Mereological Syntax

David Adger

Department of Linguistics
Queen Mary University of London

Geneva, Research Seminar
22nd November 2022

Sets as the unordered data-structure

- Classical (LSLT) theories of phrase structure: hierarchy, category (labels), order—modelled by labelled sets of strings
- 80s: get rid of order (strings). What are you left with? Chomsky's 1990s answer was that you are left with labelled sets:

(1) Merge(α, β) = $\{\gamma, \{\alpha, \beta\}\}$

Here the label is represented in the syntactic structure (residue of PS-rules)

Sets as the unordered data-structure

- Seems like a complicated definition
- The simplest object constructed from α and β is the set $\{\alpha, \beta\}$ (cf. Chomsky (1995) p243), putting aside labelling information.

(2) Merge(α, β) = $\{\alpha, \beta\}$

Sets as the unordered data-structure

- Search based approach for labelling (Chomsky (2013), Chomsky (2015)) so label is not part of structure

  (3) {{the, {n, cat}},{ 's, {n, tail}}}

- A problem: how do we know the the whole structure is targeted, rather than the 'bar-level' (cf., Adger 2013)?
- ... requires a richer theory of what labels (e.g. Cecchetto and Donati 2015)

Empty Set Issues

One side effect of taking syntactic objects to be sets is that we have the empty set. Is there evidence for the empty set being part of syntax?

- De Belder and van Craenenbroeck (2015): every derivation begins with the empty set being Merged with another element (a set containing various features that they represent as $\{\alpha\}$, yielding an ordered pair $< \{\alpha\}, \emptyset >$. They argue that $\emptyset$ provides a position for late insertion of roots, so it is explanatorily effective.
- but this stipulates the empty set. Nothing special. Could just be some random dummy object. No argument here.

Two types of syntactic objects?

(4) $A \neq \{A\}$

Lexical items are syntactic objects which are not sets (or if they are they somehow have to be unsetified to act as units), and the outputs of Merge are syntactic objects which are sets. A tad profligate.

LCA and Self-Merge

Guimaraes (2000), Kayne (2010): a means to solve an issue with the LCA when two heads are Merged:

(5) $\{A, B\}$

No asymmetric c-command.

(6) a. Merge(A, A) = $\{A, A\}$ = $\{A\}$
b. Merge(B, $\{A\}$)

B asymmetrically c-commands A.

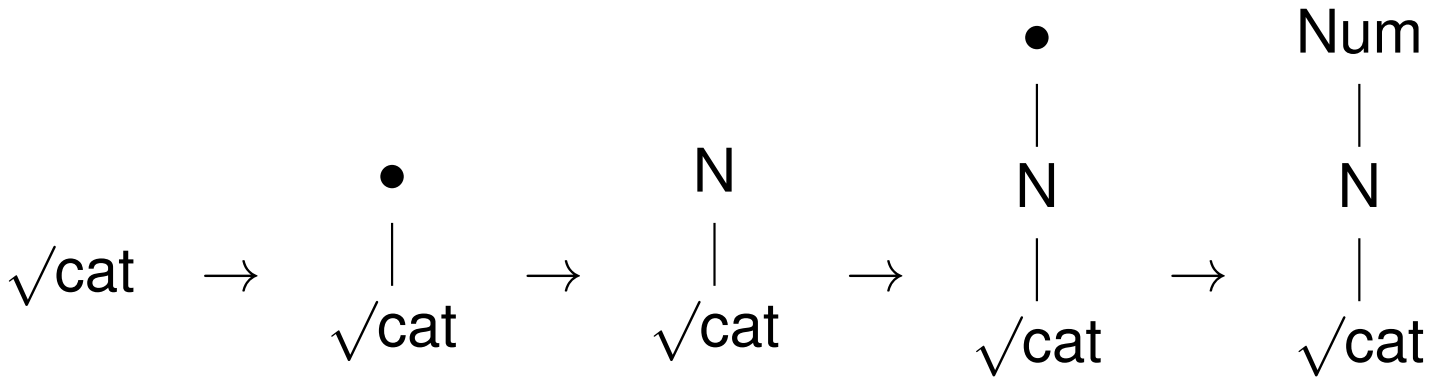
Extended Projection and Self-Merge

A more substantial use of the unary set idea is from my 2013 monograph: roots self-Merge to create telescoped extended projections as in Brody (2000)

(7) Merge($\sqrt{cat}$,$\sqrt{cat}$) = $\{\sqrt{cat}, \sqrt{cat}\} = \{\sqrt{cat}\}$.

Requires a label:

(8)



Issues with Self-Merge

General problem: Self-Merge is essentially Internal Merge (since the second argument is something that already exists)

(9) Merge($\sqrt{}$cat,$\sqrt{}$cat) = $\{\sqrt{}$cat, $\sqrt{}$cat$\}$ = $\{\sqrt{}$cat$\}$.

But Internal Merge seeks terms, and terms are defined via (the transitive closure of) membership. However, $a \notin a$, so a is not a term of a. To allow Self-Merge, we must complicate the definition of term:

(10) A is a term of B iff

a. A = B or

b. A $\in^*$ B, where $\in^*$ is the transitive closure of the member relation

More Term problems

The fundamental relationship of set membership is not transitive: but the notion of *term* is crucial to the operation of Merge. Means that there is a special kind of syntactic object that is not given by Merge.

> *...to apply Merge in the course of a derivation, when possible Σ selects a pair <P, Q> with one a term of the other (where X is a term of Y if X is a member of Y or a member of a term of Y)* *Chomsky (2021, p.17)*

Set theory is too expressive and not expressive enough.

Copy Problems

The standard approach:

(11) a. a
b. b
c. $c = \{a, b\}$
d. $d = \{b, \{a, b\}\}$

Here the syntactic object d has two terms that are inscriptionally identical (both have the form b). There are two derivational routes to d: External Merge of b twice, or Internal Merge of b:

(12) a. The window broke ⟨the window⟩
b. The window broke the window

Copy Problems

- A side effect of the set theoretic perspective is that some mechanism needs to distinguish copies (where there is a single element in the derivation) from inscriptionally identical repetitions.
- Collins and Groat 2018: indices, occurrences, memory stores. Chomsky (2021) suggests a rule FormCopy that assigns the relation *Copy* to identical inscriptions.

Summary

1. extra theory of labelling needed;
2. Attempts to find $\emptyset$ in syntax are strained at best;
3. $a \neq \{a\}$ consequence of set-theory is problematic (2 types of objects) and its efficacy in the theory dubious;
4. We need to add an extra recursive definition to the system to get the crucial notion of term;
5. Doesn't seem the right model for dependencies, as gives rise to the copy problem;
6. As a model for the relevant cognitive object, abstract sets seem implausible

Set theory is too expressive and not expressive enough.

Rethink from the ground up!

(13) Subjoin(x,y) = y modified so that x $<_d$ y

- for the moment stipulate: y is a whole (not part of anything else) and x is a part (cf. Extension Condition)
- $<_d$ is the standard 'part' relation of classical mereology (Coitnoir and Varzi 2021):

(14)
a. reflexive (so $\forall$x. x$<_d$x),
b. transitive (so if x$<_d$y and y$<_d$z, then x$<_d$z)
c. (hence it is) antisymmetric (so if x$<_d$y, and y$<_d$x, then x=y)

Rethink from the ground up!

This is a mereology that has the following properties (Fine 2010):

- constructive: wholes are built up from parts
- hylomorphic: the whole is the sum of its parts plus something else that makes the whole the whole (a principle of organization)
- pluralistic (there are ways of being a part)

(Mereologists don't usually think of the principle of organization as an algorithm for constructing parts, but I propose to.)

Dimensionality

d here is a variable over dimensions, which are 'different ways of being a part' (Fine 2010).

(15) Dimensions restrict transitivity of parthood.

A heart is part of a person, and a person may be part of an orchestra, but that does not entail that a heart is part of an orchestra. The part-of relations are in different dimensions. Transitivity holds within but not across dimensions (e.g. Rescher 1955).

Subjunction

(16) Subjoin(a, b) $\rightarrow b$, but after Subjoin, $a <_d b$

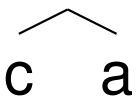
(sometimes I'll write: $a \oplus b \rightarrow b'$, where $'$ is used to distinguish b before and after Subjunction of a.)

As a 'tree':

(17) $a \oplus b = b' \rightarrow$

Dimensionality Derived

(18) Subjoin$(c, b) \rightarrow b : c <_d b$ =

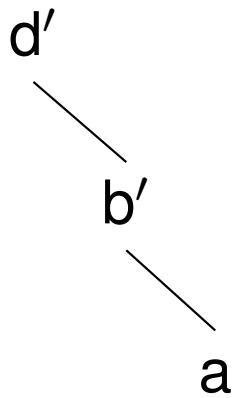


(19) Dimensionality of the part relation is read off of the derivational step:

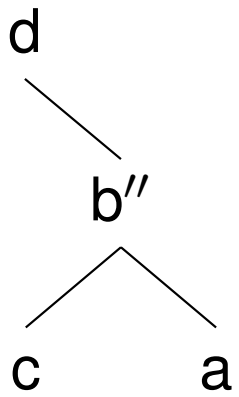
a. The first application of Subjoin is in dimension 1.

b. If an object already has a part in dimension 1, then an application of Subjoin will be the second application, and hence in dimension 2. etc.

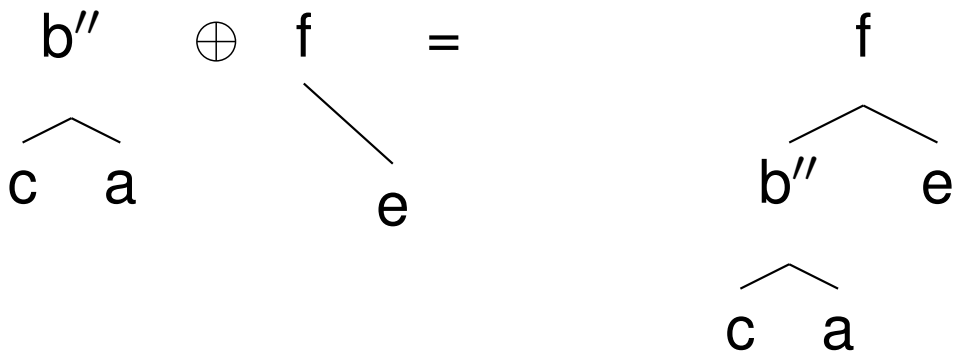
$\text{Subjoin}(b', d) \rightarrow d : b' <_d d'$



Subjoin(b'', d) $\rightarrow$



Subjoining complex objects



Merge vs Subjoin

(20) **Merge**

a. applies to two pre-existing objects and creates a new object;
b. builds a linearly unordered set,
c. creates an asymmetric relation member-of between the new object and the arguments of Merge;
d. The transitive closure of this gives *terms*.
e. There is a distinction between the output of Merge(a, a) and a (that is $a \neq \{a\}$), so there are two kinds of syntactic objects.
f. Merge(x,y)=z creates two new relations ($x \in z \wedge y \in z$)
g. Merge maps from (pairs of) objects to sets and from (pairs of) objects or sets to sets.

Merge vs Subjoin

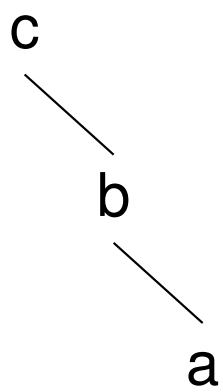
(21) **Subjoin**

a. applies to two pre-existing objects *which have labels* and modifies one of these;
b. builds a linearly unordered mereological object,
c. creates an asymmetric relation part-of between the arguments of Subjoin;
d. Nothing special needs to be said about transitivity, as part-of is transitive.
e. Only one kind of syntactic object.
f. Subjoin(x,y)=z creates one new relation ($x <_d z$)
g. Subjoin maps from (pairs of) objects to objects.

Merge vs Subjoin

- Subjoin adds one part-of relation; Merge adds two new (member-of) relations.
- LSLT: syntactic objects involve ordering and 'joining'. Merge got rid of ordering, but kept 'joining' (the arguments of Merge are the constituent parts of its result). Subjoin replaces 'joining' with a relation that directly expresses part-whole.
- No Tampering? Subjoin tampers, adding $<_d$
- No 'empty' object analogous to the empty set; nor anything analogous to $a \neq \{a\}$
- No special definition of *term*, since $<_d$ is transitive

Transitivity in Dimensions

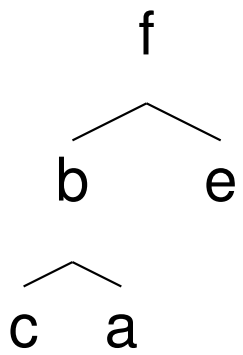


It is clear that $a <_1 b$ and $b <_1 c$. Since $<_1$ is transitive, it follows that $a <_1 c$

Transitivity in Dimensions

Parthood in the second dimension works in just the same way:

(22)



Since $c <_2 b$ and $b <_2 f$, it follows that $c <_2 f$

Since the dimensionality of *a*'s parthood relation to *b* is different from the dimensionality of *b*'s parthood relation to *f*, *a* is not part of *f* in either dimension.

Interpretation of Dimensions

(23) Proposal:

a. Dimension 1 is interpreted as the extended projection complement relation (Grimshaw 1991).

b. Dimension 2 is interpreted as the specifier relation.

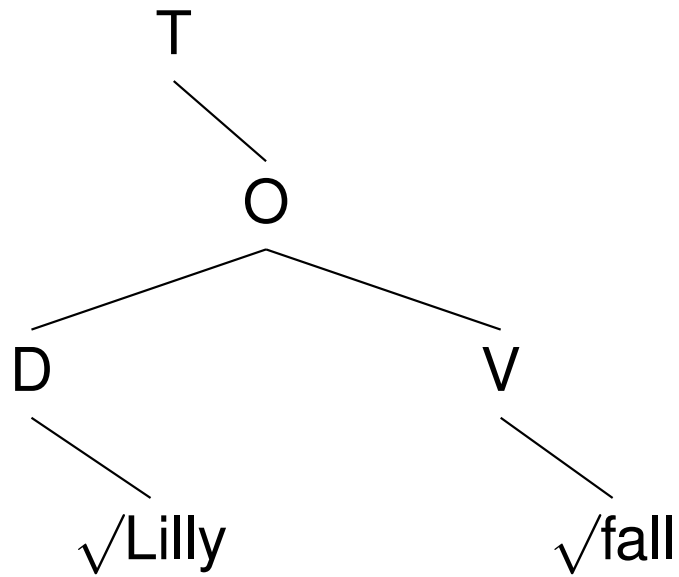
If x is $<_1$ y, x is in the same extended projection as y and is 'lower'. If x is $<_2$ y, x is a specifier (or a specifier of a specifier, etc.) of y.

A Derivation

(24)
a. Subjoin($\sqrt{\text{fall}}$, V) = V' : $\sqrt{\text{fall}} <_1 V'$
b. Subjoin(V', O) = O' : $V' <_1 O'$
c. Subjoin($\sqrt{\text{Lilly}}$, D) = D' : $\sqrt{\text{Lilly}} <_1 D'$
d. Subjoin(D', O') = O'' : $D' <_2 O''$
e. Subjoin(O'', T) = T' : $O'' <_1 T'$

The primes are just to keep track of the objects, and are not part of the theory.

A Syntactic Object



D is not a part of T in any dimension (though it is part of T if part is dimensionally unrestricted, perhaps Agree?).

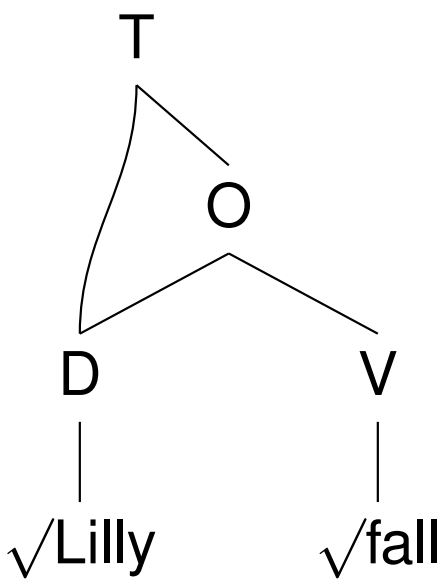
Dependency

(25) Subjoin(D, T) = D $<_?$ T

a. $?\neq$ 1, T already has a 1-part

b. ?= 2

(26)

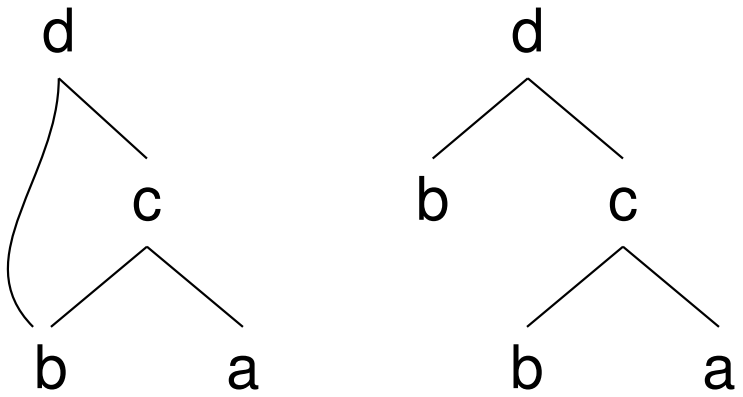


Multidominance derived

- Just as in BPS, the equivalent of movement in this approach involves the application of the same function as is used to build any structure at all, unifying structure building with structure change.
- Given that there is only one operation (Subjoin), and all it does is add part relations, there's no 'copy' problem, as there are no copies.

There are no copies

(27)



There's no meaning to the inscriptional identicality here. Objects are distinct from other objects. How one writes them is irrelevant. It's what one does with them that matters.

Collins and Groat

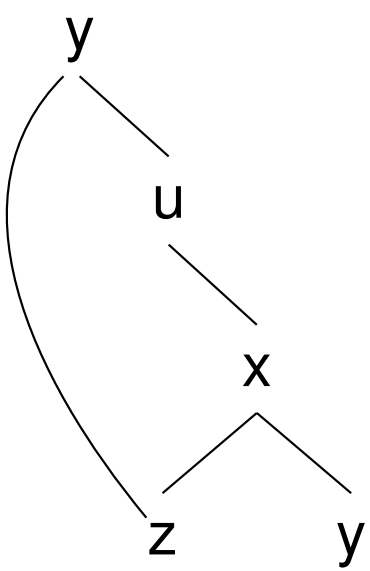
- Minimalist syntactic objects should be understood set-theoretically; multidominance makes no sense from this perspective—well, syntactic objects are not sets.
- multidominance representations are graphs so syntactic objects involving them require a more complex constructional system than is desirable—the operation building mereological objects is not obviously more complex than Merge.

Geometrical Locality

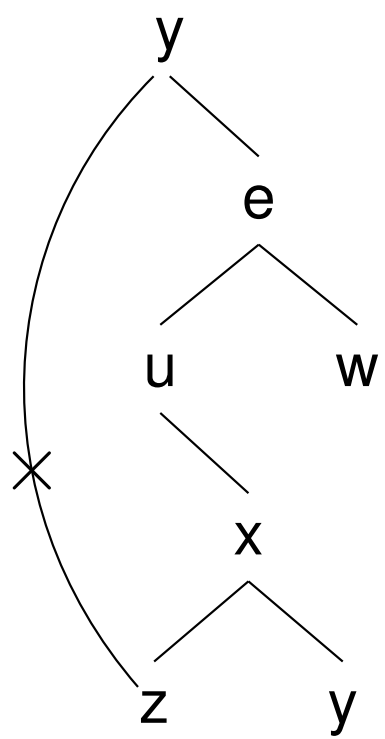
(28) Angle-based Locality: A can Subjoin to B only if there is a C, A a 2-part of C, and C a 1-part of B

(only applies if A is already Subjoined)

(29) (a)



(b)



Locality

- (a) obeys Locality as z is a 2-part of x, and x (by transitivity) is a 1-part of y, so z can be Subjoined into y. In
- In (b), the sub-structure with u as its maximal part is a 2-part of e. Given that, Locality rules out (b): z is a 2-part of x, and x is a 1-part of u, but u is not a 1-part of y.
- Locality essentially places a restriction between dependencies that they operate within the confines of an extended projection (though we'll see that there is a loophole in this below).

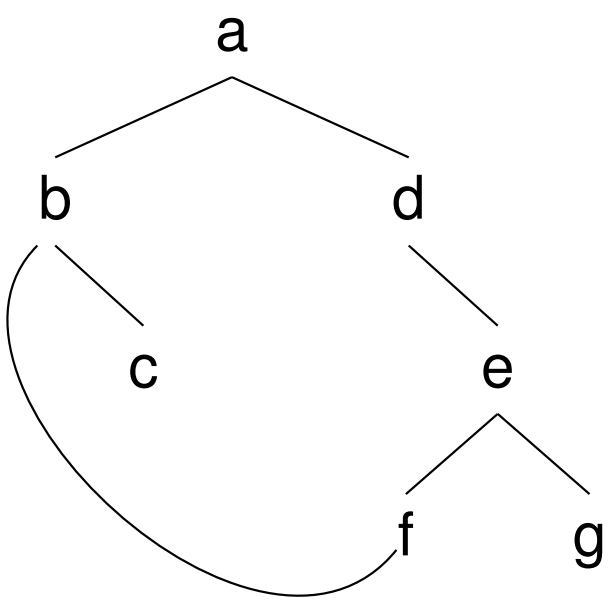
Parallel Subjoin

(30)

Locality will rule (30) out, since for a to Subjoin to d, b, which a is a 2-part of, must be a 1-part of d, and it's not. The system then rules out parallel merge derivations, even though it is essentially a multidominance system.

‘Sidewards Movement’

(31)



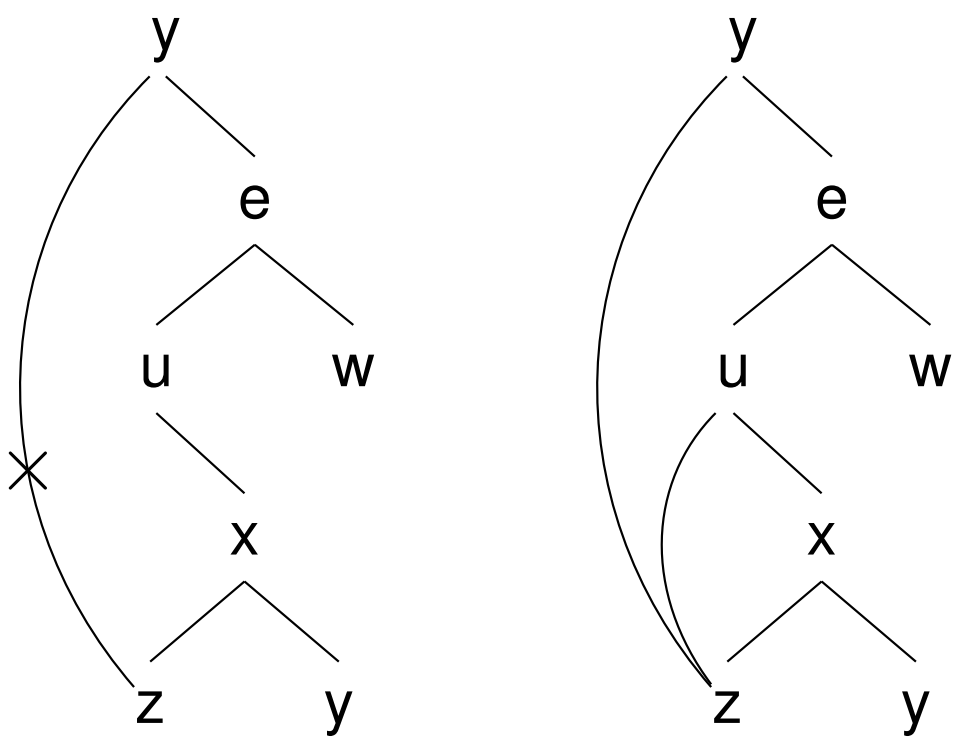
Here f is a 2-part of e, but e is not a 1-part of b, so Locality prohibits f being a 2-part of b.

Too strict?

Locality constrains non-local parthood to be between specs in an extended projection. However, given that all arguments in this system are specifiers (2-parts), this would seem to rule out all non-local dependencies from an argument to higher in the structure, incorrectly ruling out, for example, extraction from argument CPs etc.

No!

(32)



Subextraction

Extraction from a PP extended projection is blocked when the specifier is filled.

(33) a. Whose nostril did the doctor look [[very far] into ⟨whose nostril⟩] ?

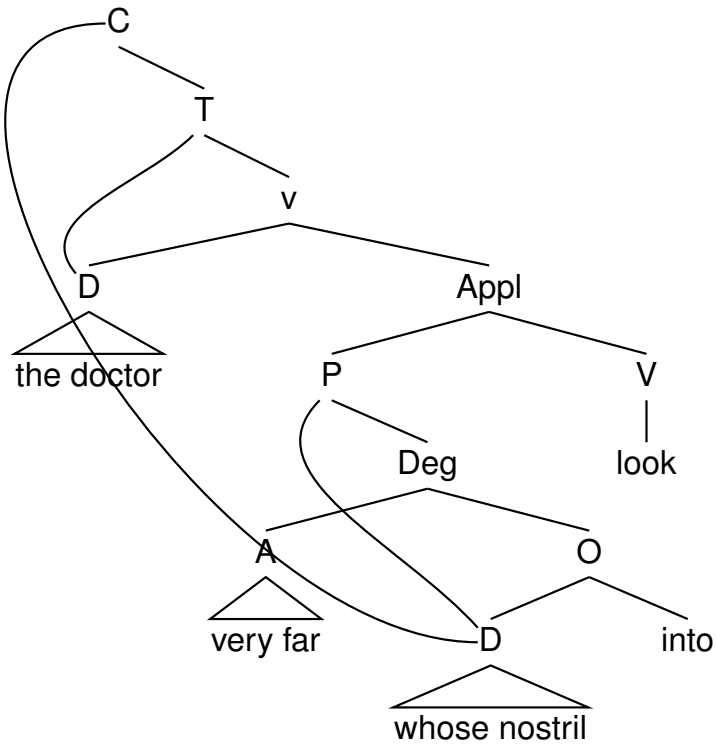
b. How far did the doctor look [⟨how far⟩ into [your nostril]]?

(34) a. *Whose nostril did the doctor look [[how far] into ⟨whose nostril⟩] ?

b. How far did the doctor look [into [whose nostril]]?

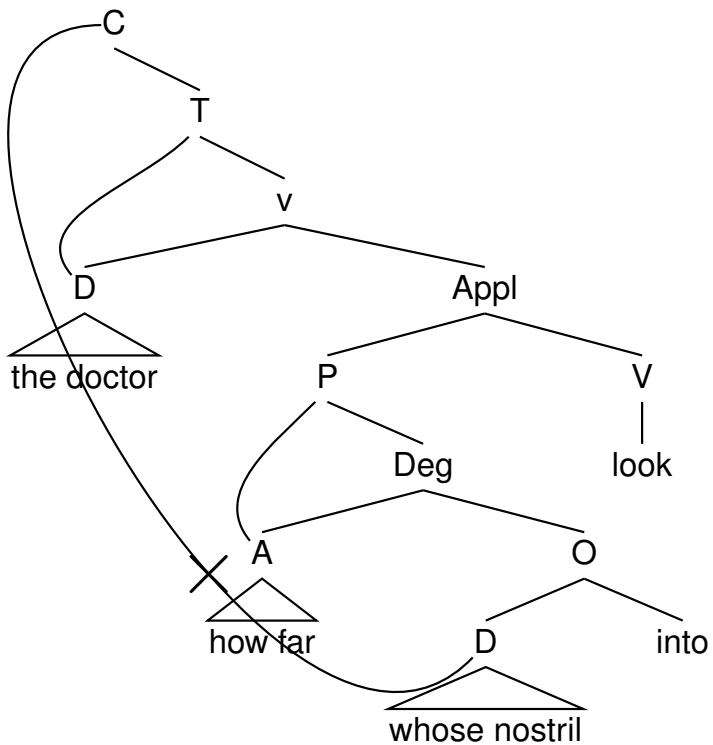
Subextraction

object can be a $<_2$ of P, so Locality is met



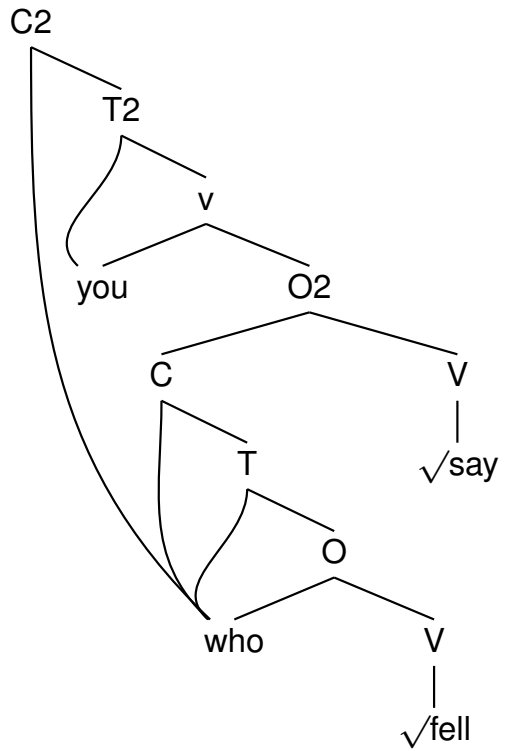
Subextraction

P already has a $<_2$, Locality violated



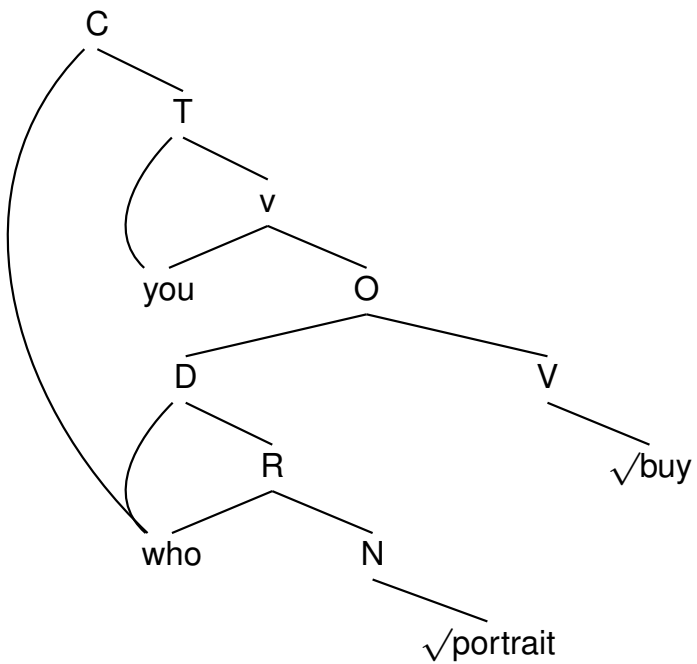
Cross-clause Extraction is Subextraction

(35) (guess) who you said fell?



Subextraction from DP

(36) Who did you buy a portrait of?



A contrast in DP islands

(37) a. ?Who did you buy Anson's portrait of?
b. *Who did you buy which artist's portrait of?

If possessors do not move to the edge of DP, but wh-possessors are forced to, then we can model this.

Even deeper embedding?

Comparative Subdeletion in Norwegian (Taraldsen 1979)

(38) Han er [likke mange] studenters ven som han er [$_{DP1}$
he is as many students friend as he is
[$_{DP2}$ laereres] fiende]
teachers enemy
"He is as many students' friend as he is that number of students' enemy"

Transitivity of $<_2$ relation between [*likke mange*] and DP2, between DP2 and DP1 and between DP1 and the predicate allows it to be a 2-part of the comparative clause headed by *som*, escaping subjacency-type effects.

Scope

Inverse linking:

(39) a. some inhabitant of every midwestern city participated

b. someone who inhabits every midwestern city participated

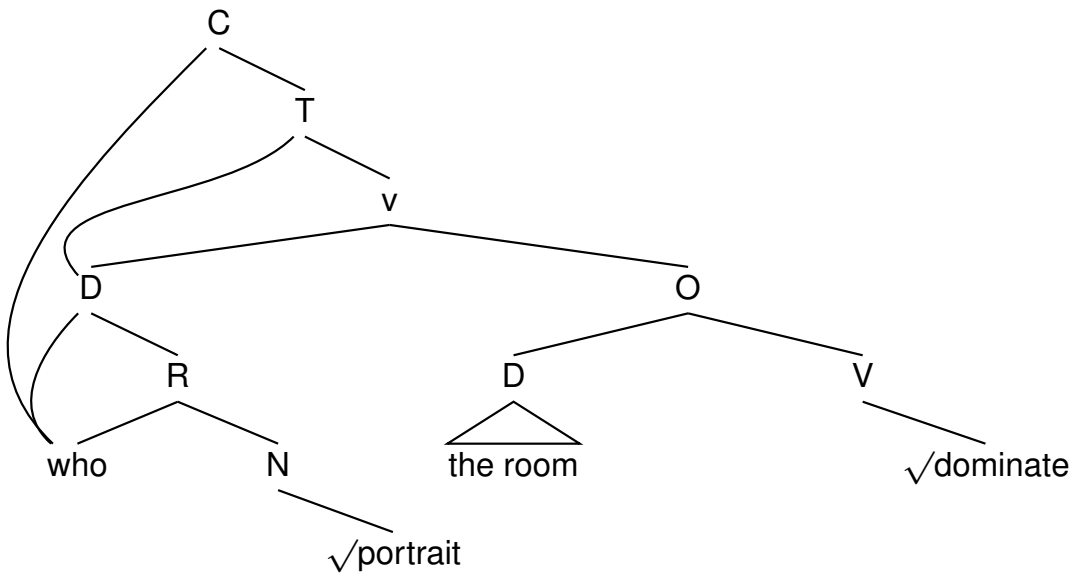
(40) Every country's queen thought she should be an absolute monarch.

Finis—in medias res

- Linearization
- Subjunction gives scope, but scope itself is not dimensionally restricted (cf Agree)
- No head movement (because no heads); roll-up (impossible if items can't change dimension); no sideways movement (because of the way locality is defined), no countercyclic operations (since Subjoin creates a part-whole relation)
- infinitival embedding/restructuring (1-part or 2 part?)

Extraction from Subjects

(41) *Who did a portrait of dominate the room?



No contrast predicted. There is quite a bit of discussion about whether these subject islands should be captured syntactically (Chavez etc.)

A possible way through?

(42) Locality: x can Subjoin to y only if there is a **unique** z, x a 2-part of z, and z a 1-part of y

This will allow all the cases we have seen so far, but rule out subextraction from subjects.

Adger, David. 2013. *A Syntax of Substance*. Cambridge, MA: MIT Press.

Brody, Michael. 2000. Mirror theory: syntactic representation in perfect syntax. *Linguistic Inquiry* 31:29–56.

Cecchetto, Carlo and Donati, Caterina. 2015. *(Re)labeling*, volume 70. Cambdridge, MA: MIT Press.

Chomsky, Noam. 1995. *The Minimalist Program*. Cambridge, MA: MIT Press.

Chomsky, Noam. 2013. Problems of projection. *Lingua* 130:33 – 49.

Chomsky, Noam. 2015. Problems of projection: Extensions. In Elisa Di Domenico, Cornelia Hamann, and Simona Matteini, eds., *Structures, strategies and*

beyond: Studies in honour of Adriana Belletti, volume 223, 1–16, Amsterdam: John Benjamins.

Chomsky, Noam. 2021. Minimalism: Where are we now, and where can we hope to go. *Gengo Kenkyu* 160.

Coitnoir, A. J. and Varzi, Achille C. 2021. *Mereology*. Oxford, UK: Oxford University Press.

Collins, Chris and Groat, Erich. 2018. Distinguishing copies and repetitions, ms. ling. auf. net/lingbuzz/003809.

De Belder, Marijke and van Craenenbroeck, Jeroen. 2015. How to merge a root. *Linguistic Inquiry* 46:625–655.

Fine, Kit. 2010. Towards a theory of part. *The Journal of Philosophy* 107:559–589.

Grimshaw, Jane. 1991. Extended projections, ms, Brandeis University.

Guimaraes, Maximiliano. 2000. In defense of vacuous projections in bare phrase structure. *University of Maryland Working Papers in Linguistics* 9:90–115.

Kayne, Richard S. 2010. Antisymmetry and the lexicon. In Anna Maria Di Sciullo and Cedric Boeckx, eds., *The Biolinguistic Enterprise*, chapter 14, 329–353, Oxford, UK: Oxford University Press.

Rescher, N. 1955. Axioms for the part relation. *Philosophical Studies* 6:8–11.