Projecting Dependency: CCG and Minimalism

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"Chomsky's Minimalist work began to appear, and I thought to myself: hey, this is like categorial grammar with movement, that's very cool." (Adger, 2016)

Prospectus

- The central problem in the theory of grammar is displacement or non-adjacent dependency.

- The response to this has been to introduce discontinuity or action-at-a-distance in rules of grammar, of which Movement is the general case.

- However, such rules are typically so expressive as to require otherwise unmotivated attendant constraints, making their explanatory value questionable.

- The present paper reduces movement to pure type-dependent merger of contiguous categories.

Prospectus (Contd.)

- The key assumptions are:
  - **Categorial Grammar**: All constituents bear a Category of either a function or an argument.
  - **Case**: Counterintuitively, entities such as subjects and objects are functors, being syntactically and semantically type-raised lexically to make verbs their arguments.
  - **Combinatory Rules**: Merger is generalized from simple application of functions to contiguous arguments to composition of contiguous functions, generalizing the classical notion of constituency.
- The result is to reduce the combination of all "moved" elements with their residues to exactly the same rules of adjacent merger as that of the corresponding "in situ" complements with their heads.

Inclusiveness

- The Inclusiveness Condition of Chomsky (1995b), and its predecessor the Projection Principle Chomsky (1981), require that all language-specific details of combinatory potential, such as category, subcategorization, agreement, and the like, must be specified at the level of the lexicon, and must be either "checked" or "projected" unchanged by language-independent universal rules onto the constituents of the syntactic derivation.

- In particular, the derivation cannot add any information such as "indices, traces, syntactic categories or bar-levels and so on" that has not already been specified there (Chomsky, 2001, 2001/2004).

Movement

- Movement seems to pose a problem for Inclusiveness.

- Consider the following familiar example (Frost, 1923):

  (1) [[Whose woods]$_i$ these are t$_i$]$_j$ I think I know t$_j$.

- Such examples have appeared to require the inclusion of discontinuity or displacement in rules themselves, such as the rule MOVE, sometimes called "internal merge",

Copies

- Nowadays, movement is usually talked of in terms of "copying", rather than traces:

(2) [[Whose woods] these are [whose woods]] I think I know [[whose woods] these are [whose woods]].

- Crucially, copies are thought of as identical, in the sense of being mysteriously simultaneously instantiated by the derivation (Epstein and Seely, 2006; Chomsky, 2007).
- This suggests the upper "attractor" copy is a variable binder, while the lower "in situ" or "internal" copy is its bound variable, as in the post-derivational LF conversions of Fox (2002) and Heim and Kratzer (1998).
- Inclusiveness seems to require that such binding be established in the lexicon.

Locality

- We are used to the idea that:

(a) subcategorization is specified locally, in the lexicon, and
(b) the language-specific linearization of those arguments at the level of phonetic form (pf) is not necessarily the same as their universal order of dominance at the level of lexical logical form, represented here as a λ-term:.

(3) a. sees := $(S\backslash NP_{3s})/NP : \lambda x\lambda y.pres(see\,x\,y)$
b. Mary sees movies := $S : pres(see\,movies\,mary)$

- Note the resemblance of Bare Phrase Structure "uninterpretable features" in "see" [V, *u*N, *u*N] (Chomsky, 1995a; Adger, 2003) to CG slashes

- Both denote selection, rather than GPSG style extraction

A-movement

- Inclusiveness says we must also specify "raising" or A movement in the lexicon. Well, why not?

(4) a. seems := $(S\backslash NP_{3s})/VP_{to} : \lambda p \lambda y.pres(seem\,(p\,y))$
b. Mary seems to be happy := $S : pres\,(seem\,(happy\,mary)$

- The binder λy and the bound y do the work of copy-movement: the y are identical and simultaneously instantiated at the level of lf by the value *mary*. The variable y is dominated by tense, while the binder λy dominates tense, and the NP "Mary" is aligned to the left of "seems" in pf by the syntactic type.

- (4) builds A-movement in to the lexical entry.

- In fact, the same was true for simple subcategorization (3).

Case and Lexical Type-raising

- For reasons that will become apparent later, CCG assumes that arguments such as subjects and other NPs are lexically type-raised to be (second-order) functors over the verbs that subcategorize for them as subject, object, etc.:

(5) Mary := $S/(S\backslash NP) : \lambda p.p\,mary$
$(S\backslash NP)\backslash((S\backslash NP)/NP) : \lambda p.p\,mary$
etc.

- We identify these categories with (nominative, accusative etc.) Case, despite its morpholexical ambiguity in English, resolved by rigid word order, unlike Latin. (Cf. Vergnaud, 1977/2006).
- Since the main effect of case-as-type-raising is to reverse the direction of combination, and the lf is invariant, it will often be convenient to abbreviate raised types as e.g. $NP^{\uparrow}$, meaning "whatever raised type the derivation needs."

Application Merge

- The two simplest forms of directionally-specified contiguous merge constitute application of a function to an argument:

(6) *Contiguous Merge I: The Application Rules:*

a. Forward Application

$$X/_{\star}Y : f \quad Y : a \quad \Rightarrow \quad X : f\,a \qquad (>)$$

b. Backward Application

$$Y : a \quad X\backslash_{\star}Y : f \quad \Rightarrow \quad X : f\,a \qquad (<)$$

- Like all rules here, Application is subject to the Principle of Adjacency that all inputs must be string-adjacent and non-empty, and the Principle of Consistency, that combination must be consistent with the directionality of the governing category X/Y or $X\backslash Y$.

Application-only Derivations

- Thus we have:

(7)

$$\dfrac{\dfrac{\text{Mary}}{S/(S\backslash NP) : \lambda p.p\,mary} \quad \dfrac{\dfrac{\text{sees}}{(S\backslash NP)/NP : \lambda x \lambda y.pres\,(see\,x\,y)} \quad \dfrac{\text{movies}}{(S\backslash NP)\backslash((S\backslash NP)/NP) : \lambda p.p\,movies}}{S/NP : \lambda y.pres\,(see\,movies\,y)}{<}}{S : pres\,(see\,movies\,mary)}{>}$$

(8)

$$\dfrac{\dfrac{\text{Mary}}{S/(S\backslash NP) : \lambda p.p\,mary} \quad \dfrac{\dfrac{\text{seems}}{(S\backslash NP)/AP : \lambda p \lambda y.pres\,(seem\,(p\,y))} \quad \dfrac{\text{happy}}{(S\backslash NP)\backslash((S\backslash NP)/AP) : \lambda p.p\,happy}}{S/NP : \lambda y.pres\,(seem\,(happy\,y))}{<}}{S : pres\,(seem\,(happy\,mary))}{>}$$

Composition Merge

- Functor categories can not only apply: they can also compose with another functor to yield a new functor:

(9) *Contiguous Merge IIa: The Composition Rules (**B**):*

a. Forward Composition:

$$X/_{\diamond}Y : f \quad Y/Z : g \quad \Rightarrow \quad X/Z : \lambda z.f\,(g\,z) \qquad (>\mathbf{B}\ )$$

b. Backward Composition:

$$Y\backslash Z : g \quad X\backslash_{\diamond}Y : f \quad \Rightarrow \quad X\backslash Z : \lambda z.f\,(g\,z) \qquad (<\mathbf{B}\ )$$

c. Forward Crossing Composition:

$$X/_{\times}Y : f \quad Y\backslash Z : g \quad \Rightarrow \quad X\backslash Z : \lambda z.f\,(g\,z) \qquad (>\mathbf{B}_{\times})$$

d. Backward Crossing Composition:

$$Y/Z : g \quad X\backslash_{\times}Y : f \quad \Rightarrow \quad X/Z : \lambda z.f\,(g\,z) \qquad (<\mathbf{B}_{\times})$$

- The above rules conform to a further Principle of Inheritance that any argument Z that appears on the result must have the same directionality as on the input.

Raising and *There*-Insertion

- (10)

$$\begin{array}{ccccc}
\text{Fairies} & \text{seem} & \text{to} & \text{be} & \text{at the bottom of our garden.}\\
\hline
S/(S\backslash NP_{3p}) & (S_{pred}\backslash NP_{3p})/VP_{to,pred} & VP_{to,pred}/VP_{pred} & VP_{pred}/XP_{pred} & PP^{\uparrow}_{pred_{stg}}\\
:\lambda p.p\,fairies & :\lambda p\lambda y.pres\,(seem\,(p\,y)) & :\lambda p\lambda y.p\,y & :\lambda p\lambda y.p\,y & :\lambda y.at\,(bottom\,garden)\,y
\end{array}$$

$$\xrightarrow{>\mathbf{B}}\quad VP_{to,pred}/XP_{pred} : \lambda p\lambda y.p\,y$$

$$\xrightarrow{>\mathbf{B}}\quad (S_{pred}\backslash NP_{3p})/VP_{to,pred} : \lambda p\lambda y.pres\,(seem\,(p\,y))$$

$$\xrightarrow{<}\quad S_{pred_{stg}}\backslash NP_{3p} : \lambda y.pres\,(seem\,(at\,(bottom\,garden))\,y))$$

$$\xrightarrow{>}\quad S_{pred_{stg}} : pres\,(seem\,(at\,(bottom\,garden))\,fairies))$$

- (11)

$$\begin{array}{cccc}
\text{There} & \text{seem to be} & \text{fairies} & \text{at the bottom of our garden.}\\
\hline
((S/XP_{pred_{stg}})/NP_{agr_i})/((S_{pred_{stg}}\backslash NP_{agr_i})/XP_{pred_{stg}}) & (S_{pred}\backslash NP_{3p})/XP_{pred} & NP^{\uparrow}_{3p} & PP^{\uparrow}_{pred_{stg}}\\
:\lambda c\lambda y\lambda p.c\,(p\,y)\land \textbf{new}\,y & :\lambda p\lambda y.pres\,(seem\,(p\,y)) & :\lambda p.p\,fairies & :\lambda y.at\,(bottom\,garden)\,y
\end{array}$$

$$\xrightarrow{>}\quad (S/XP_{pred_{stg}})/NP_{3p} : \lambda y\lambda p.pres\,(seem\,(p\,y))\land \textbf{new}\,y$$

$$\xrightarrow{<}\quad S_{pred_{stg}}/XP_{pred_{stg}} : \lambda p.pres\,(seem\,(p\,fairies))\land \textbf{new}\,fairies$$

$$\xrightarrow{>}\quad S : pres\,(seem\,(at\,(bottom\,garden)\,fairies))\land \textbf{new}\,fairies$$

What about $\overline{\mathrm{A}}$-movement?

- Inclusiveness seems to require also lexicalizing $\overline{\mathrm{A}}$-movement.
- Doing so will fully reduce MOVE to contiguous MERGE.
- Such a result will finally deliver on the promise of Epstein *et al.* (1998); Chomsky (2001/2004), and Epstein and Seely (2006), by formally defining "internal" merge as "external" or type-dependent, rather than structure-dependent.

Lexicalizing $\overline{\mathrm{A}}$-movement

- There seem to be two ways to lexicalize $\overline{\mathrm{A}}$-movement:
  1. The verb is the head of the *wh*-dependency (TAG, Joshi and Schabes, 1997; GPSG, Gazdar, 1981):
  2. The *wh*-item is the head of the *wh*-dependency (CCG, Steedman, 1987, 1996):

     a. who $:= S_{whq}/(S_{inv}/NP) : \lambda p.p\, who$

     b. [Who]$_{S_{whq}/(S_{inv}/NP)}$ [does Mary see]$_{S_{inv}/NP}$ $:= S : pres\,(see\, who\, mary)$
  - The lexical category (a) for “who” defines the unbounded domain of the *wh*-dependency via the variable p.
  - “Does Mary see” in (b) must be derived as a constituent of type S_{inv}/NP, in which $/NP$ indicates general selection, rather than anything specific to extraction, as follows:

Wh-questions

- (12)

$$
\begin{array}{cccc}
\text{Who} & \text{does} & \text{Mary} & \text{see?} \\
\hline
S_{whq}/(S_{inv}/NP) & (S_{inv}/VP)/NP_{3s} & (S/VP)\backslash((S/VP))/NP_{3s} & VP/NP \\
: \lambda p \lambda x.p\,x & : \lambda y \lambda p.pres\,(p\,y) & : \lambda p.p\,mary & : \lambda x \lambda y.see\,x\,y \\
\end{array}
$$

$$\xrightarrow{<}\quad S_{inv}/VP : \lambda p.pres\,(p\,mary)$$

$$\xrightarrow{>\mathbf{B}}\quad S_{inv}/NP : \lambda x.pres\,(see\,x\,mary)$$

$$\xrightarrow{>}\quad S_{whq} : \lambda x.pres\,(see\,x\,mary)$$

(13) a. Who bought what?
b. *What did who buy?

(14) a. Who knows who$_{S_{iq}/(S\backslash NP)}$ bought$_{(S\backslash NP)/NP}$ what$_{S_{iq}\backslash(S_{iq}/NP)}$?
b. Who knows what$_{S_{iq}/(S/NP)}$ who$_{S_{iq}/(S\backslash NP)}$ bought$_{(S\backslash NP)/NP}$?

- "In situ" and "moved" *wh*-items differ only in directionality.

Remnant/Head movement

- Derivation (12) depended on (a) assigning a fronting "mover" category $S/(S/NP)$ to "who"; (b) the remainder of the sentence composing to form its argument S/NP.
- In English, even if if we were to allow infinitival VO verbs a fronting category $S/(S/(VP/NP))$, the residue $S/(VP/NP)$ cannot compose.
- However, German can and does do exactly this with its OV verbs:

(15)

$$\begin{array}{cccc}
\text{Essen} & \text{wird} & \text{er} & \text{Äpfel} \\
\text{Eat} & \text{will} & \text{he} & \text{apples} \\
\hline
S_t/(S_{inv}/(VP\backslash NP)) & (S_{inv}/VP)/NP & NP^{\uparrow} & VP/(VP\backslash NP) \\
 & \multicolumn{2}{c}{S_{inv}/VP} & \\
 & \multicolumn{3}{c}{S_{inv}/(VP\backslash NP)} \\
\multicolumn{4}{c}{S_t}
\end{array}$$

$<$

$>\mathbf{B}$

$>$

Unbounded *Wh*-movement

- (16) a. who, that := $(N_{agr}\backslash N_{agr})/(S\backslash NP_{agr}) : \lambda p\lambda n\lambda y.n\,y \wedge p\,y$

  b. who(m), that := $(N\backslash N)/(S/NP) : \lambda p\lambda n\lambda y.n\,y \wedge p\,y$

- (17)

a	movie	that	Seymour	thinks	that	he	likes
$NP^{\uparrow}_{3s}/N$	N	$(N\backslash N)/(S/NP)$	$S/(S\backslash NP_{3s})$	$(S\backslash NP_{3s})/_{\diamond\star}S$	$S/_{\diamond\star}S$	$S/(S\backslash NP_{3s})$	$(S\backslash NP_{3s})/NP$
$:\lambda n\lambda p.p\,(a\,n)$	$: movie$	$:\lambda p\lambda n\lambda x.n\,x \wedge p\,x$	$\lambda p.p\,seymour$	$\lambda p\lambda y.think\,s\,y$	$\lambda s.s$	$:\lambda p.p\,he$	$:\lambda x\lambda y.like\,x\,y$

$$\text{Seymour thinks} \xrightarrow{>\mathbf{B}} S/_{\diamond\star}S : \lambda s.think\,s\,seymour$$

$$\text{he likes} \xrightarrow{>\mathbf{B}} S/NP : \lambda x.like\,x\,he$$

$$\text{Seymour thinks that} \xrightarrow{>\mathbf{B}} S/_{\diamond\star}S : \lambda s.think\,s\,seymour$$

$$\text{Seymour thinks that he likes} \xrightarrow{>\mathbf{B}} S/NP : \lambda x.think\,(like\,x\,he)\,seymour$$

$$\text{that Seymour thinks that he likes} \xrightarrow{>} N\backslash N : \lambda n\lambda x.n\,x \wedge think\,(like\,x\,he)\,seymour$$

$$\text{movie that Seymour thinks that he likes} \xrightarrow{<} N : \lambda x.movie\,x \wedge think\,(like\,x\,he)\,seymour$$

$$\text{a movie that Seymour thinks that he likes} \xrightarrow{>} NP^{\uparrow}_{3s} : \lambda p.p\,(a\,(\lambda x.movie\,x \wedge think\,(like\,x\,he)\,seymour))$$

- (18) a. *A man [that]$_{(N\backslash N)/(S\backslash NP)}$ [[I think that]$_{S/_{\diamond\star}S}$ [likes me]$_{S\backslash NP}$]$_{*S\backslash NP}$

  b. *[I think]$_{S/S}$ Harry$_{S/(S\backslash NP)}$ [that likes me]$_{*S\backslash NP}$.

Wh-relativization (Skip)

- (19)

$$
\begin{array}{ccccc}
\text{whose} & \text{woods} & \text{these} & \text{are} & \text{I think I know} \\
\hline
((S_t/(S/S_{iq}))/(S/NP))/N & N & S/_{\diamond\star}(S\backslash NP) & (S\backslash NP)/NP & S/S_{iq} \\
:\lambda n\lambda p\lambda q.q\,(p\,(whose\,n)) & :woods & :\lambda p.p\,these & :\lambda p\lambda y.p\,y & :\lambda q.think\,(know\,q\,me)\,me \\
\end{array}
$$

$$
\frac{\qquad}{(S_t/(S/S_{iq}))/(S/NP) : \lambda p\lambda q.q\,(p\,(whose\,woods))}> \qquad \frac{\qquad}{S/NP : \lambda p.p\,these}>\mathbf{B}
$$

$$
\frac{\qquad}{S_t/(S/S_{iq}) : \lambda q.q\,(whose\,woods\,these)}>
$$

$$
\frac{\qquad}{S_t : think\,(know\,(whose\,woods\,these)\,me)\,me}>
$$

- "Mover" categories like " whose woods" and "whose woods these are" are projected from a lexical head/specifier by derivation, together with their If *wh*-dependenc(ies), here defined by variables p and q.

An Aside on Constituency

- The above invocation of derived entities like [seem to be]$_{(S\backslash NP_{agr})/VP_{to}}$, [does Mary see]$_{S/NP}$, and [Seymour thinks that he likes]$_{S/NP}$ etc. amounts to the claim that these entities are constituents.
- While this goes against traditional narrower notions of constituency, traditional criteria (lexical substitution, movement, intonation, coordination) are inconsistent.
- In particular, we shall see that all and only CCG-typable entities can undergo coordination.
- Moreover, all and only they can form intonational phrases (Steedman, 2000a, 2014), consistent with a strong form of the MATCH theory of prosody (Selkirk, 2011).

An Aside on the Binding Theory

- However, if they are constituents, they must also be allowed in non-*wh* sentences, consistent with the intonation shown here:

(20)

$$
\begin{array}{ccc}
\text{The WOMAN} & \text{saw} & \text{a CAT} \\
\text{L+H}* & \text{LH\%} & \text{H}*\text{LL\%} \\
\hline
S/_{\diamond\star}(S\backslash NP) : \lambda p.p\,(\mathit{the\,woman}) & (S\backslash NP)/NP : \lambda x\lambda y.\mathit{saw}\,x\,y & S\backslash_{\diamond\star}(S/NP) : \lambda p.p\,(\mathit{a\,cat}) \\
\hline
\multicolumn{2}{c}{S/NP : \lambda y.\mathit{saw}\,x\,(\mathit{the\,woman}) \quad >\mathbf{B}} & \\
\hline
\multicolumn{3}{c}{S : \mathit{saw}\,(\mathit{a\,cat})\,(\mathit{the\,woman}) \quad >}
\end{array}
$$

- It follows that any part of the Binding Theory that actually depends on c-command must be defined at the level of lf (Chomsky, 1995b).

An Aside on Reconstruction

- Like any theory that treats movement as λ-reduction, reconstruction of *wh*-elements at lf is a theorem (von Stechow, 1991).
- However, it is well known that such reconstruction fails to give rise to a binding condition violation in examples like the following, implying that binding/coreference is not solely determined by structural command at any level:

(21) Which article that Harry$_i$ read did he$_i$ file?

- This is an open problem for any theory, for which only technical solutions currently exist (Büring, 2005).

Coordination: Right Node-raising

- (22)

$$\begin{array}{cccccccc}
\text{Alice} & \text{saw} & \text{and} & \text{Mary} & \text{said} & \text{she} & \text{liked} & \text{the movie} \\
\hline
S/_{\diamond\star}(S\backslash NP) & (S\backslash NP)/NP & (X\backslash_{\star}X)/_{\star}X & S/_{\diamond\star}(S\backslash NP) & (S\backslash NP)/S & S/_{\diamond\star}(S\backslash NP) & (S\backslash NP)/NP & S\backslash_{\diamond\star}(S/NP) \\
:\lambda p.p\,alice & :\lambda x\lambda y.past\,(see\,x\,y) & :\lambda p\lambda q.p\sqcap q & :\lambda p.p\,mary & :\lambda s\lambda y.past\,(said\,s\,y) & :\lambda p.p\,her & :\lambda x\lambda y.past\,(like\,x\,y) & :\lambda p.p\,(the\,movie)
\end{array}$$

$$\text{Alice saw} \Rightarrow_{>\mathbf{B}} S/NP : \lambda x.past\,(see\,x\,alice)$$

$$\text{Mary said} \Rightarrow_{>\mathbf{B}} S/S : \lambda s.past\,(say\,s\,mary)$$

$$\text{she liked} \Rightarrow_{>\mathbf{B}} S/NP : \lambda x.past\,(like\,x\,her)$$

$$\text{Mary said she liked} \Rightarrow_{>\mathbf{B}} S/NP : \lambda x.past\,(say\,(past\,(like\,x\,her))\,mary)$$

$$\Rightarrow_{<\Phi>} S/NP : \lambda x.(past\,(see\,x\,alice)) \wedge (past\,(say\,(past\,(like\,x\,her))\,mary))$$

$$\Rightarrow_{<} S : (past\,(see\,(the\,movie)\,alice)) \wedge (past\,(say\,(past\,(like\,(the\,movie)\,her))\,mary))$$

- As in the case of (20), it does not follow that such derivations must give rise to reflexive binding anomalies, or exclude the narrow-scope existential reading for the following (Steedman, 2000b, 2012):

(23) Every girl admires and every boy dislikes some saxophonist. $\forall\exists/\exists\forall$

Argument/Adjunct Cluster Coordination

- Arguments and adjuncts can also compose (Steedman, 1985,Dowty, 1988).

(24)

$$
\begin{array}{ccccccc}
\text{John} & \text{gave} & \text{Mary} & \text{pizza} & \text{and} & \text{Alice} & \text{pasta} \\
\overline{S/_{\diamond\star}(S\backslash NP)} & \overline{((S\backslash NP)/NP)/NP} & \overline{(S/NP)\backslash_{\diamond\star}((S/NP)/NP)} & \overline{S\backslash_{\diamond\star}(S/NP)} & \overline{(X\backslash_{\star}X)/_{\star}X} & \overline{(S/NP)\backslash_{\diamond\star}((S/NP)/NP)} & \overline{S\backslash_{\diamond\star}(S/NP)} \\
:\lambda p.p\,john & :\lambda w\lambda x\lambda y.past\,(give\,w\,x\,y) & :\lambda p.p\,mary & :\lambda p.p\,pizza & :\lambda p\lambda q.p\sqcap q & :\lambda p.p\,alice & :\lambda p.p\,pasta
\end{array}
$$

$$
\frac{S/_{\diamond\star}(S\backslash NP) \quad ((S\backslash NP)/NP)/NP}{(S/NP)/NP : \lambda w\lambda x.past\,(give\,w\,x\,john)}{>}\mathbf{B}^2
$$

$$
\frac{(S/NP)\backslash_{\diamond\star}((S/NP)/NP) \quad S\backslash_{\diamond\star}(S/NP)}{S\backslash_{\diamond\star}((S/NP)/NP) : \lambda p.p\,mary\,pizza}{<}\mathbf{B}
\qquad
\frac{(S/NP)\backslash_{\diamond\star}((S/NP)/NP) \quad S\backslash_{\diamond\star}(S/NP)}{S\backslash_{\diamond\star}((S/NP)/NP) : \lambda p.p\,alice\,pasta}{<}\mathbf{B}
$$

$$
\frac{S\backslash_{\diamond\star}((S/NP)/NP) \quad \text{and} \quad S\backslash_{\diamond\star}((S/NP)/NP)}{S\backslash_{\diamond\star}((S/NP)/NP) \;\; \lambda p.(p\,alice\,pasta)\wedge(p\,mary\,pizza)}{<}{\Phi}{>}
$$

$$
\frac{(S/NP)/NP \quad S\backslash_{\diamond\star}((S/NP)/NP)}{S : past\,(give\,alice\,pasta\,john)\wedge past\,(give\,mary\,pizza\,john)}{<}
$$

- Steedman (1990, 2000b) also accounts for Gapping in terms of similar argument/adjunct composition.
- Type-raising and composition can therefore be seen as providing a theoretical grounding for Johnson's (2017) derivation of ACC from Gapping, and Hirsch and Wagner (2015) and Hirsch's (2017) related claims for RNR and LNR.

Conclusion: On Locality

- All merger is strictly contiguous.
- The appearance of movement always arises from strictly contiguous merger of a second-order functor (the "mover" or "attractor") with a first-order functor (the "residue of movement")
  - In the case of raising, the second-order functor is a (type-raised) subject.
  - In the case of *wh*-movement, it is the *Wh*-item.
  - in the case of RNR etc., movers are also type-raised arguments.
- Since all arguments are type-raised, there is no difference between "moved" and "in situ" merger (cf. Richards, 2016.)
- The argument-types of both second-order mover and first-order residue are projected from a lexical head/specifier, such as a *wh*-item, determiner, or verb, by the derivation.

Envoi

- Once you sign up to Inclusiveness, Contiguity is the only Locality you need.

Questions

Postscript: Substitution Merger

- I have not discussed a further class of combinatory rules parallel to (9) of "Substitution Merger", first proposed by Szabolcsi (1983/1992), that are needed for parasitic *wh*-dependencies. The "backward crossing" rule $<\mathbf{S}_{\times}$ is seen in the following derivation:

(25) (The articles) that Harry rejected without reading

$$
\begin{array}{ccccc}
\text{that} & \text{Harry} & \text{rejected} & \text{without} & \text{reading} \\
\hline
(N\backslash_{\diamond}N)/_{\diamond}(S/NP) & NP^{\uparrow} & (S\backslash NP)/NP & ((S\backslash NP)\backslash(S\backslash NP))/VP & VP/NP
\end{array}
$$

$$((S\backslash NP)\backslash(S\backslash NP))/NP \quad >\mathbf{B} \;(\text{without reading})$$

$$(S\backslash NP)/NP \quad <\mathbf{S}_{\times} \;(\text{rejected without reading})$$

$$S/NP \quad >\mathbf{B} \;(\text{Harry rejected without reading})$$

$$N\backslash_{\diamond}N \quad > \;(\text{that Harry rejected without reading})$$

Postscript: Level 2 Rules

- I have also not discussed the "Level 2" generalization of Composition and Substitution to ternary dependent categories. The combination of level 2 composition and crossing composition allows scrambling (separable permutation Steedman, 2020) making the theory (slightly) non-context-free:

(26)

das	mer	d′chind	em Hans	es huus	lönd	hälfe	aastriiche
that	we−NOM	the children−ACC	Hans−DAT	the house−ACC	let	help	paint
	$NP^{\uparrow}_{nom}$	$NP^{\uparrow}_{acc}$	$NP^{\uparrow}_{dat}$	$NP^{\uparrow}_{acc}$	$((S_{+SUB}\backslash NP_{nom})\backslash NP_{acc})/_{\times}VP$	$(VP\backslash NP_{dat})/_{\times}VP$	$VP\backslash NP_{acc}$

$$\text{lönd} + \text{hälfe} \xrightarrow{>\mathbf{B}^2_{\times}} (((S_{+SUB}\backslash NP_{nom})\backslash NP_{acc})\backslash NP_{dat})/_{\times}VP$$

$$+\ \text{aastriiche} \xrightarrow{>\mathbf{B}_{\times}} (((S_{+SUB}\backslash NP_{nom})\backslash NP_{acc})\backslash NP_{dat})\backslash NP_{acc}$$

$$+\ \text{es huus} \xrightarrow{>} ((S_{+SUB}\backslash NP_{nom})\backslash NP_{acc})\backslash NP_{dat}$$

$$+\ \text{em Hans} \xrightarrow{>} (S_{+SUB}\backslash NP_{nom})\backslash NP_{acc}$$

$$+\ \text{d′chind} \xrightarrow{>} S_{+SUB}\backslash NP_{nom}$$

$$+\ \text{mer} \xrightarrow{>} S_{+SUB}$$

"that we let the children help Hans paint the house"

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