A parsimonious method for generating syntactic structure[1]

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Abstract

This paper reformulates (External) Merge as freely generating bare *n*-ary trees, labeled with a universal hierarchy by postorder traversal, and linearized by preorder traversal. Important word order universals follow: in several domains, all attested neutral orders are base-generated; unattested orders match a systematic gap in generative capacity. The framework unifies Universal 20 (Greenberg 1963, Cinque 2005) and the Final Over Final Condition (Holmberg 2000, Sheehan *et al* 2017) as consequences. We also find simple analyses of cross-serial dependency constructions, including English Affix-Hopping (Chomsky 1957), and Dutch cross-serial subject-verb dependencies (Bresnan *et al* 1982).

Keywords: Merge, Final-Over-Final Condition, Universal 20, Cross-serial dependencies

1 Introduction

Chomsky describes the discrete infinite character of human syntax in terms of an abstract operation Merge. Merge takes as input lexical elements or syntactic objects already built, and outputs a structured expression containing its inputs, in a format determining semantic and phonological configurations. There are various ways of working out the details, but something like Merge seems indispensable in a generative model of syntax.

Attention has focused on implementing Merge as set formation, which provides for a rich theory of syntactic structure. That implementation, whatever its successes and *a priori* appeal,[2] is not the only possibility. If other reasonable implementations of Merge

[1] I would like to thank the following individuals for providing feedback on an earlier draft: David Adger, Tom Bever, Noam Chomsky, and Guglielmo Cinque.

[2] There are several reasons to prefer a set-based implementation for Merge. One is the same reason that set theory is chosen as an axiomatic basis for mathematics: it is maximally conceptually sparse. Another reason is that sets are unordered, and semantic composition can be described in terms that eschew linear ordering. But see fn.8.

make different predictions about syntactic phenomenology, the alternatives should be evaluated by their empirical successes in addition to their conceptual properties.[3]

In recent years, Chomsky has highlighted the need for syntactic theories to provide a basis for the duality of semantics: the existence, in natural language expressions, of two layers of meaning. One layer of meaning is the information-neutral thematic structure, including predicate-argument structure and selectional relations. Another layer of meaning concerns operator-variable structure, topic and focus, and the like. This cut should be tied to some syntactic distinction, such as a distinction in how Merge applies. If Merge joins disjoint syntactic objects, it is External Merge (EM). Where Merge applies to an object and one of its subparts, we have Internal Merge (IM).

> "The two types of Merge correlate well with the duality of semantics that has been studied from various points of view over the years. EM yields generalized argument structure, and IM all other semantic properties: discourse-related and scopal properties. The correlation is close, and might turn out to be perfect if enough were understood." (Chomsky 2007: 10)

The assumption of a universal ordering of EM is an essential component of the cartographic program (Rizzi 1997, Cinque 1999), there realized in terms of hierarchies dictating how lexical items are Merged into a bottom-up derivation. IM operations interleave with EM, (ultimately) yielding displacement. If EM applies in a common order, and syntactic structures are linearized the same way across languages (Kayne 1994), it follows that IM must be involved in deriving word order variation.

But languages plainly vary in word order even in information-neutral contexts. Information-neutral contexts, by definition, do not involve discourse or scopal properties. So what drives displacement in the derivation of neutral orders? Moreover, how can we explain the constraints on possible and impossible neutral word orders?

2 Generating Universal 20

As an example, consider possible and impossible neutral orders in the noun phrase, as described in Greenberg's Universal 20.

[3] Consider the choice between the real numbers and complex numbers for modeling physical phenomena. The reals seem conceptually inevitable, and are a strict subset of the complex numbers. However, complex numbers provide a better basis for understanding phenomena like electromagnetism, and with their greater complexity comes mathematical beauty (*e.g.*, in the context of the Fundamental Theorem of Algebra).

> "When any or all of the items (demonstrative, numeral, and descriptive adjective) precede the noun, they are always found in that order. If they follow, the order is either the same or its exact opposite." (Greenberg 1963: 87)

According to Cinque's (2005) analysis, 14 of the 24 logically possible orders of these four elements are attested. Cinque shows that this pattern can be succinctly described within the EM and IM framework. He assumes a universal underlying base, built by a uniform sequence of EM operations, affected by phrasal movement but excluding head movement and remnant movement (*i.e*. IM in the noun phrase must affect the noun, possibly pied-piping dominating structure).[4] This hierarchy is given in (1).

(1) [DemP ... [NumP ... [AdjP ... [N]]]][5]

Cinque's analysis captures important facts: not just the possible and impossible nominal orders,[6] but their derivation as well, hence their bracketed structure. Any purported improvement on this account should preserve these descriptive successes, while either capturing additional empirical facts, or simplifying the theoretical apparatus.

It turns out that this array of orders (and their bracketed structure) admits a method of generation that appears simpler than Cinque's account (or that of Abels & Neeleman 2012, Steddy & Samek-Lodovici 2011, or related analyses[7]). This method

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[4] Cinque adopts Kayne's (1994) Linear Correspondence Axiom (LCA), which requires extra structure to provide landing sites for movement. Abels & Neeleman (2012) argue that the LCA is unneeded; the relevant constraint is simply that movement is leftward.

[5] In Cinque's analysis, the nominal modifiers are all phrasal specifiers rather than heads. This is significant in light of the treatment of head-complement relations below.

[6] See Dryer (2018) for a different assessment of the typological facts, allowing some orders Cinque (2005) excludes, and explaining the pattern in quite a different way. The present account assumes Cinque's typology is accurate.

[7] Medeiros (2018) proposes an analysis for Universal 20 involving identical tree structures. But that work commits to a performance-level implementation of the system as a universal parser, while the present proposal is a pure generative account. Moreover, we reject the claim made in that work that the hierarchical order (here, the postorder traversal sequence; there, the string output of stack-sorting) directly follows the order of composition. Instead, we adopt the weaker claim that the relevant linear order unambiguously determines composition; see below.

imposes freely generated *n*-ary branching structure[8] on an arbitrary string of formatives, closely following Chomsky's assertion that Merge applies freely. The account generates all and only the attested orders and bracketed structures; once the bracketing is fixed in any of the legal ways, the assignment of hierarchy to the elements follows uniquely. This result is unexpected, but notable in its simplicity. Here is the procedure:

(2) *Generative procedure over strings*

a. Start with a string of unidentified formatives.

x x x x

b. Place a left bracket just before each formative.

[x **[**x **[**x **[**x

c. Place a matching number of right brackets to form a *legal bracketing*.

[x**]** [x [x**]** [x**]** **]**

d. Scan the string *left-to-right*, indexing right brackets in increasing order.[9]

$[x]_{\mathbf{1}}\ [x\ [x]_{\mathbf{2}}\ [x]_{\mathbf{3}}\ ]_{\mathbf{4}}$

e. Copy indices from right brackets onto formatives following the corresponding left brackets.

$[x_{\mathbf{1}}\ ]_1\ [x_{\mathbf{4}}\ [x_{\mathbf{2}}\ ]_2\ [x_{\mathbf{3}}\ ]_3\ ]_4$

The indexing encodes the relative hierarchy of the formatives (see below), and the bracketed structure is the correct surface structure bracketing. In this case, we derive (3):

(3) [1] [4 [2] [3]]

Procedure (2) generates all and only attested nominal word orders, and their bracketed structure. Importantly, this does not simply repackage the Cinque-style EM and IM account. Identifying Merge with brackets (one pair of brackets represents the Merge of what the brackets enclose), there is a fixed number of such operations for all orders: exactly *n* for *n* formatives. In a standard framework employing EM and IM, for the same

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[8] The *n*-ary branching structure in question is a tree with linear order; put another way, this version of External Merge produces an ordered tuple of its operands. This loses the competition with set-based Merge for mathematical simplicity. But allowing serial order within syntactic representations plausibly draws on capacities other animals possess.

[9] Linguists number hierarchies top down, from least to most embedded. Following that convention would index right brackets in the reverse of postorder traversal order. This leads linguists to characterize the forbidden permutation as *213, (*e.g.*, in the verb cluster literature). But this conflicts with conventions in computer science and mathematics, where the *PostPre* permutations (see Feil *et al* 2005) here are the stack-sortable words, avoiding *231 permutations. I adopt the more general convention, at risk of confusion.

lexical input there are *n*-1 External Merges, and variable *k* Internal Merges. The present perspective also dissolves the question of what drives movement: the attested orders are simply the base-generable structures. There are no steps of movement, and no need to explain them.[10] Conversely, unattested orders are not ruled out by constraints on movement, but correspond to impossible bracketings; see below.

No binarity constraint applies here: brackets may enclose singletons, triples, etc., effectively permitting *n*-ary branching. Placing left brackets before each lexical element, and nowhere else, differs from standard practice; linguists would expect [[*ab*]*c*] to be a possible structure, but that is ruled out here. This does not mean that "left-branching" structure is impossible. Rather, structure traditionally analyzed as left-branching maps to a horizontal relation between nodes, while right-branching structure comes out as vertically arranged nodes.[11] While this departs from the usual way of thinking about brackets and their relation to lexical elements, it yields the right orders and their structure at a stroke. Table 1 shows all possibilities generated with four string formatives.

Brackets	Formatives	Index rt brackets	Index formatives	Order	Nominal order
(((())))	(x(x(x(x))))	$(x(x(x(x)_1)_2)_3)_4$	$(x_4(x_3(x_2(x_1)_1)_2)_3)_4$	4321	Dem-Num-Adj-N
((()()))	(x(x(x)(x)))	$(x(x(x)_1(x)_2)_3)_4$	$(x_4(x_3(x_1)_1(x_2)_2)_3)_4$	4312	Dem-Num-N-Adj
((())())	(x(x(x))(x))	$(x(x(x)_1)_2(x)_3)_4$	$(x_4(x_2(x_1)_1)_2(x_3)_3)_4$	4213	Dem-Adj-N-Num
((()))()	(x(x(x)))(x)	$(x(x(x)_1)_2)_3(x)_4$	$(x_3(x_2(x_1)_1)_2)_3(x_4)_4$	3214	Num-Adj-N-Dem
(()(()))	(x(x)(x(x)))	$(x(x)_1(x(x)_2)_3)_4$	$(x_4(x_1)_1(x_3(x_2)_2)_3)_4$	4132	Dem-N-Num-Adj
(()()())	(x(x)(x)(x))	$(x(x)_1(x)_2(x)_3)_4$	$(x_4(x_1)_1(x_2)_2(x_3)_3)_4$	4123	Dem-N-Adj-Num
(()())()	(x(x)(x))(x)	$(x(x)_1(x)_2)_3(x)_4$	$(x_3(x_1)_1(x_2)_2)_3(x_4)_4$	3124	Num-N-Adj-Dem
(())(())	(x(x))(x(x))	$(x(x)_1)_2(x(x)_3)_4$	$(x_2(x_1)_1)_2(x_4(x_3)_3)_4$	2143	Adj-N-Dem-Num
(())()()	(x(x))(x)(x)	$(x(x)_1)_2(x)_3(x)_4$	$(x_2(x_1)_1)_2(x_3)_3(x_4)_4$	2134	Adj-N-Num-Dem
()((()))	(x)(x(x(x)))	$(x)_1(x(x(x)_2)_3)_4$	$(x_1)_1(x_4(x_3(x_2)_2)_3)_4$	1432	N-Dem-Num-Adj
()(()())	(x)(x(x)(x))	$(x)_1(x(x)_2(x)_3)_4$	$(x_1)_1(x_4(x_2)_2(x_3)_3)_4$	1423	N-Dem-Adj-Num
()(())()	(x)(x(x))(x)	$(x)_1(x(x)_2)_3(x)_4$	$(x_1)_1(x_3(x_2)_2)_3(x_4)_4$	1324	N-Num-Adj-Dem
()()(())	(x)(x)(x(x))	$(x)_1(x)_2(x(x)_3)_4$	$(x_1)_1(x_2)_2(x_4(x_3)_3)_4$	1243	N-Adj-Dem-Num
()()()()	(x)(x)(x)(x)	$(x)_1(x)_2(x)_3(x)_4$	$(x_1)_1(x_2)_2(x_3)_3(x_4)_4$	1234	N-Adj-Num-Dem

[10] This also means that we lose any obvious syntax-internal explanation for the relative typological frequency of different orders (for example, the harmonic orders N-Adj-Num-Dem and Dem-Num-Adj-N are the most common), on which see Cinque (2005).

[11] A question for future research is whether the predicted asymmetry between X-Y and Y-X orders can be aligned with Wagner's (2005) observations about prosodic asymmetries correlated with linear order of predicates and arguments, and modifiers and heads.

Table 1: From free bracketing to word orders. Columns show: brackets; with formatives included; with right brackets indexed; with formatives indexed; hierarchically numbered order; nominal order. These are the attested orders, according to Cinque (2005).

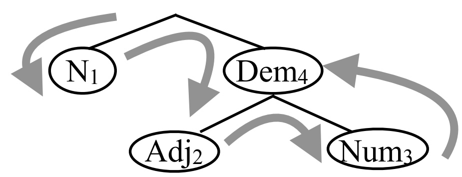
3 A closer look at the details

This section explores selected aspects of the account in greater depth. This includes describing the architecture in terms of trees and tree traversal algorithms, showing how the brackets for nominal orders correspond to Cinque's derivations, and examining how the account excludes unattested orders.

3.1 The procedure in terms of tree traversals

Procedure (2) equates to hierarchization (*i.e.*, labeling) of trees by postorder traversal, and linearization by preorder traversal. Postorder traversal visits nodes in the tree left-to-right and bottom-up. To illustrate, (2) shows 1423 nominal order (N-Dem-Adj-Num) in tree form. The direction of postorder traversal is indicated by large grey arrows; subscript indices record the order in which the nodes are visited.

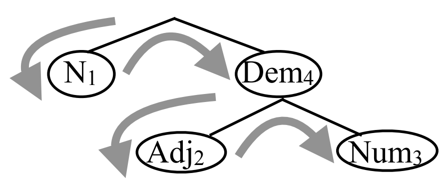
(4) *Postorder traversal*



As shown, postorder indexing allows the nodes to be mapped to a linear representation of the underlying syntax; in this example, we take the elements of the Universal 20 hierarchy bottom-up. (See section 4 for refinements in this linear hierarchy.)

Once the tree has been hierarchized this way, linear order is read off by preorder traversal, which goes top down, left-to-right. The path of preorder traversal is shown with grey arrows in (5); this path visits the nodes in surface order, N-Dem-Adj-Num.

(5) *Preorder traversal*



The notion of tree here is the computer science data structure, which differs from traditional syntactic trees (notably, words are associated with all nodes). Figure 1 summarizes the action of this generative architecture over trees.

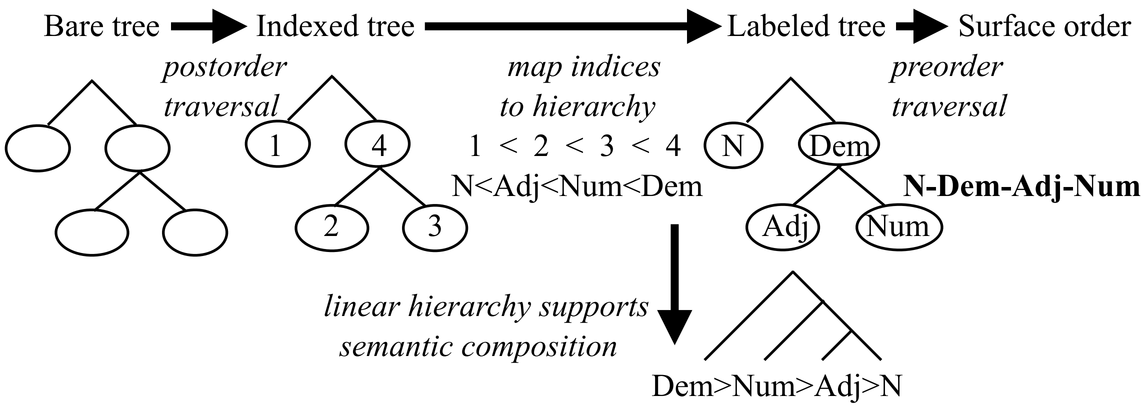


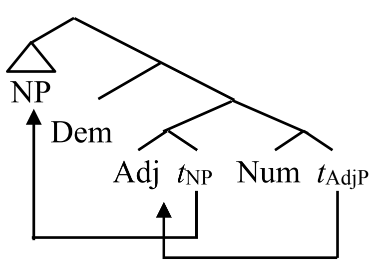
Figure 1: *Generating N-Dem-Adj-Num (1423) order*
Free Merge builds a bare *n*-ary tree. Postorder traversal indexes nodes. Indices map to hierarchical order (in this case, the hierarchy for Universal 20), yielding lexical labels on nodes. Preorder traversal of the labeled tree gives surface order; here, N-Dem-Adj-Num. Separately, hierarchical order supports semantic composition in familiar bottom-up order.

3.2 Correspondence with traditional bracketed representations

Returning to bracketed strings, the bracketing generated in this account closely matches that in Cinque's derivations. To illustrate the correspondence, we continue with the example of *1423* order. Translating to the Universal 20 hierarchy, the structure is (6).

(6) [N] [Dem [Adj] [Num]]

Illustrated below is a (simplified) Cinque-style derivation of this order.

(7)


In this derivation, the [Adj-NP] complex moves to precede Num, followed by subextraction of NP to a specifier position before Dem. In bracketed form, we have (8) :

(8) [[NP] [Dem [[Adj t_{NP}] [Num t_{AdjP}]]]]

Keeping only bracket pairs where the left bracket immediately precedes a lexical element (within the NP as well, i.e. NP ~ [N]), and ignoring traces, we get (9):

(9) [N] [Dem [Adj] [Num]]

As claimed, (9) is identical to expression (6) derived by the generative procedure in (2).

3.3 Unattested orders require impossible bracketing

Consider in more detail how unattested orders are ruled out. With a hierarchy of three elements (say, N=1, Adj=2, Dem=3), five of six logically possible orders are attested as neutral noun phrase orders. One permutation, *231 (*Adj-Dem-N, usually described as *213 according to linguists' convention; see fn. 7), does not occur as a basic noun phrase order. The present proposal explains this systematic gap.

Since left brackets occur immediately before each surface element, and nowhere else, we can begin to fill in what a *231 order would look like as a bracketed string.

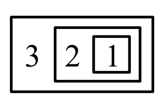
(10) $[_2$ 2 ... $[_3$ 3 ... $[_1$ 1 ...

Right brackets are indexed left-to-right, so they occur in the sequence $]_1$ ... $]_2$ ... $]_3$. Furthermore, right brackets follow the left bracket and element they match. Therefore, the entire sequence of right brackets must follow the element 1. This gives us:

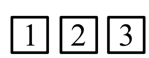
(11) $[_2$ 2 $[_3$ 3 $[_1$ 1 $]_1$ $]_2$ $]_3$

This is not a legal (indexing of a) bracketing; the boundaries of bracketings 1 and 2 cross. To see this, we can think of brackets as denoting the edges of “boxes”. In generated orders, any pair of boxes may be in a containment relation, or be disjoint; they cannot overlap partially. Illustrating with 321 and 123 order and appropriate bracketing:

(12) $[_3$ 3 $[_2$ 2 $[_1$ 1 $]_1$ $]_2$ $]_3$

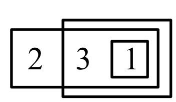


(13) [1 $]_1$ $[_2$ 2 $]_2$ $[_3$ 3 $]_3$



But the unattested *231 order entails overlapping boxes:

(14) $[_2$ 2 $[_3$ 3 $[_1$ 1 $]_1$ $]_2$ $]_3$



Given the way procedure (2) works, unattested *231 order cannot be generated. Instead, the relevant bracketing must form a 321 order; bracketing determines hierarchy.

4 Generating the Final-Over-Final Condition

In this section, I show that the architecture developed thus far provides a ready explanation for another word order universal, the Final Over Final Condition (FOFC; Holmberg 2000, Biberauer *et al* 2014, Sheehan et al 2017 i.a.). This is a surprising unification, as Universal 20 and FOFC appear to conflict; see for example Roberts (2017) on modifying the hierarchy for the noun phrase (1) to be compatible with FOFC.

4.1 Background: The Final Over Final Condition

FOFC prohibits configuration (15):

(15) $*[_{\alpha P}\ [_{\beta P}\ \beta\ \ \gamma P]\ \alpha]$

That is, a head-final phrase cannot dominate a head-initial phrase. The example below, from Finnish, illustrates the phenomenon.

(16) a. yli [rajan maitten välillä] $[P_1\ [N_1\ [[N_2]\ P_2]]]$
across border countries between
'across the border between countries'

b.*[rajan maitten välillä] yli $*[[N_1\ [[N_2]\ P_2]]\ P_1]$
border countries between across (Biberauer *et al* 2014: 187, *ex*. 29)

In the ungrammatical (16b), the outermost P_1 has its NP complement on the left, while the embedded nominal has its PP complement on the right. This is the banned *final-over-initial configuration. Biberauer et al (2014) list the following FOFC effects; these configurations are robustly ungrammatical across languages.

(17) *V-O-Aux $*[_{AuxP}\ [_{VP}\ V\ DP]\ Aux]$
*V-O-C $*[_{CP}\ [_{TP}\ T\ VP]\ C]$ or $*[_{CP}\ [_{TP}\ [_{VP}\ V\ O]\ T]\ C]$
*C-TP-V $*[_{VP}\ [_{CP}\ C\ TP]\ V]$
*N-O-P $*[_{PP}\ [_{DP/NP}\ D/N\ PP]\ P]$

*Num-NP-D(em)	*[$_{D(em)P}$ [$_{NumP}$ Num NP] D(em)][12]
*Pol-TP-C	*[CP [PolP Pol TP] C]
(Biberauer *et al* 2014: 196, *ex*. 46)

These canonical FOFC effects obtain when the elements in question are in a head-complement relation. This is a key insight in the unification pursued in the next subsection.

4.2 Refining the notion of hierarchical ordering

A crucial aspect of the account of Universal 20 in section 2 is how the nominal hierarchy is mapped to freely-generated trees. This includes not just choosing post-order traversal, one of several standard tree traversal algorithms, but determining how to compress a representation of linguistic hierarchy into a sequence that can be mapped to the node traversal order. In this regard, it is notable that fixed relations among syntactic elements seem to come in (at least[13]) two flavors: selection and adjunction, or head-complement (more generally, head-argument) and head-adjunct relations.

Postorder traversal visits nodes/right brackets inside-out, left-to-right. It is natural to assign indices in the same order: the innermost leftmost right bracket/node is 1, the next is 2, etc. We define the hierarchical ordering relation '<' in the usual way with respect to this indexing of the traversal sequence; for example, 1 < 2.

In these terms, I propose that a head H and its adjunct A are mapped to this sequence such that H < A. That corresponds to a traditional tree structure in which the head is more deeply embedded than its adjunct, a familiar analysis.

(18) H < A	*Head-adjunct hierarchical order*

If H has several adjuncts A_1, A_2, with A_1 the closest in traditional representations, we will have $H < A_1 < A_2$. Restricting attention to a hierarchy comprised of a head and a series of adjuncts to that head, we will find *231-avoidance: *A_1-A_2-H . This pattern is seen in Cinque's version of Universal 20 (understanding demonstrative, numeral, and

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[12] See Roberts (2017) for motivation of this claim. D(em) here reflects an analysis where Dem originates low in the hierarchy, and in some languages moves to higher head D.

[13] Additional stipulations may be required to model conjunction, set aside here. But if we treat coordination asymmetrically with the mechanisms here, akin to [N PP] complementation (e.g., coordination of N heads would form [N [& N]] in traditional notation), we would predict an apparent typological gap in monosyndetic coordination (Haspelmath 2017) for order *&-N-N (an observation of Ryan Walter Smith).

adjective as adjuncts)[14], and arguably in verb clusters.[15] For the Universal 20 case, I repeat the following hierarchy:

(19) N < Adj < Num < Dem *Universal 20 hierarchical order*

The next section takes up the matter of the hierarchical ordering of heads and their complements (and other arguments).

4.3 Hierarchical ordering extended to complementation

In standard analyses, heads and complements are in a symmetric hierarchical relationship. The present account provides no basis for such symmetry, and we must make a choice: heads must be hierarchically above, or below, their complements (because we are mapping syntactic hierarchy onto the necessarily-linear tree traversal sequence).

Suppose that head-complement relations obey the same *H < X* convention: head H and complement C map to the post-order traversal index sequence such that H < C.[16]

(20) H < C *Head-complement hierarchical order*

This will produce the basic phenomenology of the Final-Over-Final Condition (FOFC; Sheehan *et al* 2017) in structures characterized by head-complement relations.

To see this, consider a configuration with nested complementation: head α takes a complement headed by β, which in turn has complement γ. The hierarchical order is then (20) α < β < γ, and the forbidden permutation is (21) *β-γ-α.

(21) α < β < γ *Nested complementation hierarchy*

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14 The relevant categories are indeed optional modifiers. But if one prefers Cinque's analysis treating them as specifiers of associated functional heads (f_{Dem}, f_{Num} etc.), we make the same prediction. Anticipating what follows, the relevant hierarchical order will be $f_{Dem} < f_{Num} < f_{Adj}$ < N < AdjP < NumP < DemP. Since the functional heads are not overt, this is effectively the same hierarchy assumed in (19).

15 But see Salzmann (2019) on attested 213 (for us, 231; see fn. 7) verb clusters. See Abels (2016) on Universal 20 effects in other domains and refinements.

16 While H < Adjunct hierarchical order reflects traditional analyses, breaking head-complement symmetry this way is a stipulation. On the other hand, the distinction between head-adjunct and head-complement relations collapses (cf. Abels 2016 on the notion of "satellite"); both obey the condition H < X.

(22) * β-γ-α *Forbidden word order*

Order (22) is traditionally described as a head-final phrase (αP) dominating a head-initial phrase (βP), exactly the configuration ruled out by FOFC (15), repeated as (23).

(23) $*[_{\alpha P}\ [_{\beta P}\ \beta\ \ \gamma P]\ \alpha]$

For example, if head Aux has complement headed by V, with complement Obj, the hierarchy is Aux < V < Obj (24). We correctly exclude unattested *231 order *V-Obj-Aux (25).

(24) Aux < V < Obj

(25) *V-Obj-Aux

Since the reasoning is about heads and complements (not just verbs and auxiliaries), we expect this to generalize to any head-complement chain, reconstructing the core of FOFC.

4.4 Further extensions of hierarchical ordering

What about structures with both adjuncts and complements? Sheehan (2017) argues that FOFC extends to certain adjunct relations. Concretely, parallel to the FOFC effect *V-Obj-Aux, *V-Adv-Aux is unattested. A full discussion is put aside, but note that this effect is correctly predicted here. This follows from the already-motivated hierarchical sequence, Aux < V < Adv (26); unattested *V-Adv-Aux (27) is the forbidden *231 permutation.

(26) Aux < V < Adv *Auxiliary, verb, adverb hierarchy*

(27) *V-Adv-Aux *Forbidden word order*

In existing models of syntax, complements are the closest element to the head; adjuncts are farther away. The same relation is encoded by our ordering, H < Comp < Adjunct: the complement is the unique closest element to the head. In the standard model, while H-adjunct relations involve asymmetric hierarchy (the adjunct is above the head), head-complement relations are symmetric. The present approach avoids this unwanted symmetry (by stipulation), with promising consequences for word order constraints.

Where a head H takes both arguments and adjuncts, I assume the relative hierarchy is H < Arg < Adj (28). If there are multiple arguments of a head, the complement is closest to the head: H < Comp < Arg' (29).

(28) H < Arg < Adj *Hierarchical order of head, argument, adjunct*

(29) H < Comp < Arg' *Hierarchical order of head, complement, argument*

In particular, for verb head V and complement object O, V < O. The same hierarchy holds for a verb and complement clause: V < CP. A ditransitive verb would have V < DO < IO (see Abels 2016). If there is an adverbial and an object, the hierarchy is V < O < Adv. (30) puts these together into a single ordering.

(30) V < DO/CP < IO < Adv *Hierarchy of verb, objects, adverb*

Adding Tense and subject, the order is T < V < O < S. If we include little *v*: T < *v* < V < O < S. No overt item realizes little *v* in the examples considered below; I omit it for simplicity. If complementizer C is present, I assume it takes TP as complement: C < T < V < O < S.

(31) C < T < *v* < V < O < S *Hierarchical order for transitive clause*

This all may seem stipulative. Note, first, that the hierarchy in (31) is identical to standard proposals, *modulo* the unusual resolution of head-complement structures.[17] Once we have postulated an underlying hierarchy, this system makes systematic predictions about possible and impossible neutral word orders of the relevant elements. If an error is made in determining the hierarchy, a multitude of false predictions should follow through interactions with the rest of the ordering. But with the assumptions made so far, an impressive range of familiar typological facts are captured.

We can consider elements belonging to a larger hierarchy three at a time; we should find, for each such triple, five attested orders and one forbidden order. Drawing on the order (31), with the understanding that the O position may be realized as clausal complement CP, we make the following predictions about impossible neutral orders.

(32) a. *O-S-V
b. *CP-S-V
c. *O-S-T
d. *V-O-T
e. *V-CP-T
f. *[C-TP]-V

---

[17] Note that the sequence taken in descending order (S-O-V-T-C) is a cross-linguistically common clause order.

An adpositional phrase object O will be hierarchically ordered after a noun head N it complements; I take adposition P to be a head with noun phrase complement NP.

(33) N < O

(34) P < NP

This yields hierarchical order (35), with forbidden permutation (36).

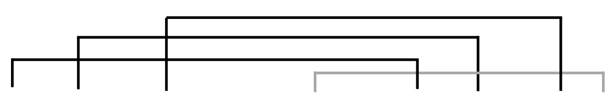
(35) P < N < O *Hierarchical order for PP within PP*

(36) *N-O-P *Forbidden order*

This explains the typological gap illustrated in Finnish (16b) above, previously described with FOFC. In fact, setting aside the last two items in (17) (we have not treated Polarity, though the ban on *Pol-TP-C follows from our realization of standard hierarchy C < Pol < T; and adopt Cinque's hierarchy for Universal 20 effects), we have reconstructed the list of canonical FOFC effects in Biberauer *et al* (2014: 196).

5 Generating some well-known crossing dependencies

Thus far, we have been concerned with ruling out typologically unattested orders. In this section, I turn to showing that the analysis of allowed orders extends to somewhat exotic constructions that have figured prominently in arguments that natural language grammars are mildly context-sensitive. Bresnan *et al* (1982) discuss unbounded crossing subject-verb dependencies in Dutch. Example (37), taken from Steedman (2000: 25), illustrates:



(37) ...omdat ik Cecilia Henk de nijlpaarden zag helpen voeren
...because I Cecilia Henk the hippos saw help feed
'...because I saw Cecilia help Henk feed the hippos'

Shieber (1985) discusses similar facts in Swiss German, which also exhibits long-distance cross-serial case dependencies. Interestingly, the system already established can base-generate these orders.[18] I assume the example above contains the categories in (38),

[18] Stabler (2004) discusses four different classes of cross-serial dependency constructions, with distinct formal properties. I restrict attention to the two classes in this section.

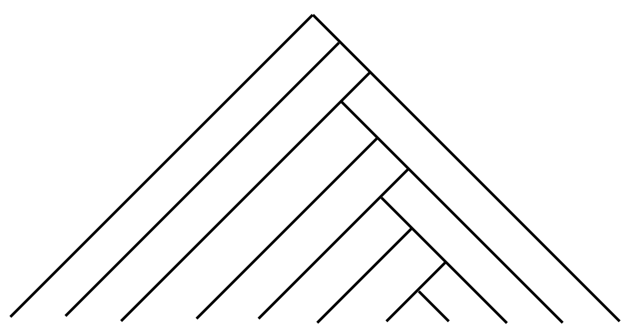
abstracting away from internal structure of the object *de nijlpaarden* 'the hippos' and segmenting a Tense suffix from inflected and non-finite verbs, even if realized as zero.

(38) ...omdat ik Cecilia Henk de nijlpaarden zag-0 help-en voer-en
C S_1 S_2 S_3 O V_1 T_1 V_2 T_2 V_3 T_3

The categories in (38) will be rendered as a single linear hierarchy, which we assemble from the general clause ordering (31), together with the standard assumption that complement clauses occupy the canonical direct object position; this allows us to integrate clausal complementation with the clause order (31) above.[19]

For single clausal embedding, $[_{CP1} \ldots [_{CP2} \underline{\quad}]\,]$, we have: $C < T_1 < V_1 < \underline{T_2 < V_2 < O_2 < S_2} < S_1$. Replacing O_2 with another embedded clause, we derive (39), the hierarchical order for sentence (37) above. I show postorder indices aligned to the hierarchy, on which a superposed tree shows bottom-up semantic composition.

(39) *Integrated hierarchy for (37) with postorder index and composition tree*



Composition tree

$C < T_1 < V_1 < T_2 < V_2 < T_3 < V_3 < O_3 < S_3 < S_2 < S_1$ Hierarchical order
$1 < 2 < 3 < 4 < 5 < 6 < 7 < 8 < 9 < 10 < 11$ Postorder index

Given this mapping from syntactic hierarchy to post-order index sequence, we can easily recover the tree structure corresponding to the Dutch surface order,[20] shown in (40).

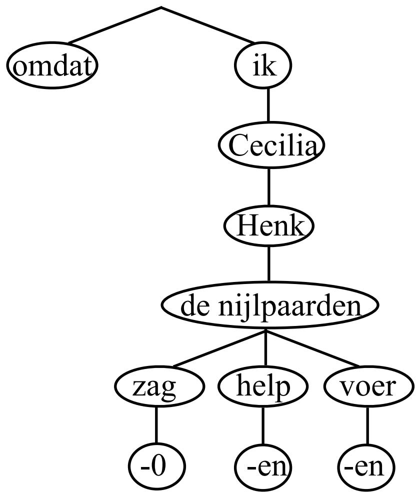
(40) ...omdat ik Cecilia Henk de nijlpaarden zag-0 help-en voer-en
Category C S_1 S_2 S_3 O_3 V_1 T_1 V_2 T_2 V_3 T_3

---

[19] At least for these structures, we are implicitly developing a simple account of recursion by substitution. I leave fuller consideration of recursion in other domains to future work.

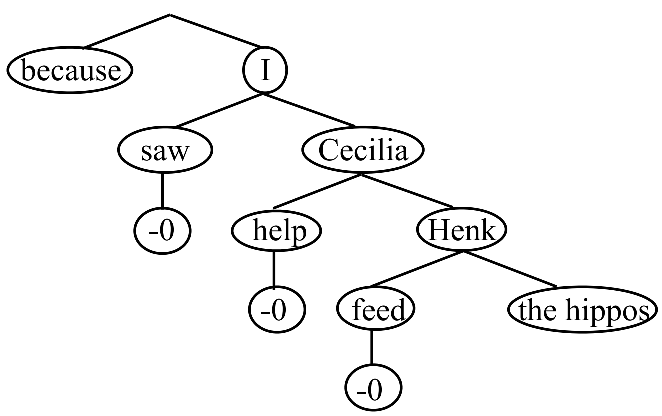
[20] An important question is whether these trees provide a basis for a successful theory of prosody (see also fn. 9). While it is promising that the trees derived here correspond closely to Cinque's derivations of nominal orders, I leave this question for future work. Unlike the nominal trees, the clausal trees in this section differ from standard analyses.

Index	1	11	10	9	8	3	2	5	4	7	6
Brackets	( )	(	(	(	(	(	( ))	(	( ))	(	( ))))))



With the relevant syntactic hierarchy resolved as a universal linear sequence, we can readily represent other orders of the same elements, as in English in (41).

(41)	...because	I	saw	-0	Cecilia	help	-0	Henk	feed	-0	the hippos
Category	C	S_1	V_1	T_1	S_2	V_2	T_2	S_3	V_3	T_3	O_3
Index	1	11	3	2	10	5	4	9	7	6	8
Brackets	( )	(	(	( ))	(	(	( ))	(	(	( ))	( ))))

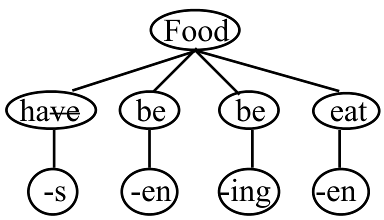


Finally, this architecture generates the more limited bounded crossing dependencies in English Affix-Hopping (Chomsky 1957), as seen in example (42).

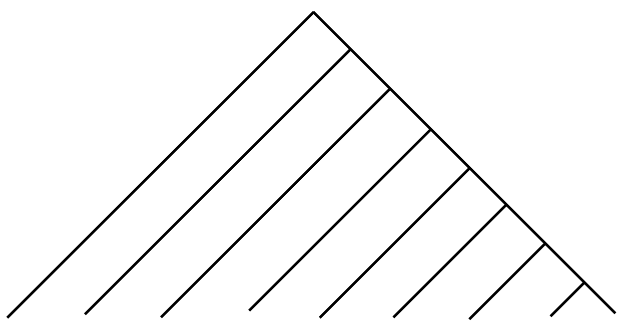
(42) Food ha-s be-en be-ing eat-en

As Chomsky noted, affixes group with preceding auxiliaries in distribution and meaning, despite being separated by the intervening verb in surface order. To accommodate this pattern, suppose auxiliary Aux and associated affix -Fx have hierarchical order Aux < -Fx < VP-Comp.[21] This generates (43), with composition structure (44).[22]

(43)	Food	ha~~ve~~	-s	be	-en	be	-ing	eat	-en
Cat.	Obj	Aux_1	T	Aux_2	$-Fx_1$	Aux_3	$-Fx_2$	V	$-Fx_3$
Index	9	2	1	4	3	6	5	8	7
Brackets	(	(	( ))	(	( ))	(	( ))	(	( )))



(44) *Hierarchical order and composition tree for English Affix-Hopping (42)*



Composition tree

-s have -en be -ing be -en eat food — Lexical items

$T > Aux_1 > Fx_1 > Aux_2 > Fx_2 > Aux_3 > Fx_3 > V > Obj$ — Hierarchical order

9 > 8 > 7 > 6 > 5 > 4 > 3 > 2 > 1 — Postorder index

6 A unified hierarchy after all?

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[21] One can read this as saying the affix (*e.g.*, -*ing*) is a head sandwiched between selecting auxiliary (*be*) and host verb. Or auxiliary and associated affix might "fuse" for interpretation, mirroring Chomsky's (1957) analysis with a single lexical item (*be*+*ing*).

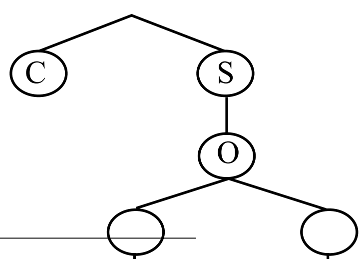
[22] It is unclear if passive movement of the object should be base-generated, or if it is obligatorily "real" movement. It is at least possible to generate with just this mechanism.

Abels (2016) examines effects paralleling Universal 20 in other domains, focusing on verb clusters. He argues that verbal arguments and verb-auxiliary hierarchies cannot be unified into a single hierarchy, on the basis of examples like the following.

(45) a. ...dass er das Buch nicht hätte lesen sollen.
that he the book not had read should
'...that he shouldn't have read the book'
b. ...dass du mindestens bestätigen können musst, dass Fritz schwimmen kann
that you at.least certify can must that Fritz swim can
'...that you must at least be able to certify that Fritz can swim'
(Standard German; Abels 2016: 188 ex. 9)

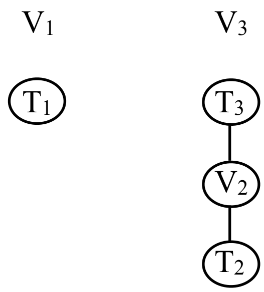
In (45), the nominal direct object and complement clause appear on opposite sides of the verb. Together with the surface order of verbal elements, this seems to prevent any account of a consistent hierarchy that preserves standard assumptions about constituency. Abels' argument rests on a traditional conception of head-complement hierarchy. The assumptions developed to this point generate the examples Abels discusses.[23] I illustrate with (46), ignoring Neg for the moment:[24]

(46) ...dass er das Buch nicht hätte lesen sollen
C S O Neg V_1 T_1 V_3 T_3 V_2 T_2
1 9 8 ? 3 2 7 6 5 4
( ) ((- (( )) (((( )))))



[23] The position of the object left of adverbials and negation reflects Scrambling, with interpretive consequences. As such, it is presumably not an information-neutral movement, and falls outside the generative system here. Note that such movement produces Obj-Adv-V order, an instance of *Arg-Adj-H, predicted to be unattested as a neutral order in light of hierarchy (28), H < Arg < Adj.

[24] Negation, like agreement, may not adhere to a single, universal cartographic position (see, *e.g*., Cinque 1999: 126). We can infer something about its position in the tree in (46) on the basis of its linear order: the node for negation must be to the right or below the node for the object O, and above or left of the the node for V1. But see below.



In a similar vein, Abels (2016) argues from the examples in (47) that adverbs and auxiliaries cannot be placed into a consistent hierarchy obeying the generalization of Universal 20 he pursues. However, we find unremarkable analyses of these orders in the present system (the key difference again is how head-complement relations are represented). I show in (48) the categories indexed in hierarchical order; the reader may verify that the neutral orders (47b, c, d) are all 231-free, generated by the present architecture. Example (47a) contains a 231-like order, and falls outside the generative capacity of the current system. But this is an expected result; (47a) is an example of VP-topicalization, a non-information-neutral effect.

(47) a. schön singen hat er früher können — Standard German
beautifully sing has he formerly can — VP-topicalization
'He formerly used to be able to sing beautifully.'
b. ...dass er früener hat chöne schöön singe — Zurich German
that he formerly has can beautifully sing
c. ...dass er früher schön hat singen können — Standard German
that he formerly beautifully has sing can
d. ...dat hij vroeger prachtig heeft kunnen zingen — Standard Dutch
that he formerly beautifully has can sing

(48) a. schön singen hat er früher können — Standard German
A_3 V_3 T_3 V_1 T_1 S A_2 V_2 T_2 — VP-topicalization
7 6 5 2 1 9 8 4 3
b. dass er früener hat chöne schöön singe — Zurich German
C S A_2 V_1 T_1 V_2 T_2 A_3 V_3 T_3
1 10 9 3 2 5 4 8 7 6
c. dass er früher schön hat singen können — Standard German
C S A_2 A_3 V_1 T_1 V_3 T_3 V_2 T_2
1 10 9 8 3 2 7 6 5 4
d. dat hij vroeger prachtig heeft kunnen zingen — Standard Dutch
C S A_2 A_3 V_1 T_1 V_2 T_2 V_3 T_3
1 10 9 8 3 2 5 4 7 6

We are up to ten elements in the surface order, admitting very many possibilities, including thousands of orders that do not contain 231-like subsequences. But note that the number of 231-avoiding permutations forms a shrinking proportion of all orders, as the number of elements in the order increases. That is, with just two elements, both possible orders are allowed; with three elements, 5 of 6 possible orders are generated, and we find 14 of 24 orders with 4 elements. With ten elements, there are 16,796 231-avoiding surface orders, among 10! = 3,628,800 possible orders. Put another way, the chance that a randomly selected order of ten elements is 231-avoiding, and thus generated by this system, is less than 0.5%. The chance that three randomly chosen orders (such as 47b,c,d) all fall into the generated orders is about 1 in 10 million. This should provide some confidence that we are describing the hierarchy accurately for these examples, provided the rest of the framework is on the right track.

We return to the issue of the placement of negation, left open in the discussion of (46). Tentatively, let us hypothesize that negation is generated "high", in the cartographic zone corresponding to Laka's (1990) Pol head: C < **Neg** < T < V < O < S. I consider typical word orders with negation in a selection of languages below, which appear to be consistent with this hypothesis. For the overt elements appearing in these examples, the relevant hierarchy is Neg < T < (Aux < -Fx <) V < O < S.

(49) *English*

a. She did not write it.
   S T Neg V O — 5 2 1 3 4

b. She has not written it.
   S Aux T Neg V -Fx O — 7 3 2 1 5 4 6

c. She will not have written it.
   S T Neg Aux V -Fx O — 7 2 1 3 5 4 6

(50) *Spanish*

a. Élla no lo escribió.
   S Neg O V T — 5 1 4 3 2

b. Élla no escribió el libro.
   S Neg V T O — 5 1 3 2 4

c. Élla no estaba escribiéndolo.
   S Neg Aux T V -Fx O — 7 1 3 2 5 4 6

d. Élla no lo estaba escribiendo.
   S Neg O Aux T V -Fx — 7 1 6 3 2 5 4

Note that this gives us the beginnings of an account of Romance clitic-climbing constructions. So long as the relative order of auxiliaries and verbs is fixed such that selecting forms precede the verbal head of their selected complements on the surface (i.e., the typical Spanish order), and ignoring other elements, an object clitic could, in principle, be placed immediately before any verbal element in the sequence, but not between verbal stem and affix: (*lo*) *esta*(**lo*)-*ba* (*lo*) *escribi*(**lo*)-*endo* (*lo*).

(51) *Irish*
Ní-or chuir sé isteach ar phost ar bith.
Neg.past put.past he in on job any
'He didn't apply for any job.' (McCloskey 2017)
Neg (T) V (T) S P PP 1 (2) 3 (2) 6 4 5

It is not entirely straightforward to locate Tense in Irish. On the one hand, there are a set of verbal suffixes that differ in different tenses/moods. But at least historically, past tense was expressed with a preverbal particle *do*, triggering lenition. For present purposes, either location of T, before or after the verb, produces a 231-free surface order. With clausal embedding, Irish again avoids 231 permutations of the hierarchical order. In (52), I place T before the verb, although placement after the verb is also 231-avoiding.

(52) *Irish*
Deir siad gur ghoid na síogaí í.
say they C-[PAST] stole the fairies her
'They say the fairies stole her away.' (McCloskey 2001: 67, ex. 1)
T_1 V_1 S_1 C_2 T_2 V_2 S_2 O_2 1 2 8 3 4 5 7 6

At least for this small selection of data, a single hierarchical position for clausal negation may be viable after all.[25]

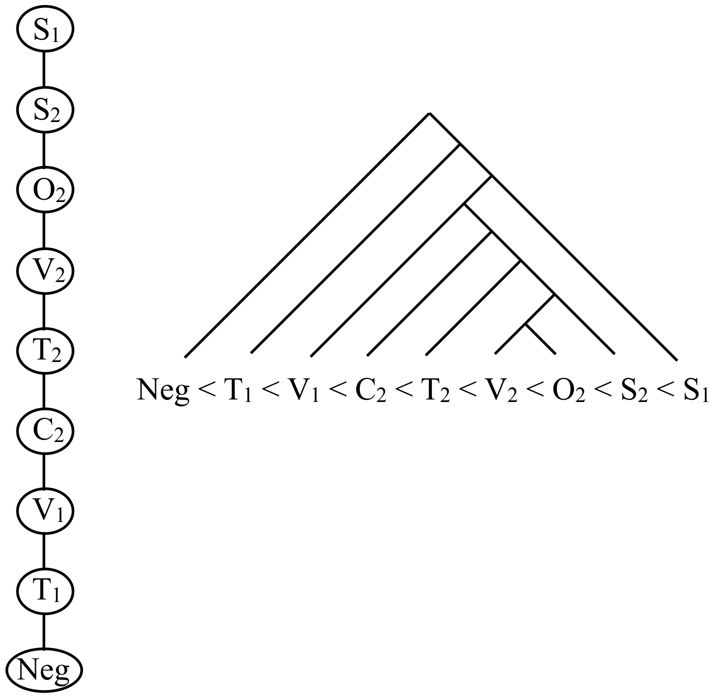
Next, I illustrate the account for some basic sentences in Malagasy and Japanese. Again, much more work is required to claim that this system will work for other languages; surely adjustments and refinements will be required. And yet, even with just this crude sketch in hand, we continue to find unexceptional analyses of orders quite different from the clausal orders we have examined to this point. Japanese presents an interesting case: standard word order with clausal embedding corresponds to a vertical arrangement of nodes in this framework.

(53) *Japanese*

[25] One problem for this approach to negation is presented by Standard German right-peripheral clausal negation with VO order. That gives a 231-like surface order, ruled out here. But this order in German is usually analyzed as reflecting two separate movements: Scrambling of the object, and raising of the finite verb to C (den Besten 1983).

Bill-wa [John-ga sore-o katta ka] siranai.
'Bill does not know whether John bought it or not.' (Fukui 1995:115, ex.33c)

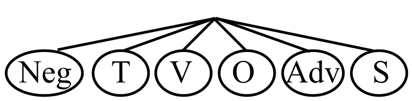
(54) Bill-wa John-ga sore-o ka-tta ka siranai
S_1 S_2 O_2 V_2 T_2 C_2 V_1 T_1 Neg
9 8 7 6 5 4 3 2 1



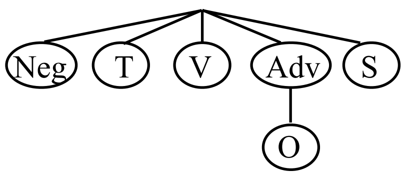
Malagasy, by contrast, presents a surface order corresponding to a nearly flat tree.

(55) *Malagasy*
a. Tsy manasa lamba intsony Rakoto 1 2 3 4 5 6
Neg wash clothes anymore Rakoto
b. Tsy manasa intsony ny lamba Rakoto 1 2 3 5 4 6
Neg wash anymore det. clothes Rakoto
'Rakoto doesn't wash clothes anymore.' (Rackowski 1998: 14, ex. 9a,b)

(56) Tsy manasa lamba intsony Rakoto
Neg T V O Adv S
1 2 3 4 5 6



(57) Tsy manasa intsony ny lamba Rakoto
Neg T V Adv O S
1 2 3 5 4 6



Consider now the placement of the interrogative particle *ve* within this order.

(58) a. Tsy manasa lamba mihitsy **ve** Rakoto? 1 2 3 4 5 ? 6
Neg wash clothes at-all Q Rakoto
b. Tsy manasa mihitsy ny lamba **ve** Rakoto? 1 2 3 5 4 ? 6
Neg wash at-all det. clothes Q Rakoto
'Does Rakoto not wash clothes at all?'
(Rackowski & Travis 2000: 120, ex. 6a,c)

It is easy to see that if the *ve* element is treated as a head high in traditional tree structures, these orders will be 231-containing. That is, *ve* is preceded by a series of ascending-index items, and would have a lower index than any of them. However, pursuing an observation of Medeiros (2018), the hierarchy format described here is closely related to postfix notation. In such notation, operators follow their operands; if we identify the meaning of *ve* as operator-like, we might guess that it appears at the end rather than the beginning of the hierarchical order.

(59) Neg < T < V < O < Adv < S < **Q**

With this conjectured hierarchy, the Malagasy examples are unproblematic.[26] This move may, in turn, shed light on one well-known class of exceptions to FOFC, involving VO order with clause-final particles, as in Mandarin.

(60) *Mandarin*
Hongjian xihuan zhe ben shu **ma**?
Hongjian like this CL book Q

[26] On the other hand, we cannot treat Japanese *ka* the same way, as it would create a 231-containing order; *ka* must instead be a "high" C-like head

‘Does Hongjian like this book?’

(Li 2006:13, cited in Biberauer *et al* 2014: 199)

While the particles in question appear to contribute interrogative force, treating them as C heads leads to a violation of FOFC: *V-O-C is predicted to be impossible. However, suppose we extend the treatment of Malagasy *ve* to these elements in Mandarin as well. Then the relative hierarchy is V < O < Q, and the surface order in question is a 123 order; this order is allowed. I leave open the question of whether other instances of V-O-Q order might yield to such an analysis.

Finally, I turn to another well-known apparent counterexample to FOFC: OV languages such as German allow determiner-noun word order.

(61) *German*

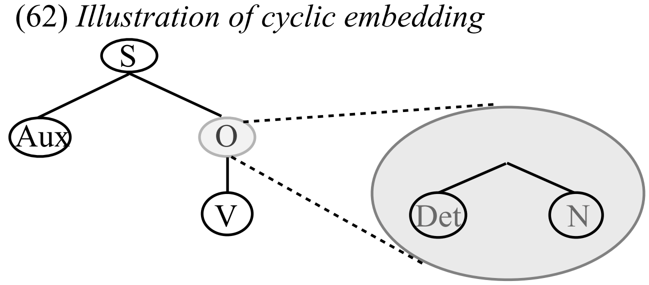
Johann hat [$_{VP}$ [$_{DP}$ einen Mann] gesehen].
Johann has a man seen
‘Johann has seen a man.’ (Biberauer *et al* 2014)

It is standardly assumed that determiners are heads, so the partial hierarchy should be Det < N. Together with the verb-object hierarchy V < O, we get V < Det < N; *Det-N-V should be impossible, violating FOFC. I adopt the usual solution, supposing that nominal and verbal cycles are somehow disjoint for the purposes of this condition.

One intriguing aspect of the present proposal is that a notion of *phase* is baked into the architecture. The tree traversal algorithms, which take the place of Transfer in a standard Minimalist model, cannot apply at each step of incremental construction of the bare trees here. Instead, they must apply to whole trees, or subtrees, mapping a hierarchy onto them and reading off linear order. If this process is recursive (trees may embed references to already-transferred subtrees), further ordering predictions follow.

We can sketch how this would work. Suppose a single node within the verbal cycle can contain a pointer to a separately-computed nominal cycle. The nominal subtree is generated, hierarchized, and linearized by itself, internally obeying the permutation-avoidance condition. But internal structure of the nominal is unavailable, and irrelevant, within the embedding verbal cycle; its already frozen word order is "plugged in" at the corresponding node. Det-N order by itself is 231-free, as is S-Aux-O-V.

(62) *Illustration of cyclic embedding*



In this case, using the notion of cycles allows an order that otherwise falls outside this system's generative capacity. However, in the general case cyclic effects of this sort will tend to reduce ordering possibilities (because the elements of the embedded domain cannot be permuted among elements of the embedding domain).[27] Note that we do not, as a rule, need to treat each clause as a single cycle; indeed, doing so would prevent an account of the cross-serial subject-verb dependencies discussed here. This aligns with the literature on FOFC, where the relevant effects are observed to hold across clause boundaries. I leave a fuller discussion of cyclicity in this architecture to future research.

7 Conclusion

Implementing Merge as an operation building bare trees, lexicalized and linearized by traversal algorithms, we derive and unify Universal 20 and FOFC permutation-avoidance patterns, and find simple analyses of cross-serial dependency constructions. Strikingly, these effects follow from the structure-building system itself and single hierarchical ordering condition H < X, without additional constraints or mechanisms.

In this view, no additional operations create displacement in neutral orders; the typologically possible orders are all base-generated. This unification of movement with structure-building goes further than the view of movement as Internal Merge, where Internal Merge involves extra operations beyond the constant number of External Merges required to join the lexical items involved. Here, the same number of External Merge operations (bracket pairs) derives all neutral orders: exactly *n* such for *n* items.

That said, we still need actual movement in the present framework: effects like *wh*-movement and topic and focus displacement produce other orders.[28] However, the residue of actual movements under this account is the set of non-information-neutral transformations. This result aligns with Chomsky's suggestion that the duality of semantics is tied to the distinction between External Merge and Internal Merge: EM builds the base thematic structure, and IM induces discourse-information effects.

The theory developed here is a fragment. I have not demonstrated how this system generalizes to a full theory of word order, nor spelled out how real movement works, nor accounted for core grammatical phenomena such as coordination, ellipsis, binding, agreement, and so on. These are important topics, and much more work will be required to determine if they might find satisfying accounts within this framework.

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[27] See Cinque (2020) for discussion of ordering facts within the nominal domain that appear to support this kind of analysis.

[28] Thanks to David Adger for discussion on this point.

References:

Abels, K., & Neeleman, A. (2012). Linear asymmetries and the LCA. *Syntax* 15(1), 25-74.

Abels, K. (2016). The fundamental left–right asymmetry in the Germanic verb cluster. *The Journal of Comparative Germanic Linguistics* 19(3), 179-220.

Biberauer, T., Holmberg. A., and Roberts, I. (2014). A syntactic universal and its consequences. *Linguistic Inquiry* 45, 169-225.

Bresnan, J., Kaplan, R.M., Peters, S., & Zaenen, A. (1982). Cross-serial dependencies in Dutch. *Linguistic Inquiry* 13(4), 613-635.

Chomsky, N. (1957) *Syntactic Structures*. The Hague: Mouton.

Chomsky, N. (2007). Approaching UG from Below. In Hans-Martin Gärtner, H.-M., & Sauerland, U. (eds.). *Interfaces + Recursion = Language? Chomsky's Minimalism and the View from Syntax-Semantics.* Berlin: Mouton de Gruyter.

Cinque, G. (1999). *Adverbs and Functional Heads: A Cross-linguistic Perspective*. New York: Oxford University Press.

Cinque, G. (2005). Deriving Greenberg's universal 20 and its exceptions. *Linguistic Inquiry* 36(3), 315-332.

Cinque, G. (2020). Word order variation: towards a restrictive theory. Ms., University of Venice.

Dryer, M. (2018). On the order of demonstrative, numeral, adjective, and noun. *Language* 94(4), 798-833.

Feil, T., Hutson, K., & Kretchmar, R.M. (2005). Tree traversals and permutations. *Congressus Numerantium* 172, 201-221.

Fukui, N. (1995). *Theory of Projection in Syntax*. Stanford, CA: CSLI Publications.

Greenberg, J. (1963). Some universals of grammar with particular reference to the order of meaningful elements. In Greenberg, J., (ed.), *Universals of language*, 73-113. Cambridge, MA: MIT Press.

Haspelmath, M. (2007). In Shopen, T. (ed.), *Language typology and syntactic description Vol. II: complex constructions*, 1-51. Cambridge, MA: Cambridge University Press

Holmberg, A. (2000). Deriving OV order in Finnish. in Svenonius, P., (ed.), *The Derivation of VO and OV*. Philadelphia: John Benjamins.

Kayne, R. (1994). *The Antisymmetry of Syntax*. Cambridge, MA: MIT Press.

Laka, I. (1990). Negation in Syntax: on the nature of functional categories and projections. Ph.D. dissertation, MIT.

McCloskey, J. (2001). The morphosyntax of WH-extraction in Irish. *Journal of Linguistics* (37): 67-100.

McCloskey, J. (2017). Ellipsis, polarity and the cartography of verb-initial orders in Irish. In Aboh, A., Haeberli, E., Puskás, G., & and Schönenberger, M., (eds.), *Elements of Comparative Syntax: Theory and Description*, 99–151. Berlin: De Gruyter.

Medeiros, D.P. (2018). ULTRA: Universal Grammar as a Universal Parser. *Frontiers In Psychology: Language Sciences 9*. https://doi.org/10.3389/fpsyg.2018.00155

Pearson, M. (2000). Two types of VO languages. In Svenonius, P. (ed.), *The derivation of VO and OV*. Philadelphia: John Benjamins.

Rackowski, A. (1998). Malagasy Adverbs. In Paul, I. (ed.), *The Structure of Malagasy: UCLA Occasional Working Papers in Linguistics 20*, 11-33.

Rackowski, A. & Travis, L. (2000). V-Initial Languages: X or XP-Movement and Adverbial Placement. In Carnie, A., & Guilfoyle, E., (eds.), *The Syntax of Verb-Initial Languages*, 117-141. New York: Oxford University Press.

Rizzi, L. (1997). The fine structure of the left periphery. In Haegeman, L. (ed.), *Elements of Grammar: Handbook of Generative Syntax*. Dordrecht: Kluwer.

Roberts, I. (2017). The Final-over-Final Condition in DP: Universal 20 and the Nature of Demonstratives. In Sheehan, M., Biberauer, T., Roberts, I., & Holmberg, A. (eds.) *The Final-over-Final Condition: A syntactic universal* (Vol 76), 151-186. Cambridge, MA: MIT Press.

Salzmann, M. (2019). On the limits of variation in Continental West-Germanic verb clusters. Evidence from VP-stranding, extraposition and displaced morphology for the existence of clusters with 213 order. *Journal of Comparative Germanic Linguistics* 22, 55-108.

Sheehan, M., Biberauer, T., Roberts, I., & Holmberg, A. (eds.). (2017). *The Final-over-Final Condition: A syntactic universal* (Vol. 76). Cambridge, MA: MIT Press.

Sheehan, M. (2017). The final-over-final condition and adverbs. In Sheehan, M., Biberauer, T., Roberts, I., & Holmberg, A. (eds.) *The Final-over-Final Condition: A syntactic universal* (Vol 76), 97-120. Cambridge, MA: MIT Press.

Shieber, S.M. (1985). Evidence against the context-freeness of natural language. *Linguistics & Philosophy* 8(3), 333-344.

Stabler, E. (2004). Varieties of crossing dependencies: structure dependence and mild context sensitivity. *Cognitive Science* 28: 699-720

Steddy, S. & Samek-Lodovici, V. (2011). On the ungrammaticality of remnant movement in the derivation of Greenberg's universal 20. *Linguistic Inquiry* 42(3), 445-469.

Steedman, M. (2000). *The Syntactic Process*. (Vol. 24) Cambridge, MA: MIT press.

Wagner, M. (2005). Prosody and recursion. Ph.D. dissertation, MIT.