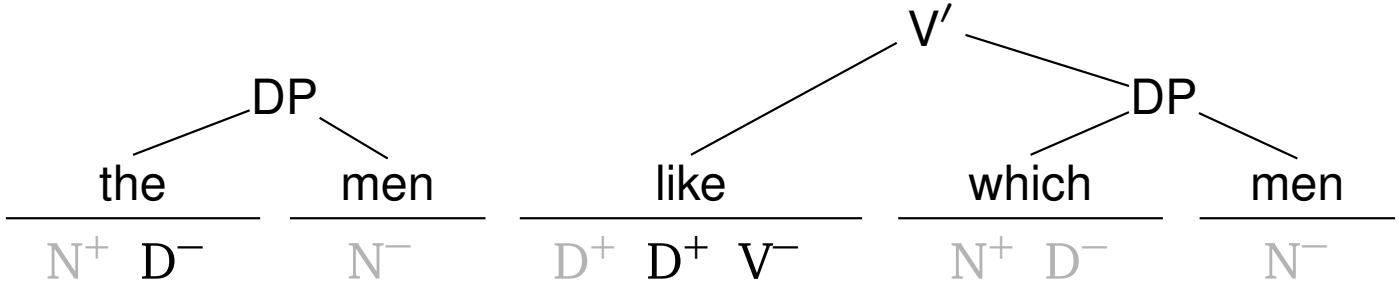

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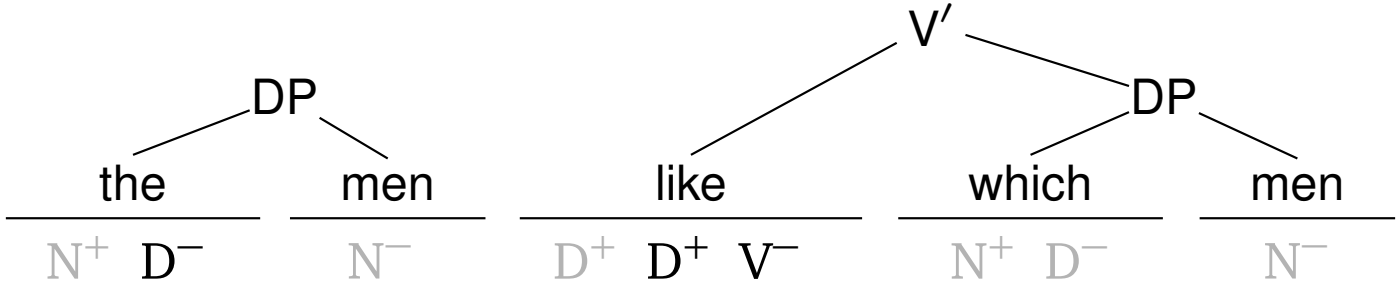

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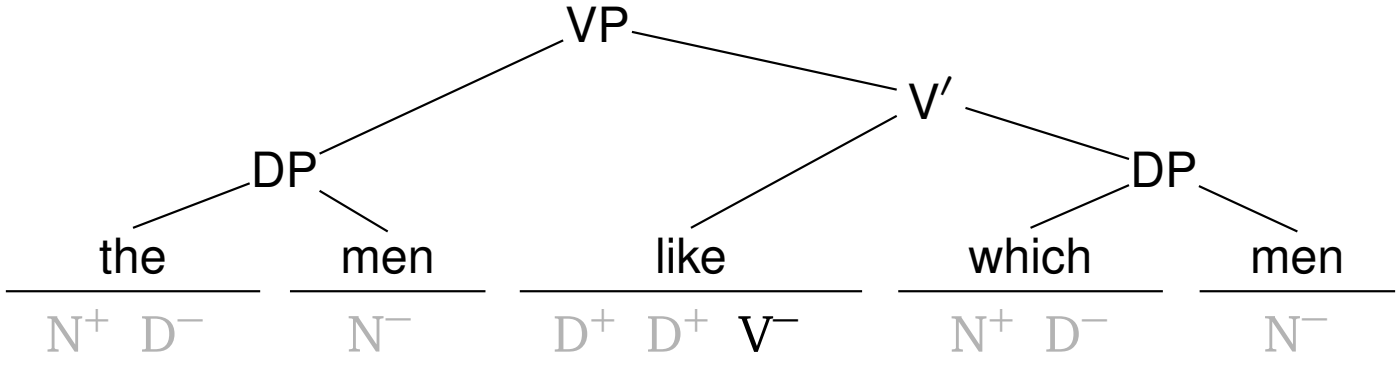

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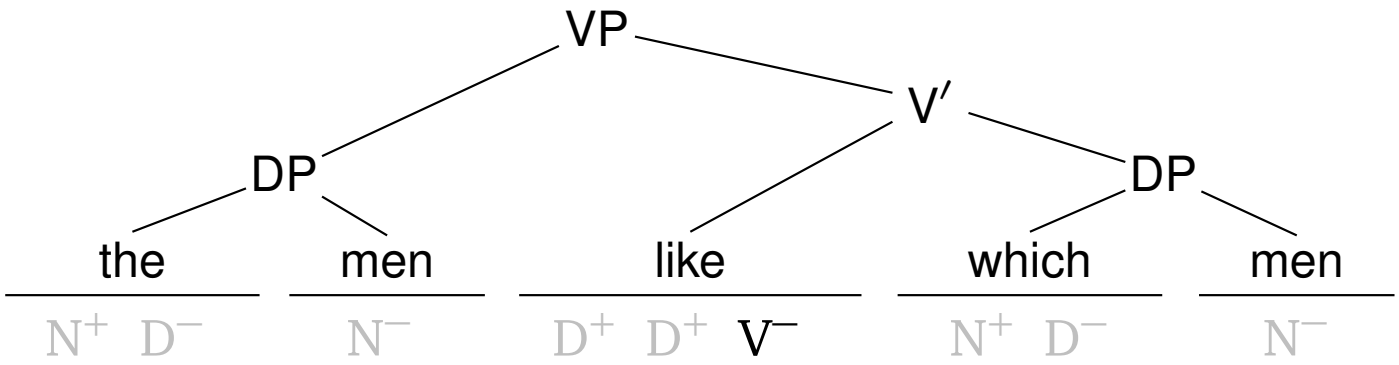
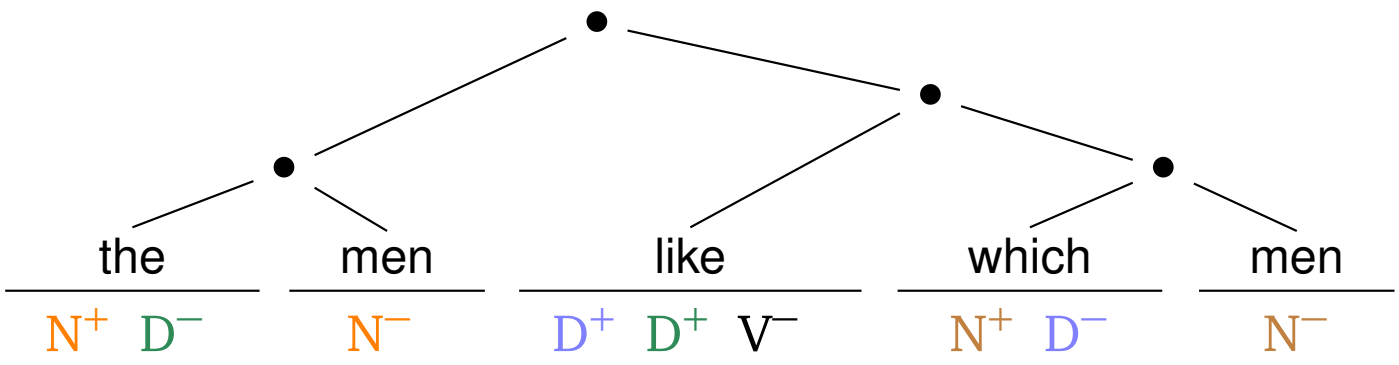
Merge in Derivation Trees



Derived Tree



Derivation Tree

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Move displaces subtrees to derive the correct **linear order**.

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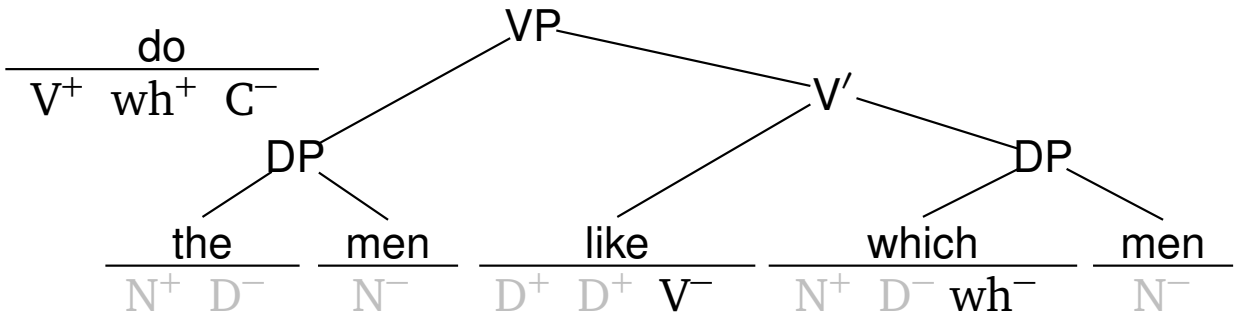

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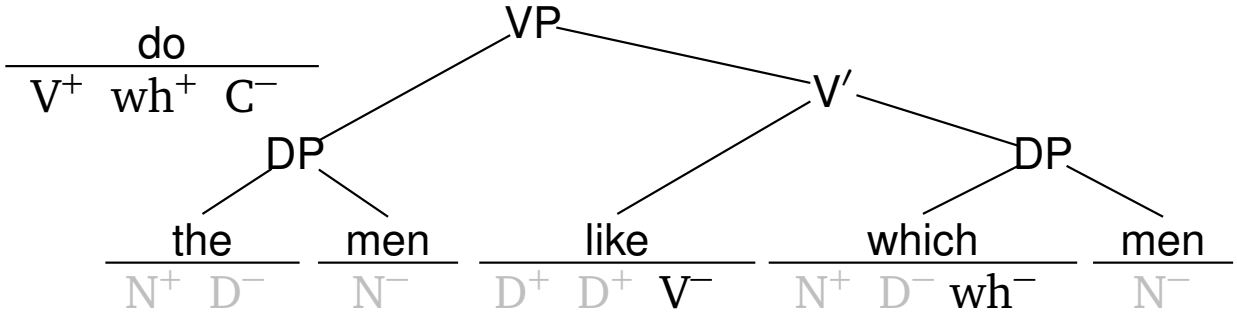

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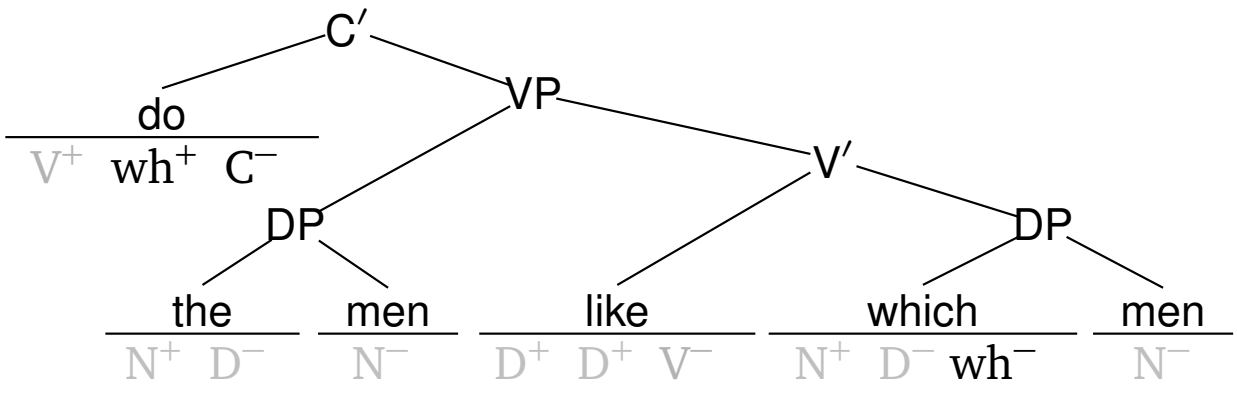

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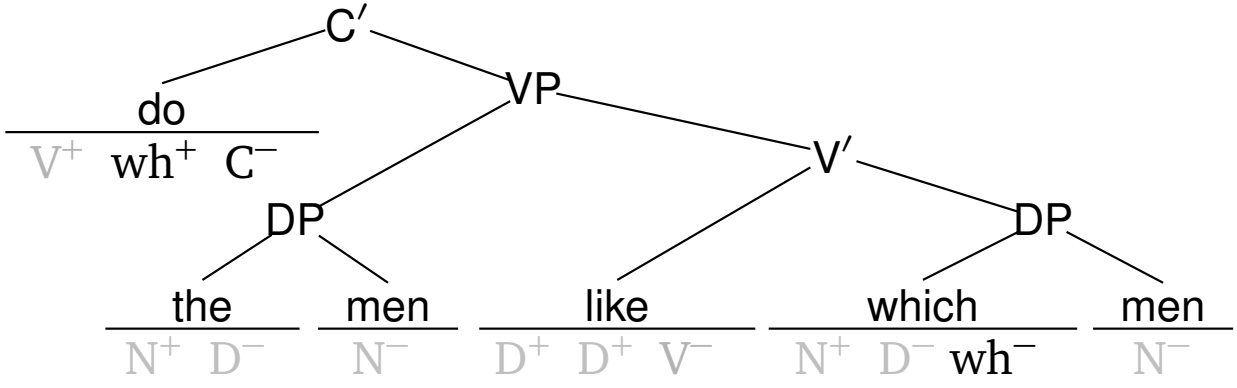

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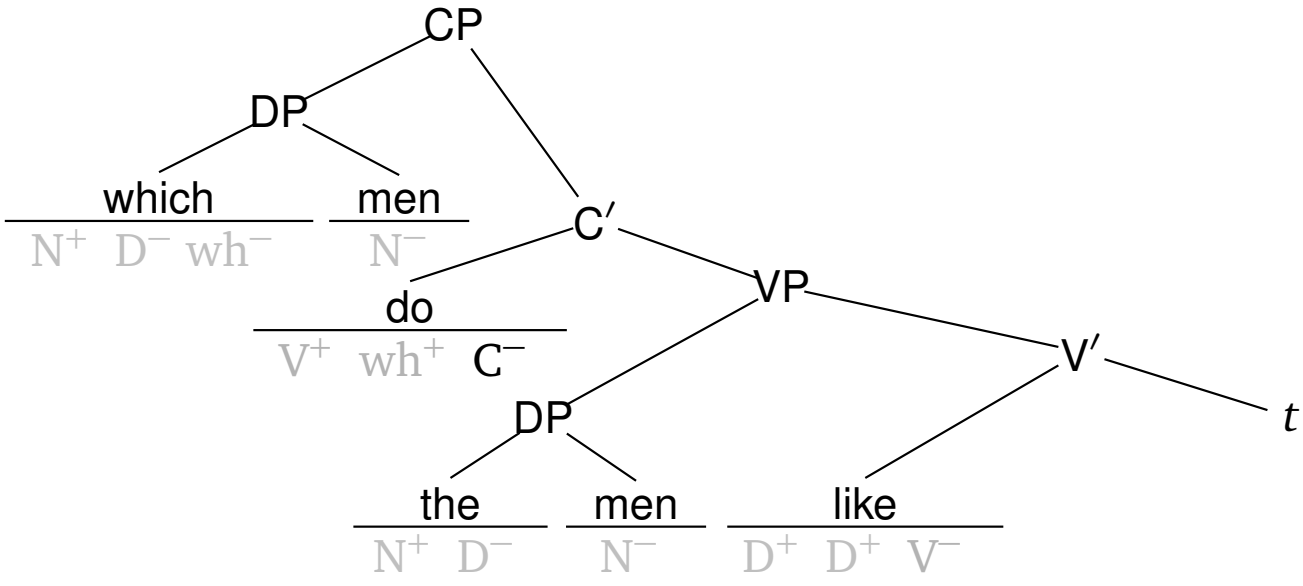

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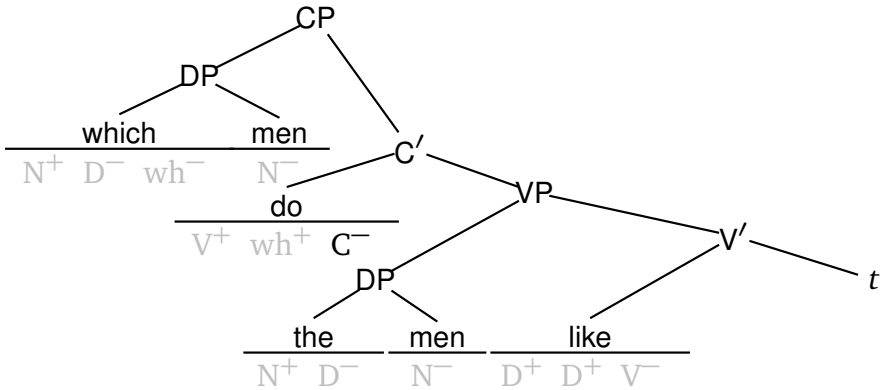

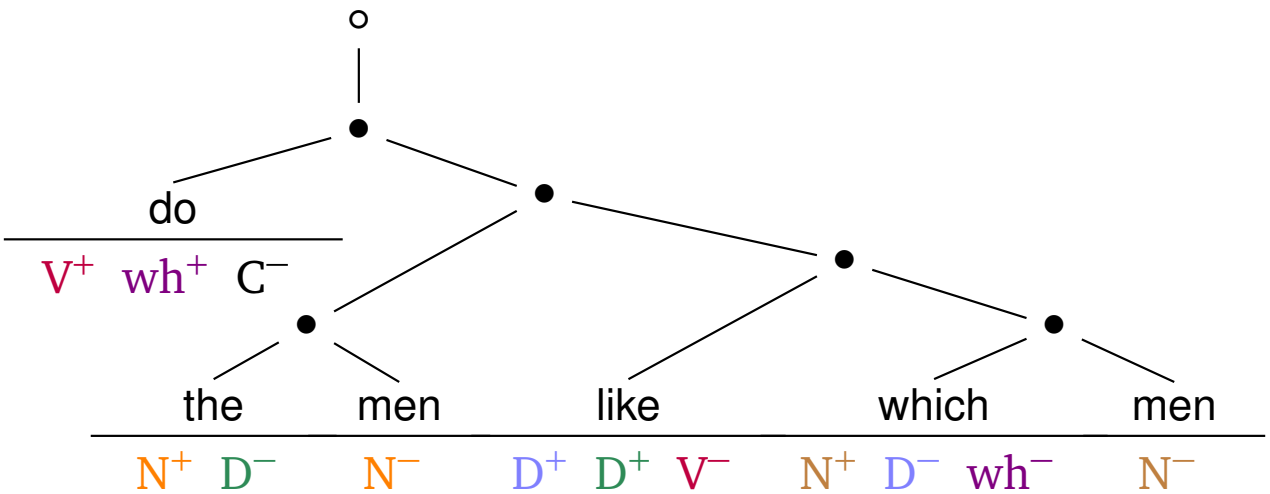

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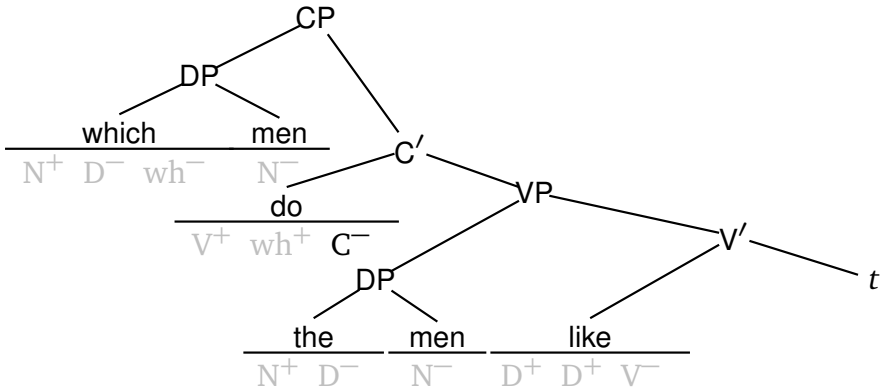
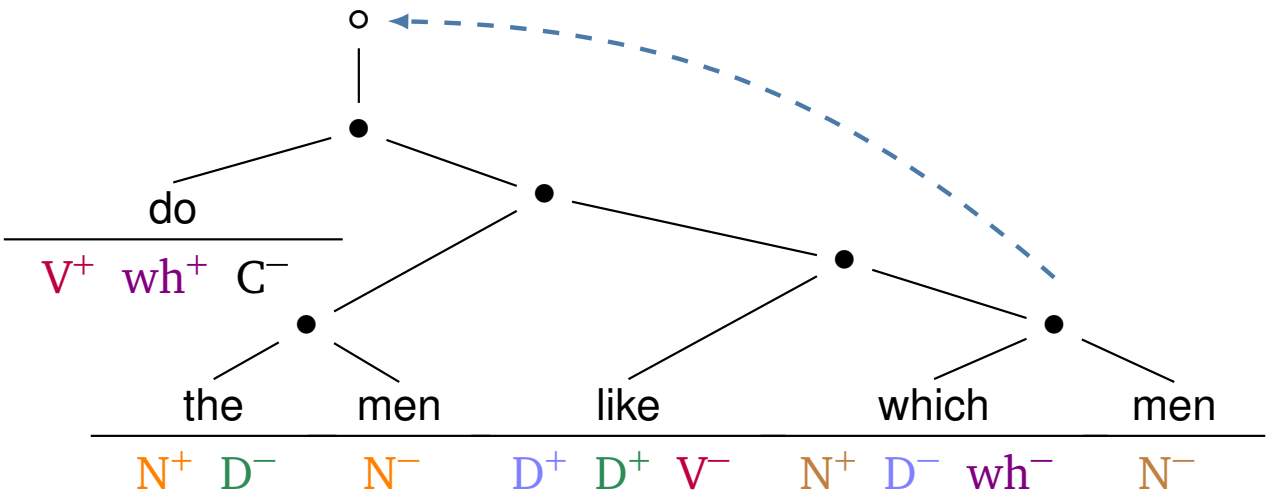
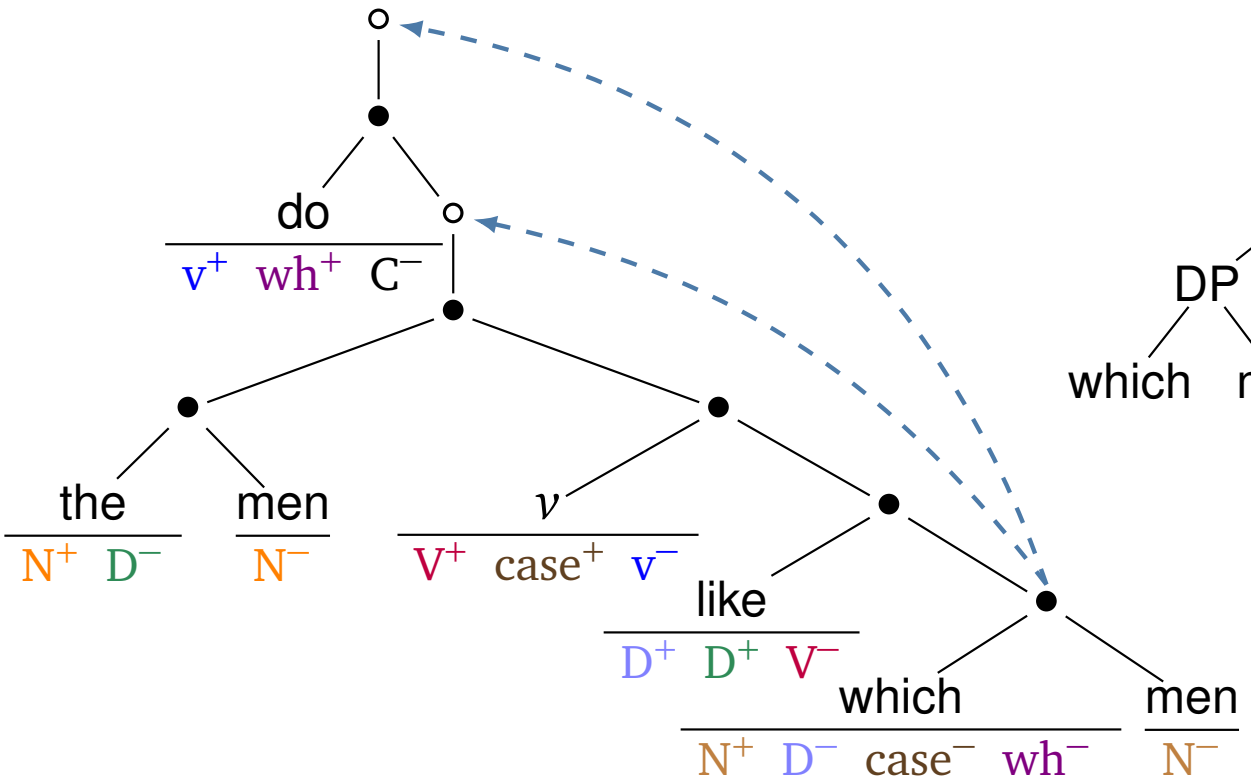
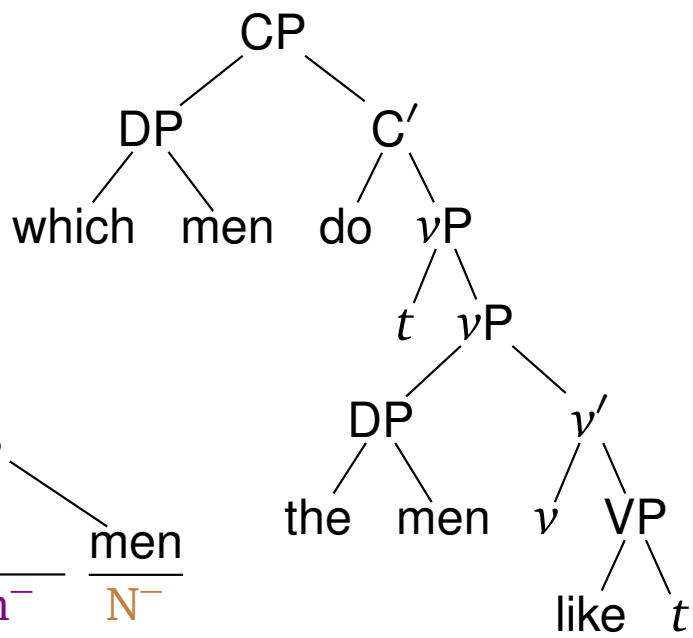




Intermediate Movement

Intermediate movement is possible, but has no effect on output.



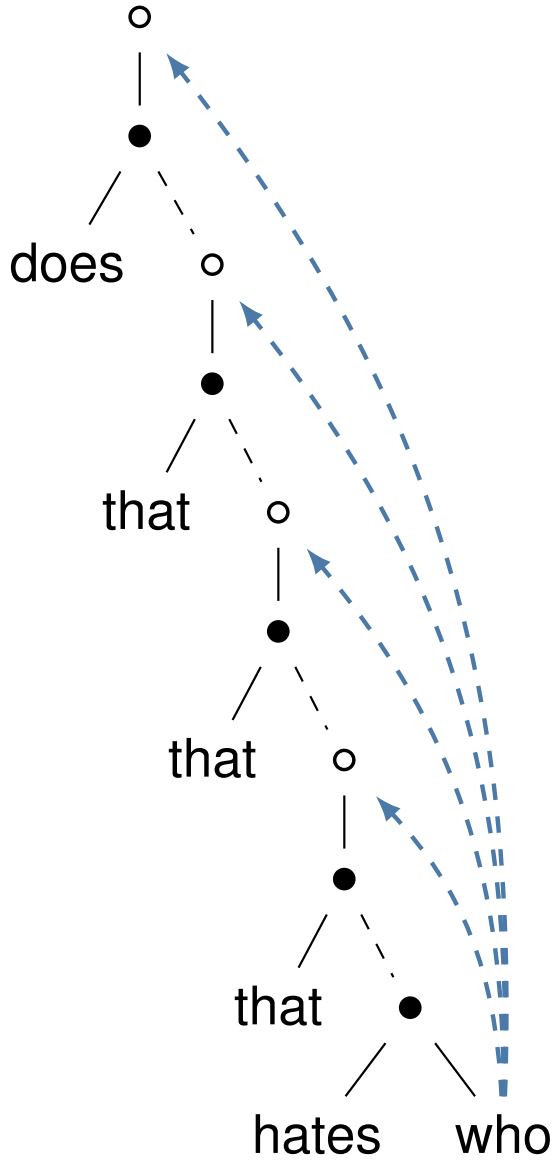


An Issue with Intermediate Movement

Minimalist analyses posit an unbounded number of intermediate landing sites.

(1) Who does John think
t that Mary believes
t that Sue said
t that . . .
t that Bill hates *t*?

But every LI can only carry **finitely many features**!

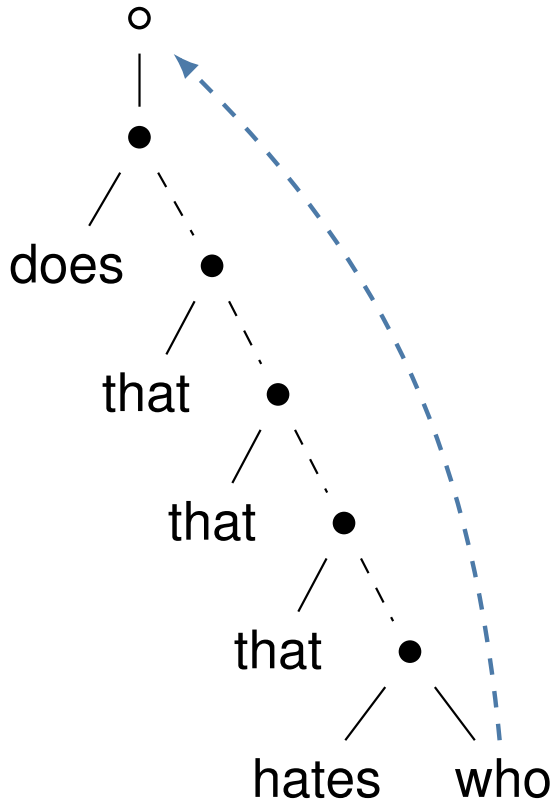


Derivational Solution (Kobele 2006)

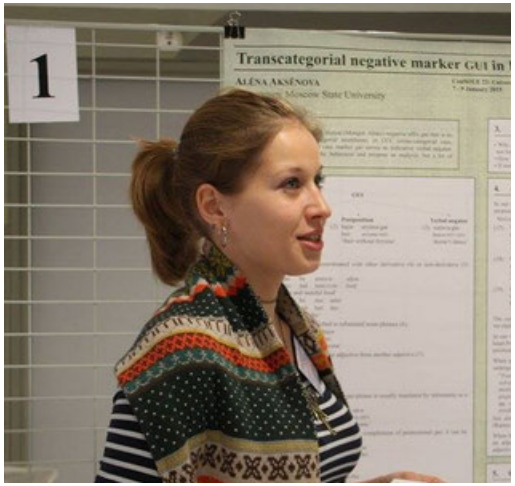
- Only final landing site has feature.
- Intermediate movement is inserted by mapping to phrase structure trees

Recipe for Successive Cyclic Movement

Add trace in every crossed Spec,CP.



Generalization: No Intermediate Movement (Graf et al. 2016)



Alëna Aksënova

Aniello De Santo

- Kobele's solution can be generalized.
- Intermediate movement never needs to be feature triggered.
- It is **derivationally redundant**.

Definition (Single Movement Normal Form)

An MG is in single movement normal form **(SMNF)** iff every LI has at most one licensee feature.

Theorem

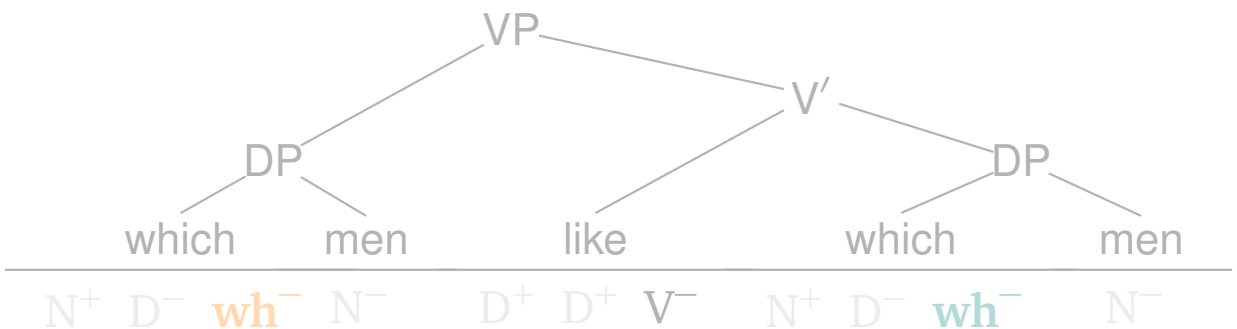
For every MG there is a strongly equivalent MG that is in SMNF.

An Annoying Complication

MGs have one central locality restriction on Move.

Shortest Move Constraint (SMC)

If two LIs in a tree both have a licensee feature as their first currently unchecked feature, then these features must be distinct.



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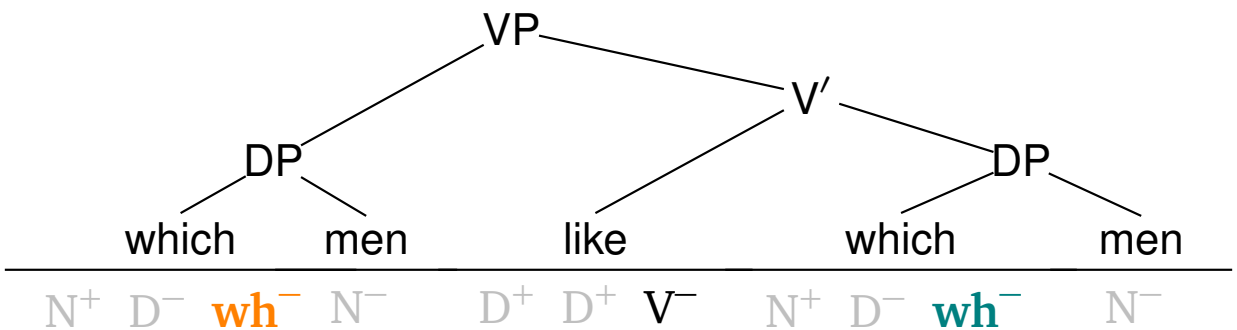

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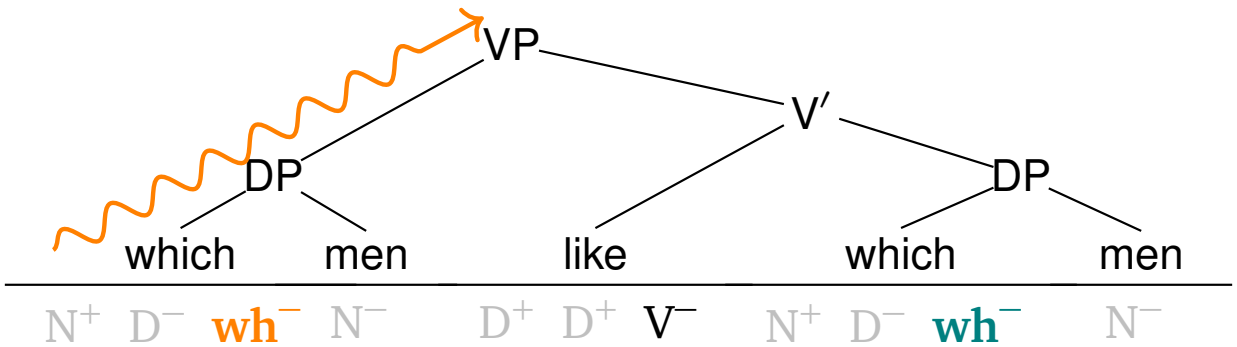

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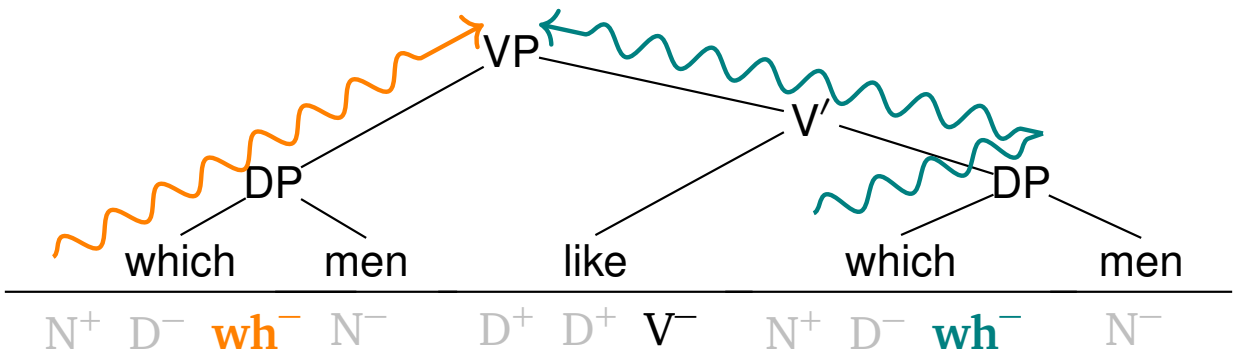

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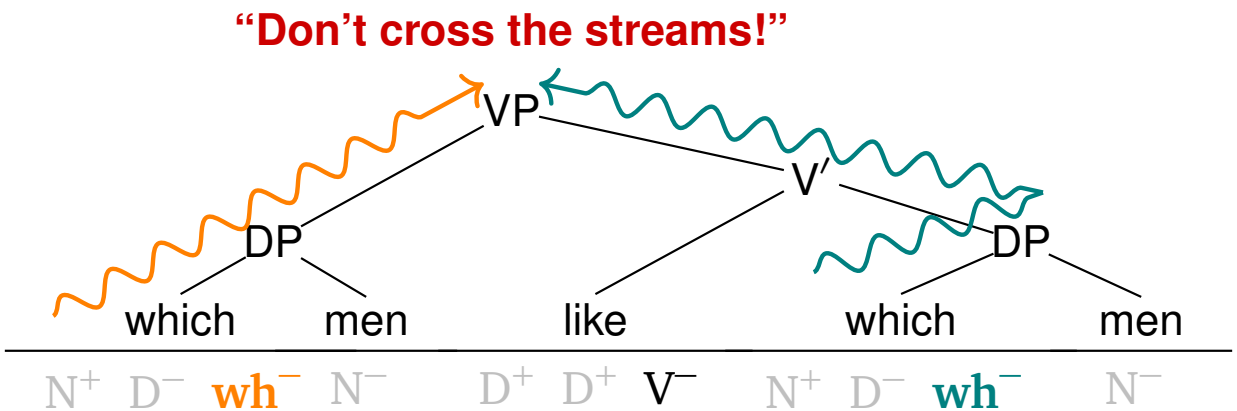
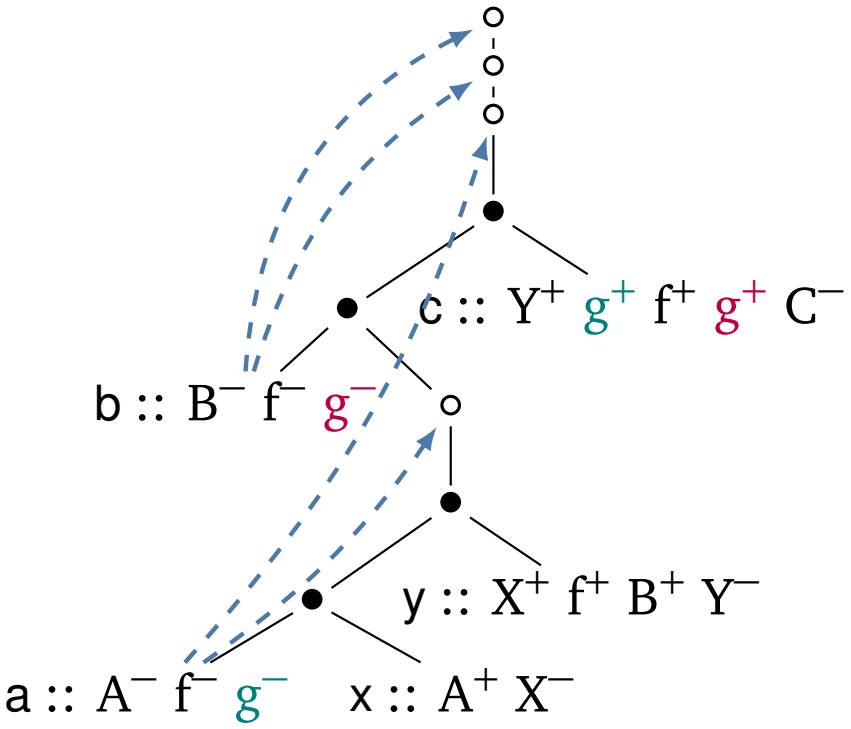


A Work-Around with Subscripts

Feature Subscripting

- For every LI l, only keep its last licensee feature.
- Add subscripts to licensee features to avoid SMC violations.



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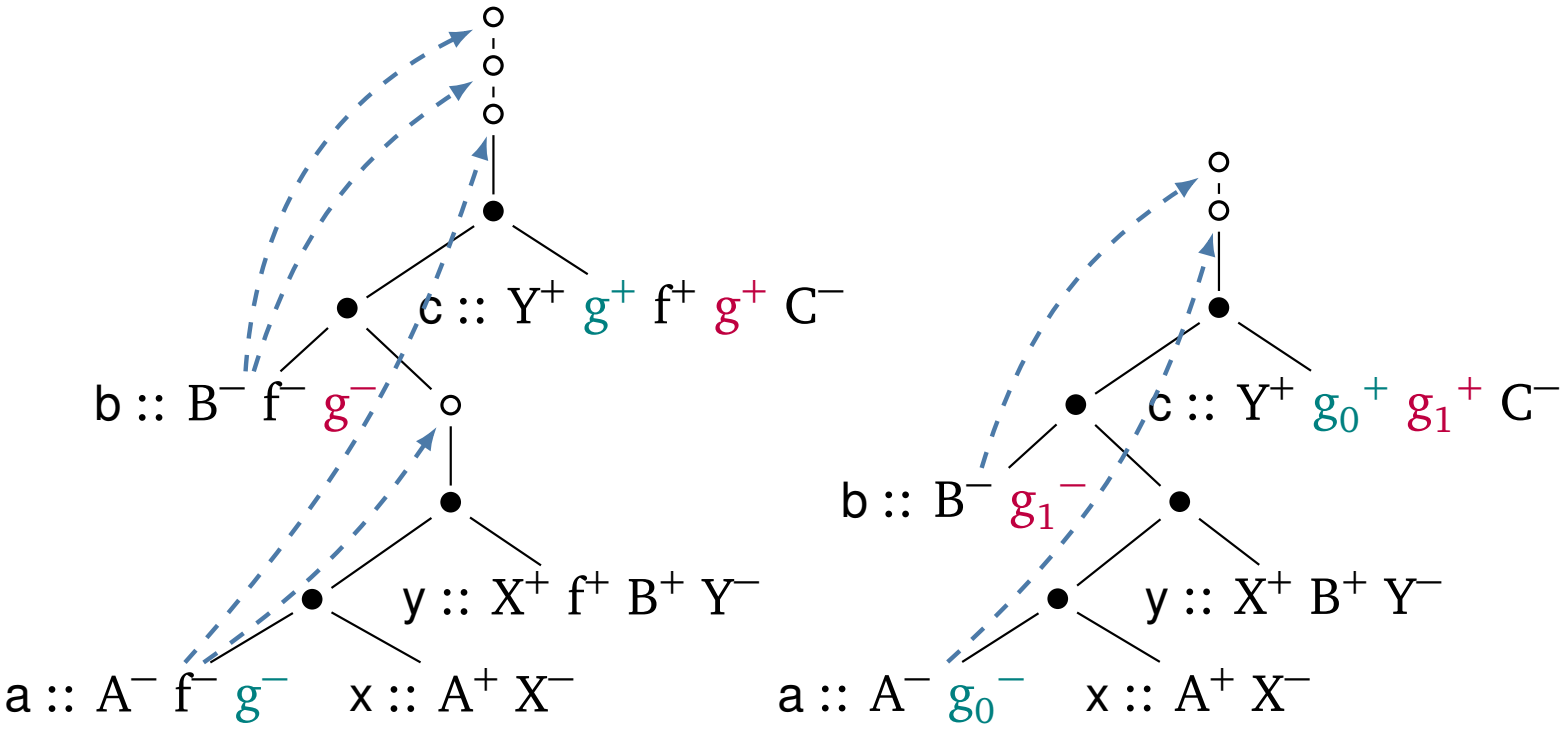


Lexical Blow-Up

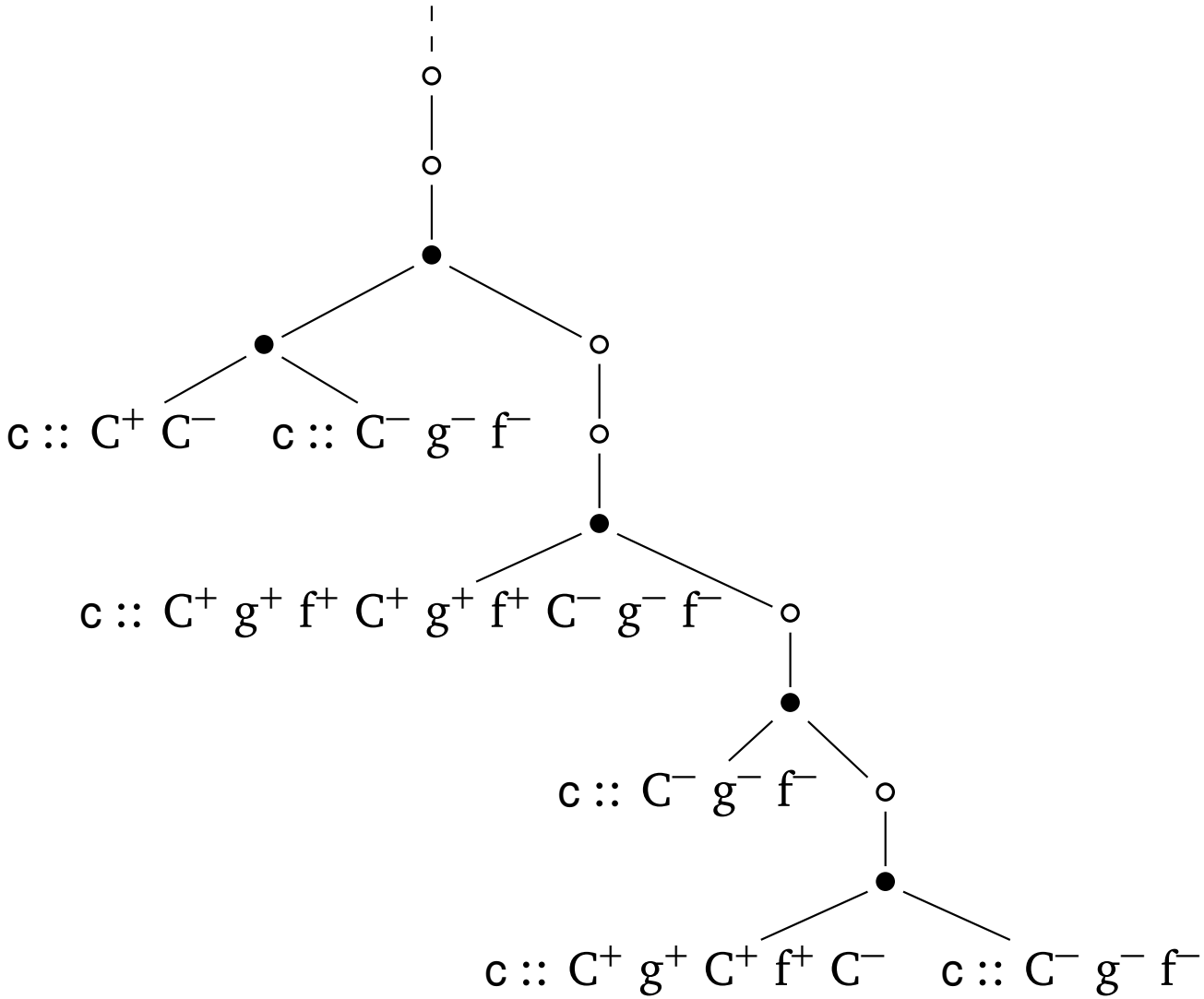
- SMNF translation induces **linear lexical blow-up**
- Effect varies a lot depending on movement configurations:

lower bound	linear size reduction(!),
	1:1 for non-redundant grammars
upper bound	large linear blow-up

$$\sum_{l \in \mathbf{Lex}} \mu^{\gamma(l)+\delta(l)}$$

μ ... maximum number of required indices
$\gamma(l)$ ... number of licensor features of LI l in original grammar
$\delta(l)$ ... 1 if l has licensee features, 0 otherwise

Abstract Example (Sketch)



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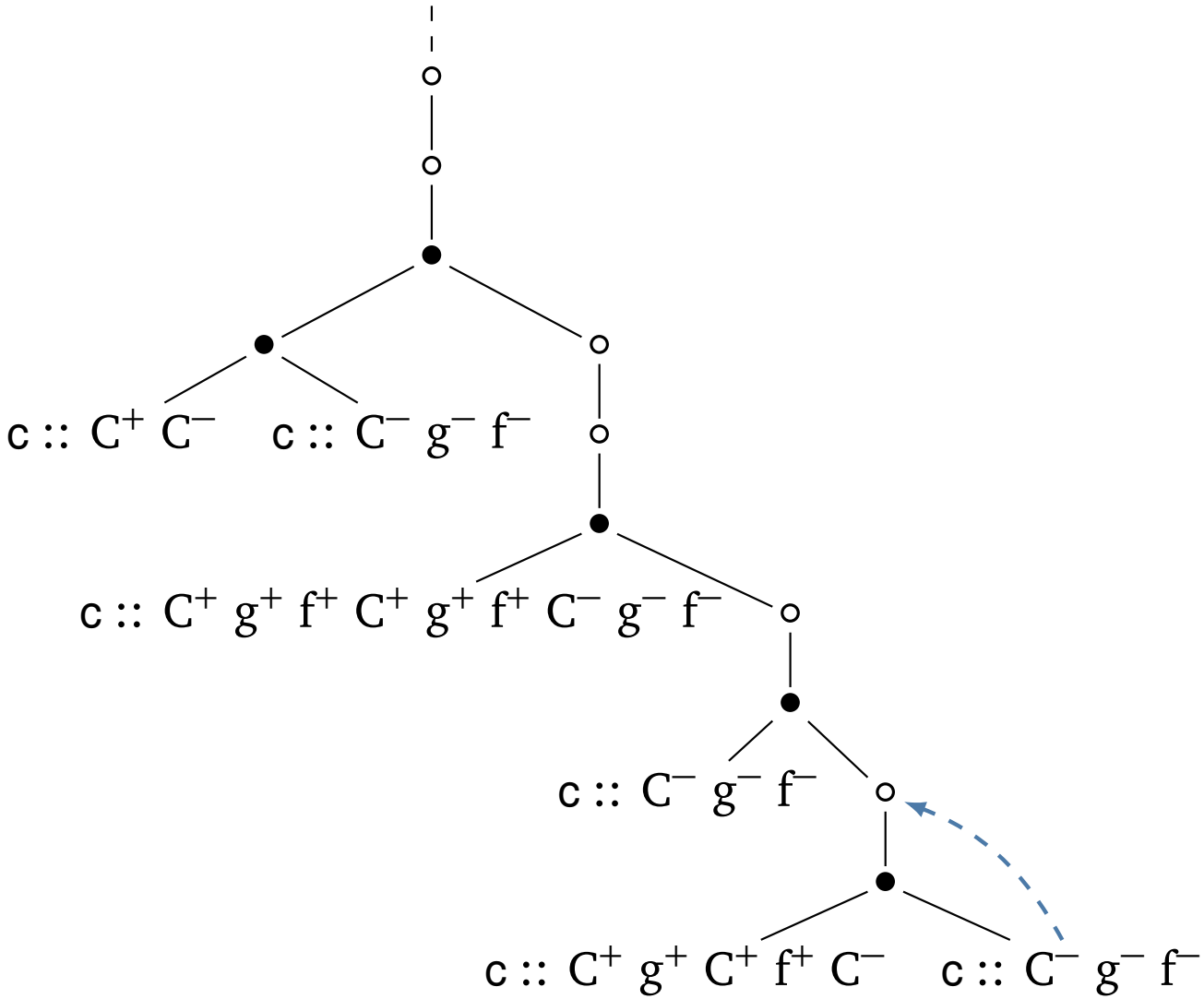

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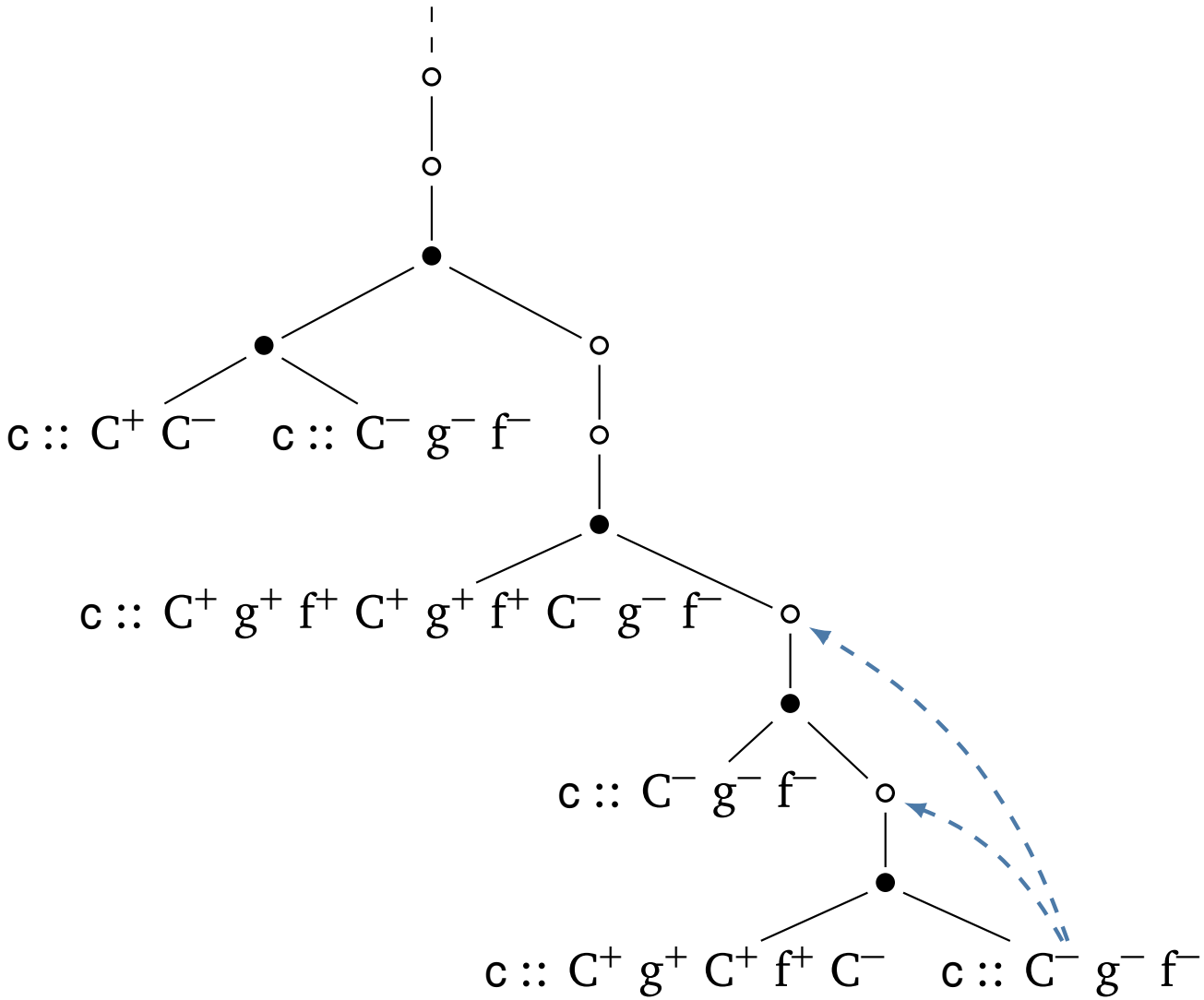

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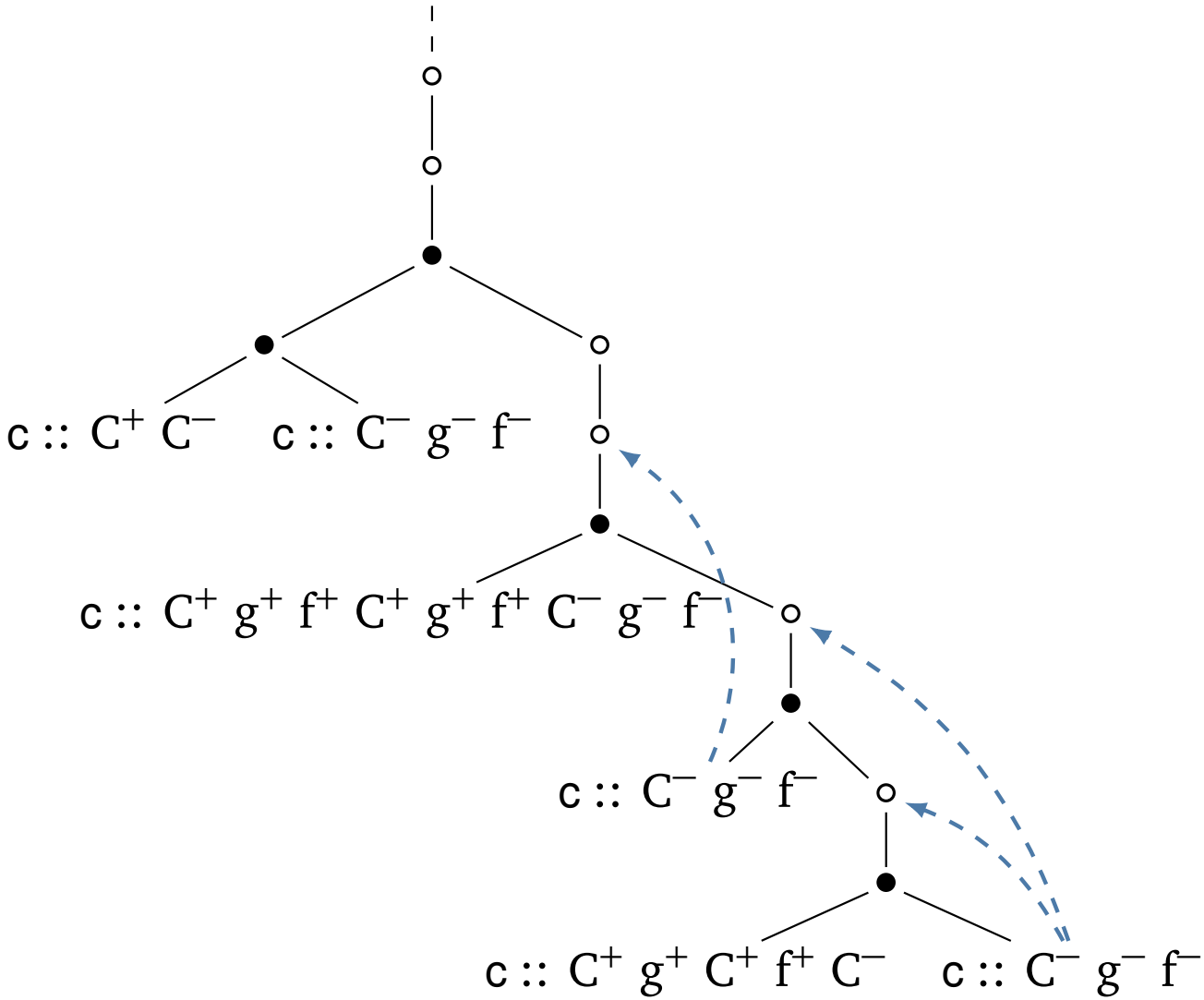

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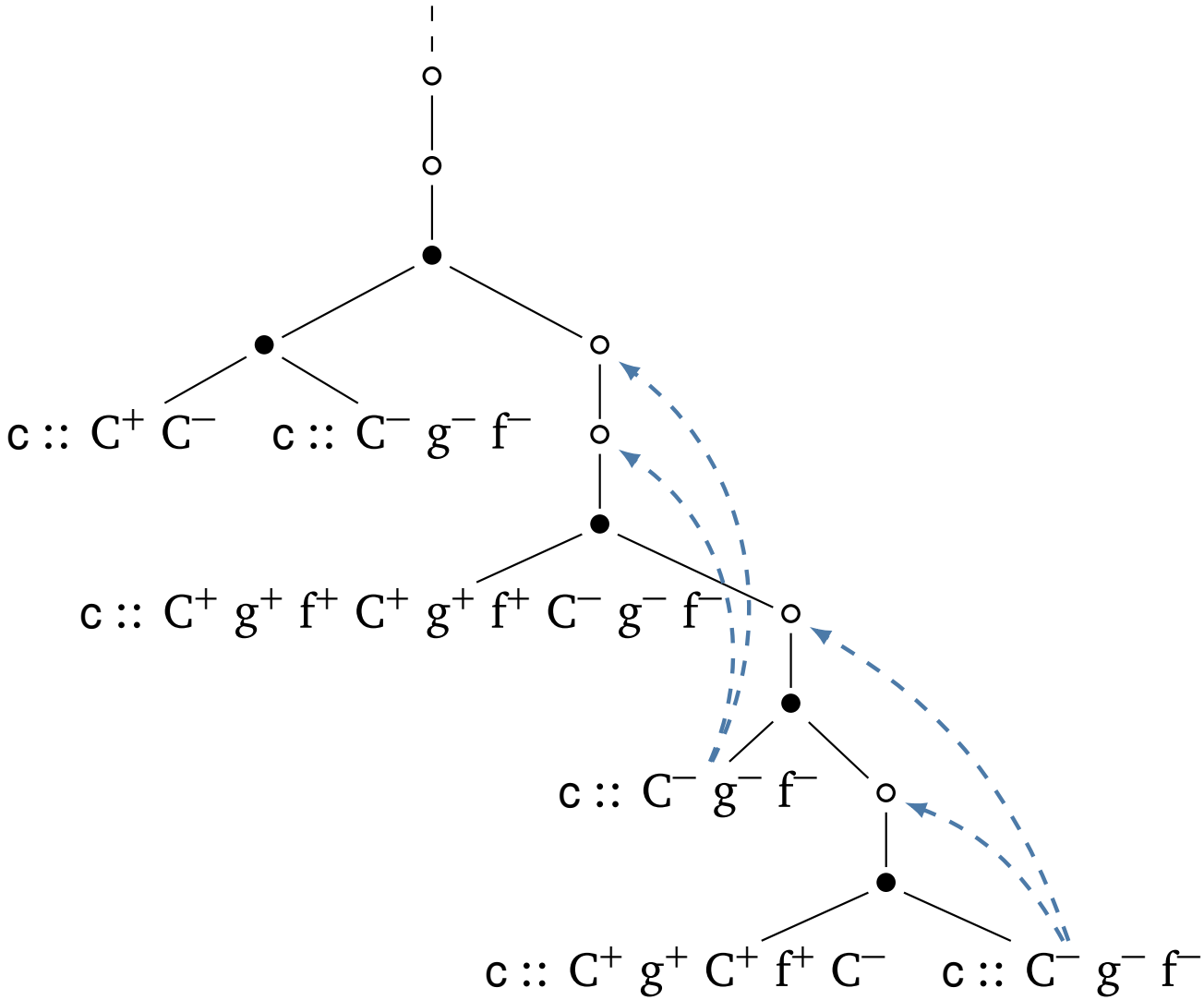

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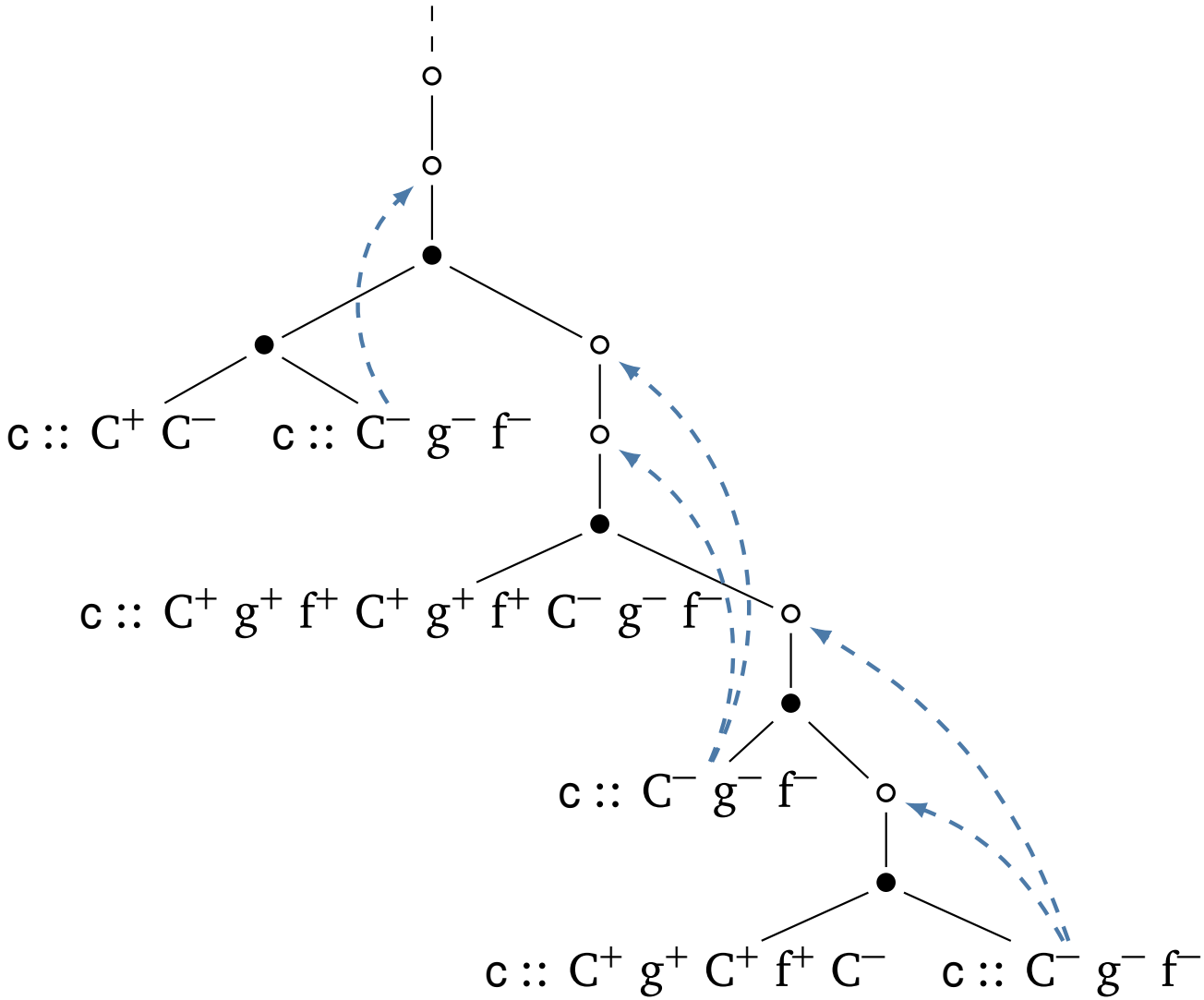

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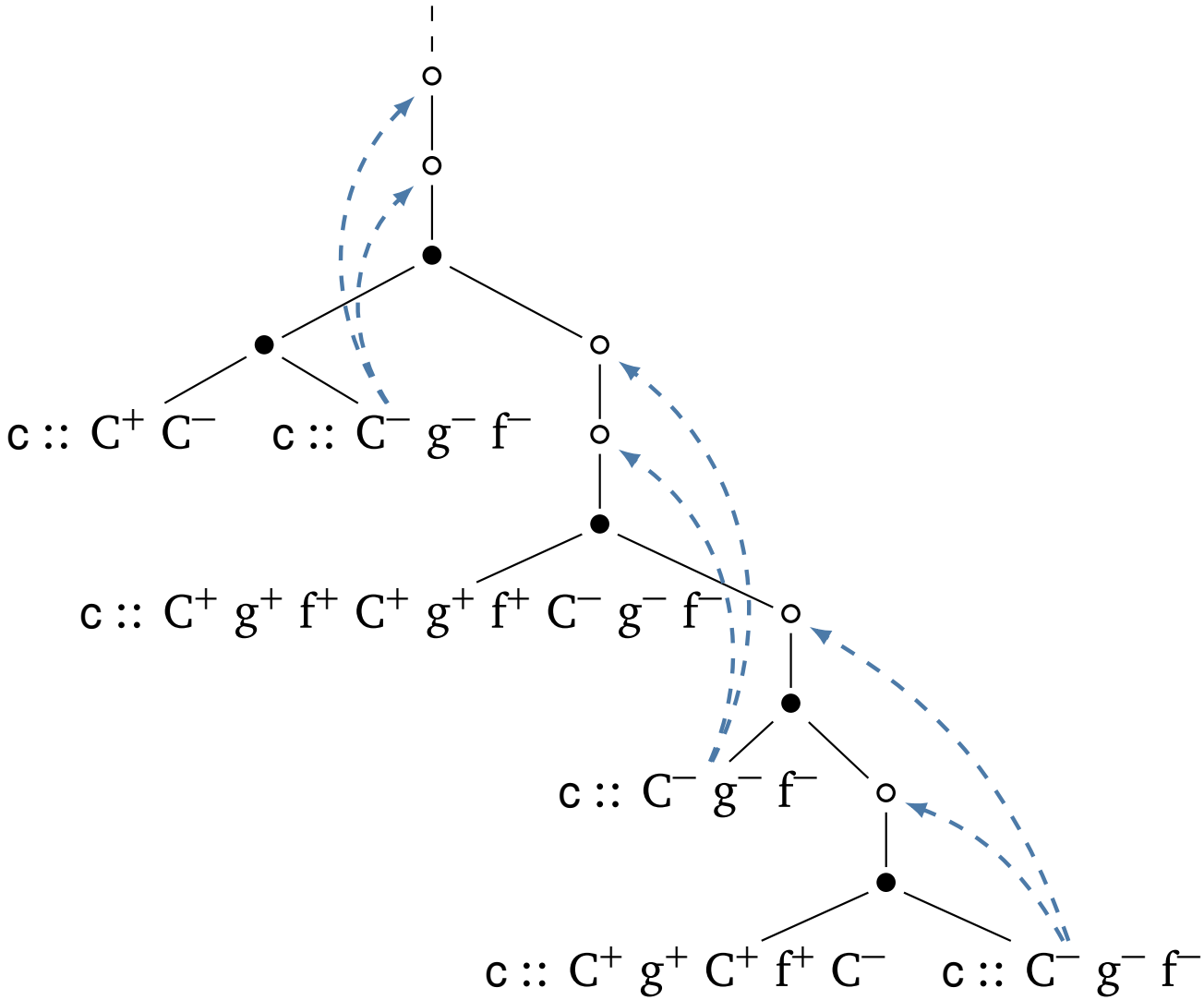

Abstract Example (the Math)

- The original grammar contains a single LI.

$$c :: C^{+}\ g^{+}\ f^{+}\ C^{+}\ g^{+}\ f^{+}\ C^{-}\ g^{-}\ f^{-}$$

- The SMNF grammar contains **8** variants.

$$c :: C^{+}\ f_0^{+}\ C^{+}\ f_0^{+}\ C^{-}\ f_0^{-} \qquad c :: C^{+}\ f_0^{+}\ C^{+}\ f_0^{+}\ C^{-}\ f_1^{-}$$
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- We can get **n** variants of the LI by changing the phonetic exponent, so the grammar size increases at least by **8n**.
- But we can keep increasing number **m** of arguments:

$$2^{m+1} \times n$$

Interim Summary

- Every MG is a finite set of LIs.
- The more LIs, the larger the grammar.
- Derivation trees are the primary data structure.
- Intermediate movement is derivationally redundant and costly:
  - complicates proofs
  - increases computational complexity (Graf and Heinz 2015)
  - at odds with MG processing models (Graf et al. 2017)
- But SMNF MGs may be much larger, which is bad for
  - parsing
  - learning
  - explanatory adequacy

A New Empirical Puzzle

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- Large blow-up occurs whenever there are multiple LIs s.t.
  1. they all have the same final movement feature, and
  2. they have overlapping movement paths, and
  3. their relative configuration is not fixed across derivations.
- That's easy to do with abstract examples,
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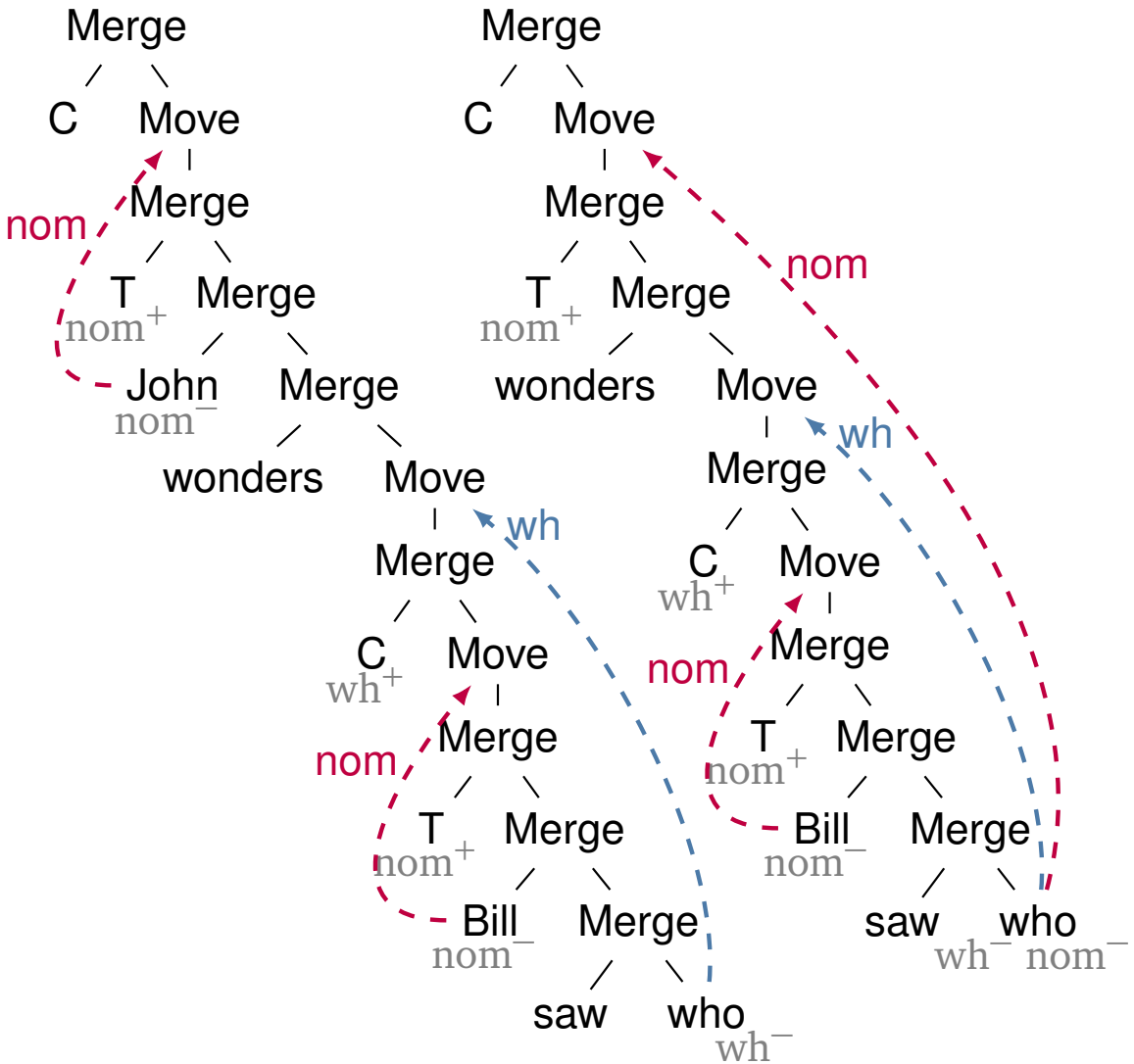
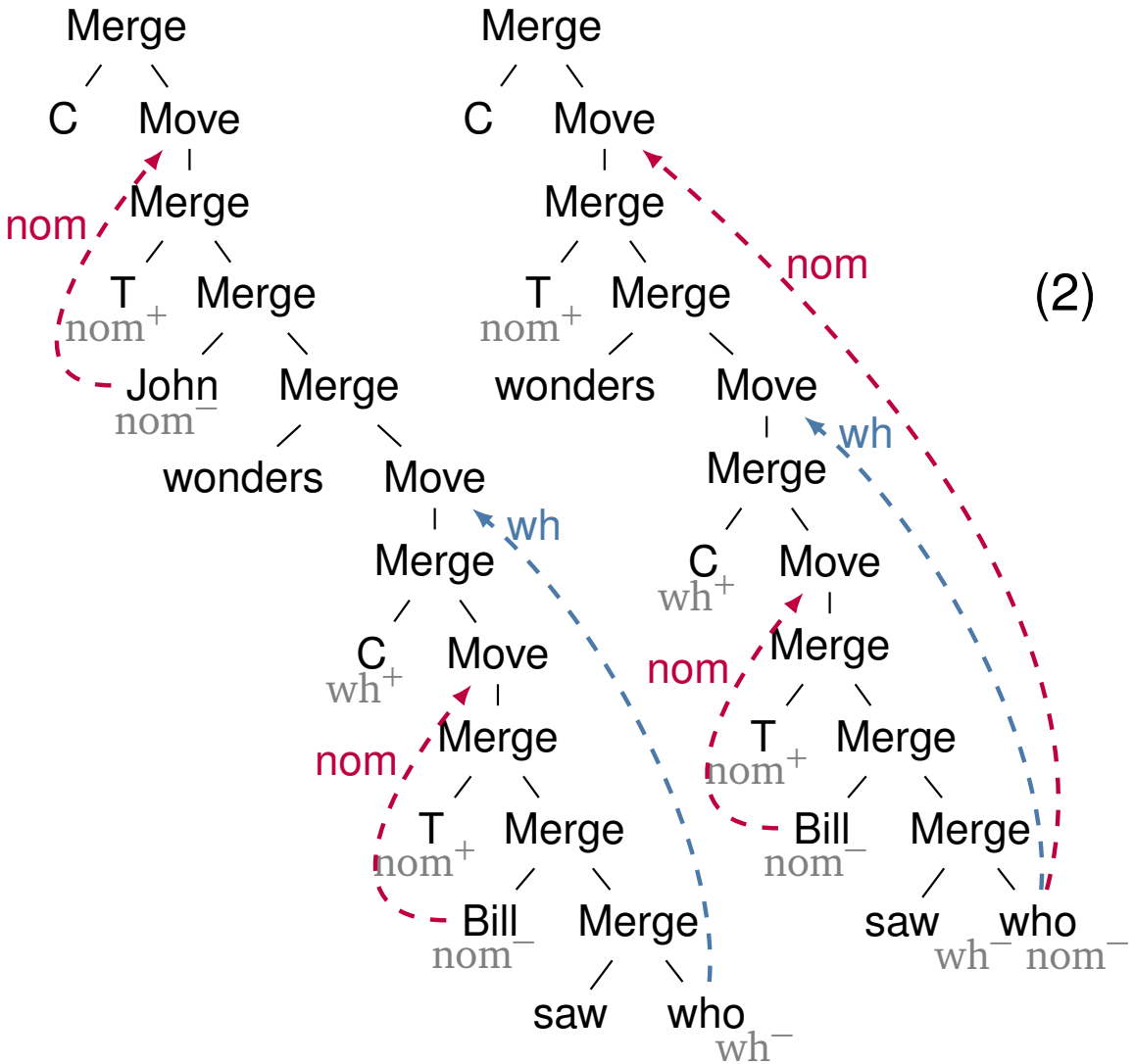
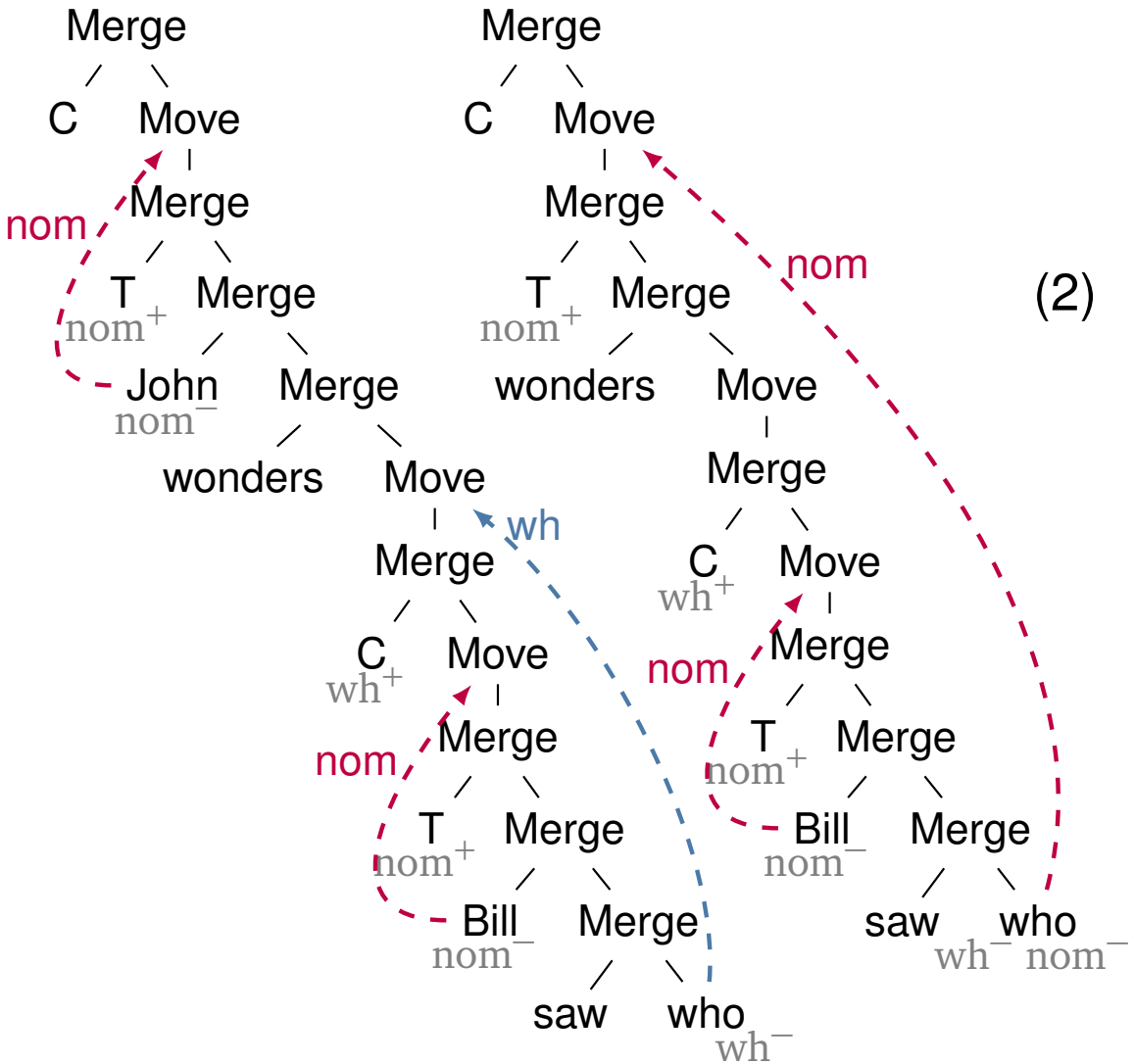


Improper Movement



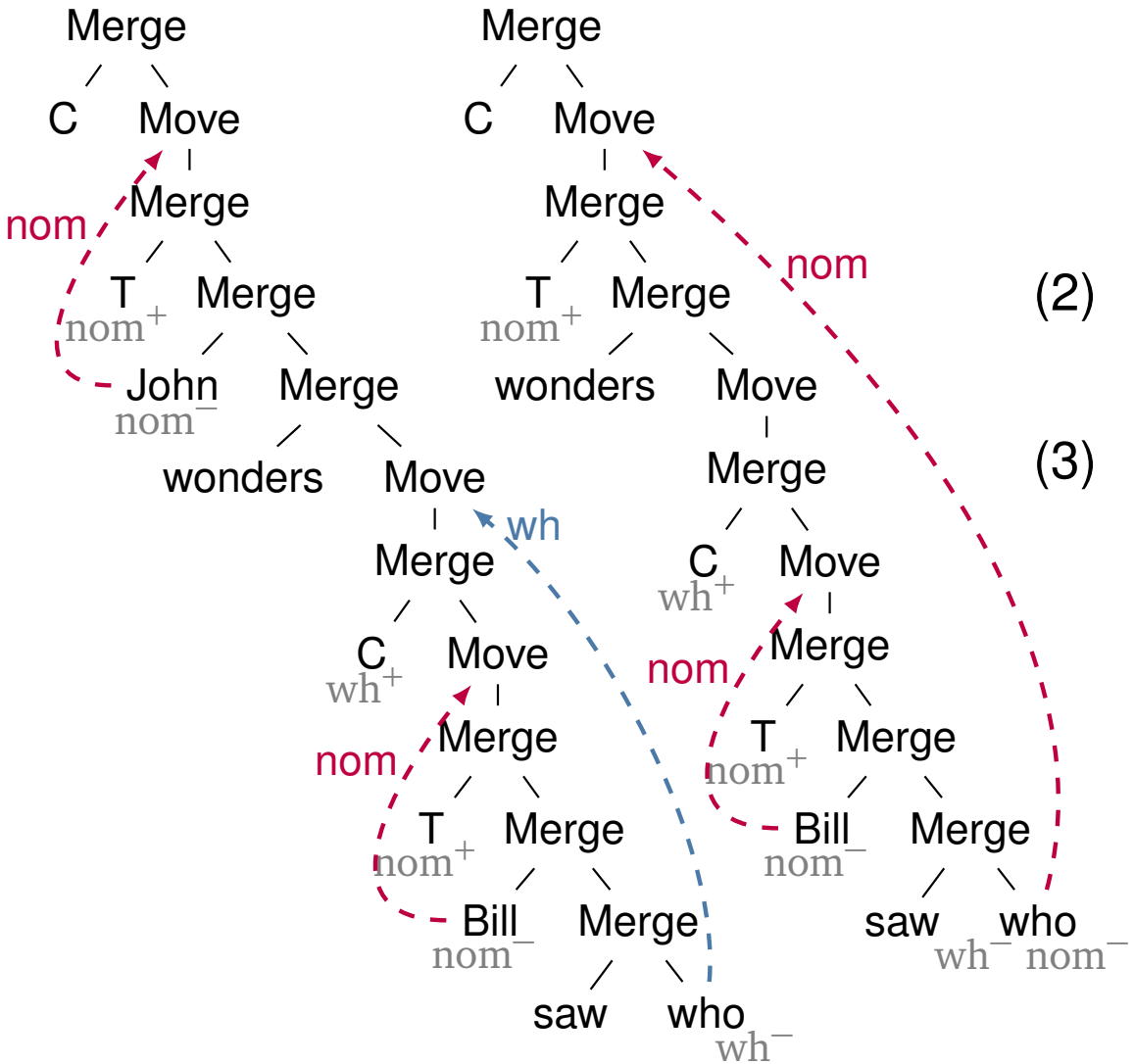
(2) John wonders who Bill saw.

Improper Movement



(2) John wonders who Bill saw.

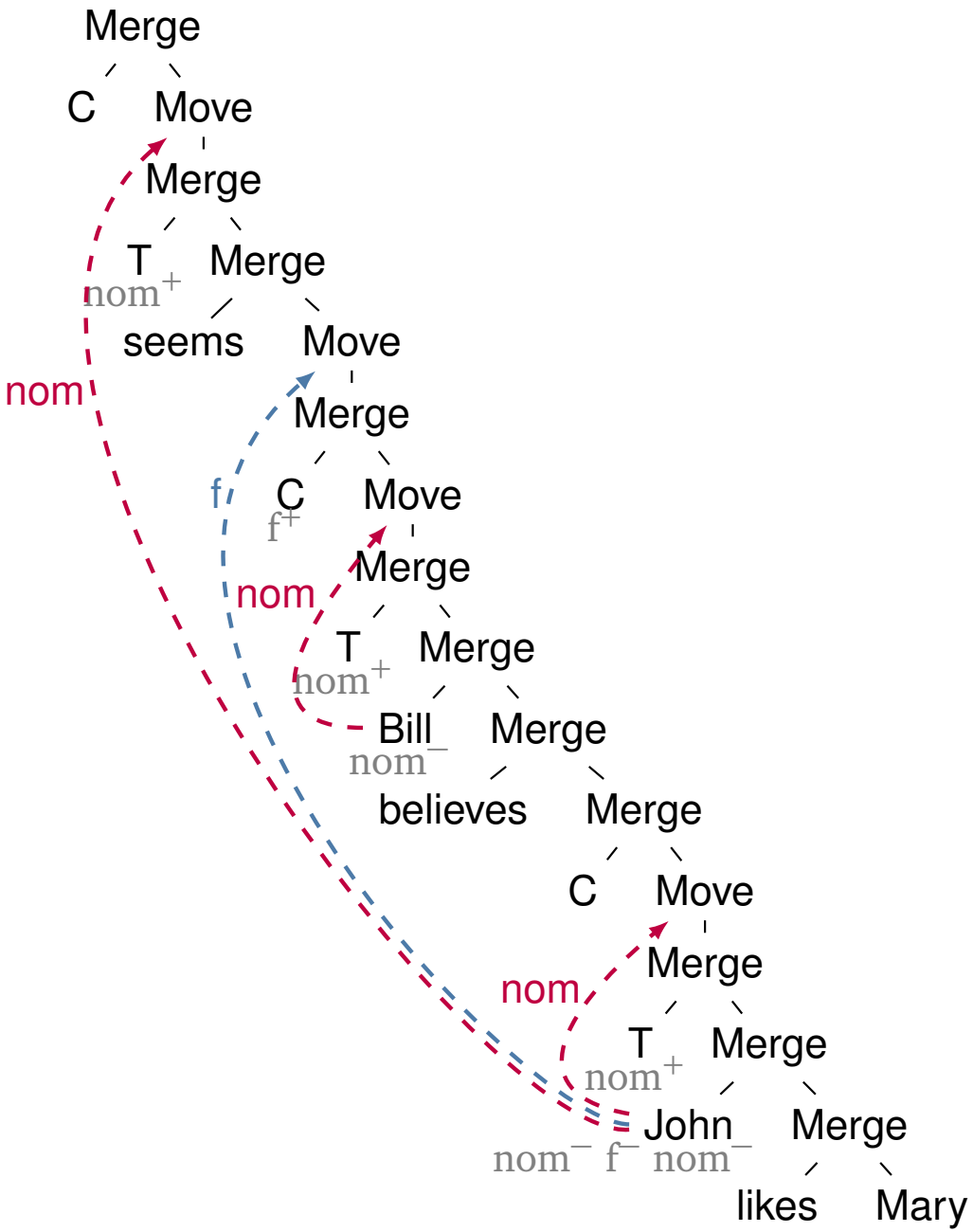
Improper Movement



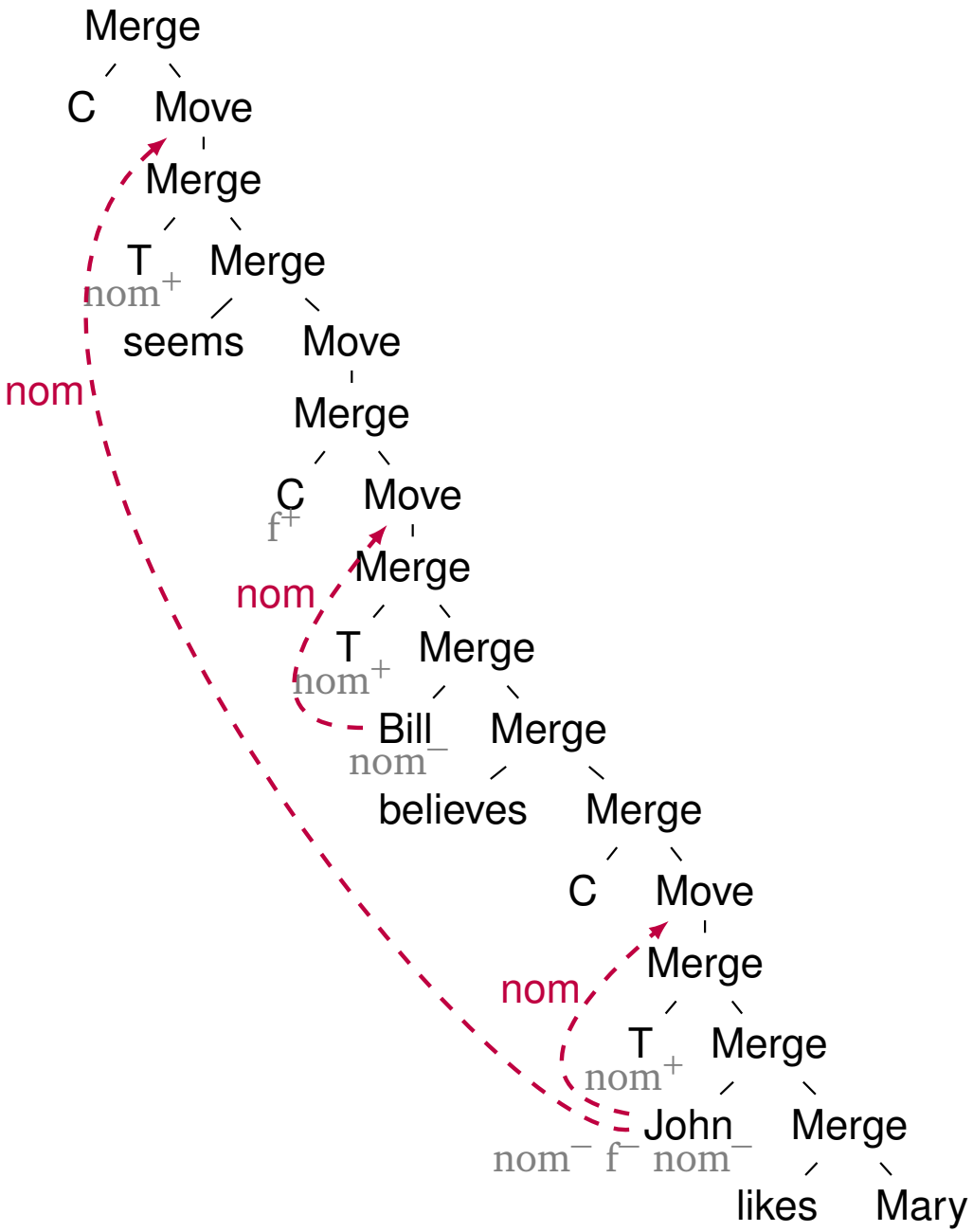
(2) John wonders who Bill saw.

(3) * Who wonders Bill saw?

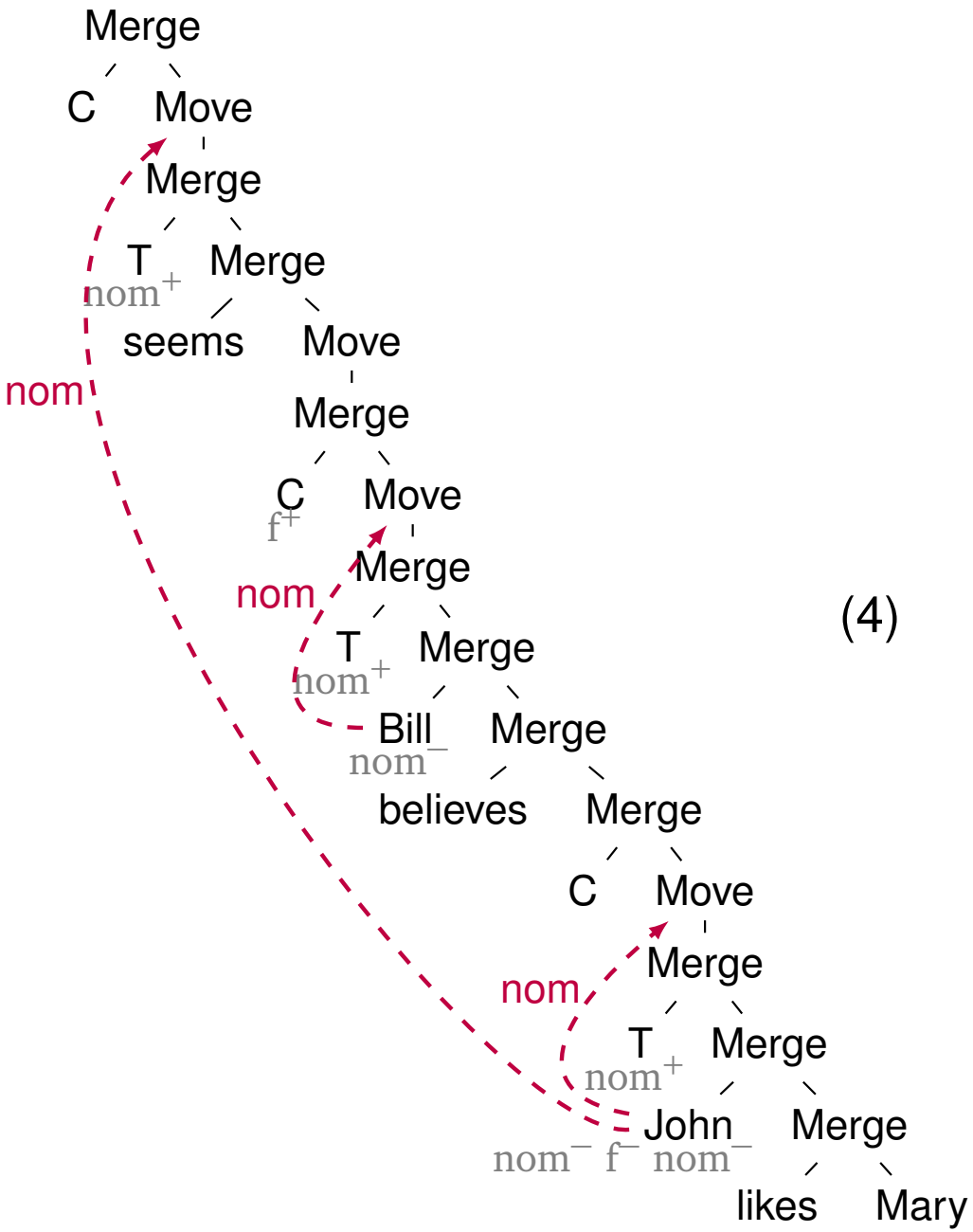
Superraising



Superraising



Superraising



(4) * John seems Bill believes likes Mary

Freezing Effects

- One could also get overlapping paths by extracting an f-mover from within an f-mover.
- But this produces freezing effects.

(5) It seems your comment about John annoys Sue.

(6) * John seems your comment about t annoys Sue.

(7) * Who don't you know [which pictures of t] Mary bought.

Wh-Islands

- Multiple A′-movers of the same type would also be an option.
- But here the wh-island constraint intervenes.

(8) a. What$_{wh}$ did John say Mary gave t_{wh} to Bill?

b. * What$_{wh0}$ did John say who$_{wh1}$ Mary gave t_{wh0} to t_{wh1}? (Wh-island violation)

c. * What$_{wh0}$ did Bill think which$_{wh1}$ man t_{wh1} says who$_{wh1}$ Mary gave t_{wh0} to t_{wh1}?

d. * What$_{wh0}$ did Sue claim who$_{wh1}$ Bill thinks which$_{wh2}$ man t_{wh2} says Mary gave t_{wh0} to t_{wh1}?

Taking Stock

- MGs are all about two structure-building operations: **Merge** and **Move**.
- Intermediate movement complicates formalism
- SMNF simplifies MGs, but at the risk of larger lexicons.
- Realistic grammars block the truly dangerous configurations.
- Unclear whether this is **coincidence or conspiracy**

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