A third factor account of locality: explaining intervention and impenetrability effects with Minimal Search

- Summary: Derive both effects from minimal search, a reflex of 3rd factor notion of Minimal Computation (MC). Derives intervention principle of Agree Closest, the Phase Impenetrability Condition, and Antilocality from narrow syntax.

1. Minimal search, third factors, and efficiency

- Strong Minimalist Thesis: language is "optimal solution to legibility conditions".
- I-language shaped by: UG, PLD, and third factors (F3s) – domain-general cognitive principles of efficient computation.
- Locality: domain over which syntactic functions operate.
- Intuitively, locality reduces search space.

- Intervention:

(1) *Have$_i$ they could t$_i$ left?

(2) Could$_i$ they t$_i$ have left?

- Impenetrability:

(3) *[[Which person]$_i$ did you believe [$_{DP}$ the allegation that [$_{TP}$ we had seen t$_i$]]]?

Minimal Search:

- Chomsky (2013, 2015a): Labelling Algorithm (LA) operates via minimal search (MS).
- Agree (i.e. Probe-Goal relation) also operates via MS (MS for Probe-Goal).
- If correct, then LA and Agree can be unified by F3. F3s 'come for free' (Chomsky 2005)
    - But e.g. Agree involves valuation (first factor) – so not fully unified.
- Chomsky (2015a): (Internal) Merge involves some type of Search; I suggest it is also MS (MS for Merge).
- Proposal: Intervention is due to restricted operation of MS for Probe-Goal; Impenetrability is due to restricted operation of MS for Merge.

Processing:

- PT is derivational: doesn't nullify appeal to processing; derivation is abstract procedure, a proof.
- Relativized Minimality (RM) suggested to have (evolutionary) link with processing (Ortega-Santos 2011).
    - Any connection to language use – processing or production – is likely to be highly indirect.
- RM is representational: awkward in Minimalist Program (MP).
    - Recasted here as derivational principle (cf. Minimal Link Condition; Agree Closest).

    - MP aims to eliminate conditions on representations and derive them in a different way.
    - Appealing to F3s is the *only* valid appeal to processing in the MP.
- Current approach:
    - Derives derivational RM and PIC from existing components of system, operating via MS.
    - Reducible to legibility requirements.
    - Optimal solution – maximally computationally efficient.
    - Reflex of F3 MC.

Definition:

- Following Ke (2019:44). MS is minimal in that search is terminated when first target is returned.

(4) MS = <SA, SD, ST>

- Where MS is minimal search, SA is search algorithm, SD is search domain in which SA operates, and ST is search target (features SA searches for).

(5) SA:

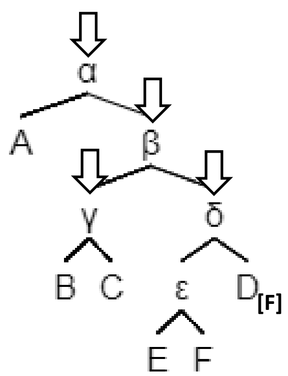
a. Given ST and SD, match against every head member of SD to find ST.

b. If ST is found, return the heads bearing ST and go to c. Otherwise, get the set members of SD and store them as list L:

i. If L is empty, search fails and go to c. Otherwise

ii. Assign each of the sets in L as a new SD and go to a. for all these new SDs.

c. Terminate Search.



Cycle 1: Search α, nothing returned

Cycle 2: Search β, nothing returned

Cycle 3: Search γ and δ in parallel, $D_{[F]}$ returned

Figure 1: An example of Minimal Search

- MS runs iteratively 3 times.
    - Cycle 1: searches α, storing β in list L_1, and assigned as new SD

- Cycle 2: searches β, storing γ and δ in list L_2, and assigned as new SDs
- Cycle 3: searches γ and δ in parallel, returning head $D_{[F]}$.

- $D_{[F]}$ then enters into some syntactic relation.

Issues:

- Is search Breadth-first or depth-first?
  - Ke (2019) – breadth first search (BFS).
    - Argued to capture minimality by storing sets as a list, not by counting the levels of sets MS looks into.
    - All nodes searched at a given depth before the next level.
    - BFS is complete, not optimal, high memory demand.
    - In Fig.1: α, A, β, γ, δ, B, C, ε, $D_{[F]}$, E, F.
  - Depth-first search (DFS)
    - Searches down a node before backtracking to higher nodes.
    - Not complete, not optimal.
    - In Fig.1: α, A, β, γ, B, C, δ, ε, E, F, $D_{[F]}$.
  - Iterative deepening depth-first search (IDDFS).
    - DFS but increases depth limit each iteration with initial depth of 1.
    - Complete, Optimal, and modest memory requirements.
    - Preferred uninformed search method
- Is search uninformed?
  - CED effects – suggest preference for searching *down* spine, and arise from cost of going *into* spine; so there may be some heuristic to inform search.
  - For now, I treat MS as uninformed.
- Redefine (5) as (uninformed) IDDFS MS:

(6) SA:

a. Given ST and SD, match against every head member of SD to find ST [initial depth-limit of SD = 1; search depth-first].

b. If ST is found, return the head(s) bearing ST and go to d. Otherwise, go to c.

c. Increase the depth-limit of SD by 1 level; return to a.

d. Terminate Search.

- More efficient than (5): removes additional memory requirement in storing list of new SDs, just increasing depth of initial SD each iteration. IDDFS is more economical than BFS. Captures c-command relations.
- Is search parallel?
  - Ke suggests when >1 set in the search list, MS operates in parallel, as he sees no reason to privilege one branch over the other.
  - Under (6), parallel search is harder to implement (though possible) – and CED effects might suggest complements have a privileged status.
  - Potentially relevant phenomena: parasitic gaps; across-the-board movement.

2. Intervention effects, Relativized Minimality, and MS

Background:

- Rizzi (1990) RM:
  - $\alpha_i \ldots \alpha_j \ldots \alpha_i$ where α_i c-commands its trace, and an intervening element of the same *type* α_j c-commands the trace α_i and is c-commanded by the higher element α_i, is ungrammatical due to the identity constraint that prohibits an element (representationally) having moved over a position of the same structural type.
  - Successfully accounts for argument-adjunct asymmetries.
  - Representational.
- Starke (2001) Featural RM:
  - More explanatory conception of *type*, in terms of featural specification.
  - $\alpha_i \ldots \alpha_j \ldots \alpha_i$ is ungrammatical if α_i and α_j have fully matching featural specifications.
- Chomsky (1995b:311) Minimal Link Condition:
  - K attracts a iff there is no b, b closer to K than a, such that K attracts b.
  - Also accounts for superiority (unlike RM), which is not sensitive to argument/adjunct status.
  - Derivational.

Current approach:

- Differentiate MS for Probe-Goal and MS for Merge.
- For Agree, MS for Probe-Goal.
- Probe-Goal is a relation established by MC.

(7) Probe Closest Goal (PCG)
A probe for feature(s) $[F_n]$ enters probe-goal relation with the closest goal bearing feature(s) $[F_n]$ in its search space via MS.

(8) *$[_{CP}$ $C_{[uWh]}$ Jean et Pierre croient $[_{CP}$ $que_{[-wh]}$ Marie a vu $qui_{[+wh]}$]]?
Jean and Pierre believe that Marie saw who?

(9) $[_{CP}$ $Qui_{i\ [uWh]}$ $C_{[+Wh]}$ Jean et Pierre croient-ils $[_{CP}$ t_i $que_{[-Wh]}$ Marie a vu]]?

(10) $[_{CP}$ $C_{[uWh]}$ Marie a vu $qui_{[+Wh]}$]?

- (8): long-distance wh-in-situ is disallowed in French; (9): overt wh-movement in long-distance questions is allowed.
- In (8), Matrix C cannot establish probe-goal (and therefore Agree) relation with embedded clause wh-phrase *qui*, due to the intervening embedded complementizer *que*, specified [-wh].
  - PCG, operating via MS, forces Agree to occur with the closest element *specified* for a [wh] feature (exact specification is irrelevant).
- In (9), intervention problem does not arise. Wh-phrase *qui* moves to embedded specCP (before matrix C is merged), to avoid the PIC for further movement; this avoids intervention effects by moving above *que*.
- In (10) no head specified for [wh]-F intervenes between wh-phrase and C.

- In effect, intervention effects fall out quite naturally from MS; they are essentially the same thing.
- More interesting question is deriving PIC.

3. Impenetrability, the PIC, and MS

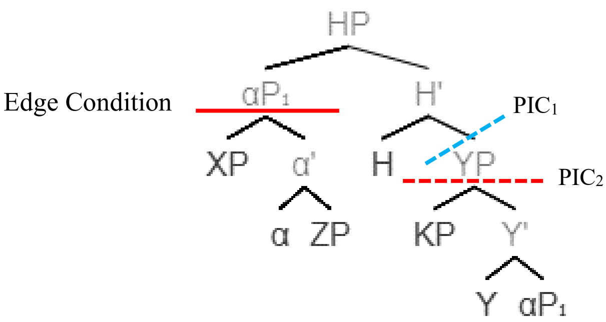
Background:

- Subjacency & bounding nodes (Chomsky 1973). TP and DP are bounding nodes.

(11) *[$_{CP1}$ Which person$_i$ did **[$_{TP1}$** you believe **[$_{DP}$** the allegation [$_{CP2}$ t'$_i$ that **[$_{TP2}$** we had seen t$_i$]]]]]?

- Barriers: explains characterisation of blocking category with L-marking.
- Phase theory (PT) (Chomsky 2000c, 2001a): at certain points, derivation is fixed and cannot be manipulated further. Forces successive cyclic movement via phase edges.
- Phase Impenetrability condition:
  - Chomsky – PIC$_1$: entire phasal complement YP is sent to spell out and invisible for further operations.
  - Bošković (2015a) – PIC$_2$: In a phase α with head H, only the immediate domain of H is accessible to operations outside of α, where K is in the immediate domain of H if the first node that dominates K is a projection of H
    - i.e. complement YP is visible but nothing inside YP is visible.

(12)



  - Assume Bošković's contextual phase approach (2015a): Highest projection in a domain is a phase.
  - PIC$_2$ captures Hiraiwa's (2005) observation (Edge Condition) that anything inside the edge is not visible; the entire edge αP is visible.
- Also assume Antilocality (AL) (Bošković 2015a:11):
  - Movement of A targeting B must cross a projection distinct from B (where unlabelled projections are not distinct from labelled projections).

Current approach:

- PIC is a lower bound on MS.
- Phase heads introduce movement inducing (uninterpretable) features (Gallego 2010, Larson 2015, Chomsky 2015a).
  - Why? To force successive cyclic movement and identify points where strict cyclicity applies.

- uFs then have something to do with phases and PIC.
- IM involves MS for Merge (~ selection) to find appropriate target to check uF on phase head H via movement into specHP.
- Consider stage where search finds αP to move to specHP in (14). Search is initiated by H to check [F_{Edge}]. Search covers material in bold:

(13) [$_{H'}$ H [$_{YP}$ **KP [$_{Y'}$ Y [αP$_1$]]]]**

- This looks like PIC_2.
- I propose that:

(14) MS can only search a structure once.
(15) MS must begin in the set below the set containing phase head H.

- With these two assumptions, we derive PIC_2 using only MS. MS has searched inside YP so insides of YP cannot be searched again, and are inaccessible for further search.

- (14): MS is optimally minimal.
- (15): MS searches merged pairs. MS cannot search the immediate merged pair of {H YP} because otherwise MS would find H as the goal to its probe, and only searching YP (not H) would be asymmetrical. So MS begins in next set, {KP Y'}.
  - N.B. Unclear how PIC_1 can be derived in this framework.
- (15) gives a natural characterisation of AL too – movement must cross a phrase. (15) means that search begins in next projection, meaning AL cannot be violated.
  - Deriving both PIC_2 and AL from a F3 is a major advantage.
- Edge condition: derived from (14). For (12), assume search find head α, meaning entire αP is searched (then moved to specHP). Any further searches cannot modify αP further (since it has been searched); αP as a whole is visible and can move through further phases since α's features project to αP and are visible.

Complex XP Constraint:
- Complex NP Constraint:

(16) ??Who$_i$ did you hear [$_{DP}$ [$_?$ t''$_I$ [$_{NP}$ rumours [$_?$ t'$_I$ [$_{CP}$ that [$_{TP}$ a dog [$_{vP}$ bit t$_i$]]]]]]]?

- NP and CP are phases (as highest projections in their domain) and introduce uFs, and trigger movement.
- Derivation of ungrammaticality:
  - Movement directly from t' to matrix specCP violates PIC:
    - When NP merges with unlabelled ?, MS searches down to t', where *who* is found and must move to ?. This movement violates AL as it does not cross a distinct projection.
    - Phase escape is forced here, but it would violate AL.
    - If phase escape is ignored and *who* moves to matrix specCP, PIC_2 is violated, because MS has already searched NP and lower ?.
- Current account: forces movement from phase when possible, but AL can block this, giving island effects.

- Complex AP Constraint:

(17) *How$_i$ are you [$_?$ t$_i$ [$_{AP}$ proud [$_?$ t$_i$ [$_{CP}$ that [$_{TP}$ John [$_{vP}$ hired Mary t$_i$]]]]]]?

- Complex PP Constraint:

(18) ??Who$_i$ did you read [$_?$ t$_i$ [$_{PP}$ about [$_?$ T$_i$ [$_{DP}$ friends of t$_i$]]]]?

- Current approach derives island status for CXPC islands

Left Branch Constraint:

(19) *Beautiful he saw [$_{DP}$ [$_{NP}$ t$_i$ houses].

- DP is phase (highest projection in domain).
- In (23), movement of AP to specDP is too close, violating AL.
- In (24), movement of AP beyond DP violates PIC (as under current proposal, movement feature on D forces movement to specDP asap; if movement occurs after merging of specDP, the structure has already been searched, inducing a PIC$_2$)

(20) *[$_{DP}$ AP$_i$ [$_{D'}$ D [$_{NP}$ t$_i$ [$_{NP}$ …
(21) *AP$_i$ [$_{DP}$ [$_{D'}$ D [$_{NP}$ t$_i$ [$_{NP}$ …

Coordinate Structure Constraint:

- CSC-1: Extraction *of* conjuncts is banned
- CSC-2: Extraction *from* conjuncts is banned
- CSC-1 receives same analysis as LBC assuming following coordination structure (Oda 2018) (with functional F$_{Conj}$P phrase only present in DP languages – Talić (2015) Structural Parallelism):

(22) [$_{FConjP}$ FConj^0 [$_{ConjP}$ XP [$_{ConjP}$ Conj^0 XP]]]

- Second conjunct extraction blocked by intervention by first conjunct bearing [+Coord.].

- CSC-2:

(23) *Who$_i$ did you see [[enemies of t$_i$] and John]?
(24) Who$_i$ did you see [[enemies of t$_i$] and friends of t$_i$]?

- More difficult to account for given Across-The-Board (ATB) exception in (24).
- Bošković (2018): Movement out of one conjunct delabels it, causing mismatch of labels, violating Conjunction of Likes (CL) principle, crashing derivation.
- ATB exception:

- Movement to specConjP in both conjuncts delabels both conjuncts, giving entire coordination structure $F_{Conj}P$ which is unlabelled.
- $F_{Conj}P$ is highest projection in domain, but is unlabelled, so it is not a phase head.
- Bošković (2018): Projecting features requires projecting a label; unlabelled elements do not project features.
- MS searches for features: so MS cannot search unlabelled projections.
- Chomsky (2013): requirement for labelling drives successive cyclic movement
- Derives potentially naturalistic explanation of edge feature:
  - [F_{Edge}] is the effect of movement forced by LA due to requirement for labelling (from interfaces).
- $F_{Conj}P$ is unlabelled, so does not introduce an edge feature/force movement, so no MS occurs at this stage, so no PIC is induced, allowing movement past spec$F_{Conj}P$ position.

- LA approach to edge features may also account for arguments that edge features are sometimes/always on moving element rather than probe (Bošković 2007, 2011).

- Adjunct Condition: Bošković (to appear) draws parallels between coordination and adjunction structures, suggesting latter involves coordination with null $Conj^0$.
- AC receives same explanation as CSC-2.

(25) $^{?*}$What$_i$ did you [$_{VP}$ [$_{VP}$ fall asleep] [$Conj^0$ [after John had fixed t$_i$]]]?

- Parasitic gaps are the parallel exception to ATB and receive same analysis.

(26) *What$_i$ did you file the book$_i$ without reading ~~the book~~$_i$?
(27) What$_i$ did you file t$_i$ without reading t$_i$?

- Extraction from one gap saved by extraction from the other.

Final considerations:

- Current proposal accounts for Bošković's (2007) observations that Agree is not subject to PIC; only need to assume that there is MS for Probe-Goal and MS for Merge.
- Agnostic toward spell-out implications (cf. Uriagereka 1999).
- Binding Theory – Chomsky (2015a) suggests might be reducible to MS.
- CED effects – potentially explainable with informed MS.

Conclusion:

- MS can derive:
  - Intervention effects via PCG principle
  - Impenetrability effects via PIC and AL derivation
- Thus we can reduce two central ideas of locality to a third-factor reflex acting on the derivation.

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