Merge: Properties and boundary conditions

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1. Introduction

The goal of a generative syntactic module is to create linguistic objects that connect sound to meaning. Therefore, a basic structure building operation is needed that combines syntactic objects into more complex objects. In the Minimalist Program (Chomsky 1995) this operation is called Merge. At first sight, both the existence and the working of Merge are close to being trivial, but on nearer inspection this is not at all the case. The reason is that it must be interpreted within a nontrivial system of boundary conditions on its input and output.

   The following text is a brief explorative discussion of these conditions. Attention is paid to the organization of the syntactic work space, the notation of syntactic objects, and the idea of a strict cycle. It is shown that an evaluation of unconventional concepts such as 'interarboreal movement' and 'multidominance' is almost inevitable. Three possible grammars are defined in the conclusion.

2. The basics of Merge

The operation Merge is structure building and, at the same time, it automatically creates a hierarchy. These properties can be understood as different perspectives on the definition of Merge:

(1)   *Structure building:* Merge combines syntactic objects into one new, larger object.

(2)   *Hierarchy:* The input objects of Merge are included in the newly created output object.

Furthermore, it is often assumed that Merge is binary:

(3)   *Binary Branching:* Merge takes two input objects.

This assumption is conceptually the simplest, but it is also empirically supported by constituency tests, etc. (as far as it can be tested).

If there is a relation between the two input objects of Merge — and of course there is always some relation; otherwise, there would be no reason for merger to begin with — it is most probably asymmetric. The one object is selected by or dependent on the other in terms of semantic or syntactic features. Therefore, it seems that asymmetry is an inherent property of Merge:

(4)   *Asymmetry:* The output of Merge is an ordered pair.

Strangely, this view is not supported by Chomsky (1995), but see e.g. Koster (1999), Di Sciullo (2000), Langendoen (2003), Zwart (2004a/b). Notice that it would be a misconception to equate syntactic asymmetry with linear/temporal precedence. Surely, it can be mapped onto literal precedence at the PF interface, which is necessary for the linearization of the structure, but that is a possible effect of this property, not the property itself.[1]

The combination of (1) through (4) leads to the definition of the operation Merge in (5), in set or graph notation:

(5)   Merge $(X,Y) \rightarrow <_Z X,Y>$ or $\underset{X\quad Y}{\overset{Z}{\wedge}}$ where X, Y, Z are syntactic objects.

X, Y and Z are the labels of the syntactic objects. I will leave aside the issue whether some version of X'-theory is needed, or that the labels are completely predictable from the feature content of the words involved ('bare phrase structure'), and a possible combination with a universal order such as SHC 'spec-head-comp' (Kayne 1994) or SCH (Haider 1994, Fukui & Takano 1998).

3.   The input and output of Merge

Both the input and output of Merge are subject to boundary conditions. It is usually assumed that Merge is applied strictly cyclically, that is, a syntactic structure is extended at the top. This condition can be formulated as a restriction on the output of Merge:

(6)   *Strict Cycle/Extension:* The output of Merge is not included in
        (=dominated by) a larger syntactic object.

Concerning the input, standard practice leads to the conclusion that it is essentially free, as long as it involves syntactic objects. There are three possible sources of syntactic objects: they can be drawn from the lexicon (or numeration), from the syntactic work space (working memory), where the different parts of the derivation are composed, or from within a partial derivation (in the syntactic work space), namely if movement takes place:

(7) *Free selection:* An input object for Merge is a syntactic object that is
    i.   selected from the lexicon (or numeration), *or*
    ii.   a partial derivation selected from the syntactic work space, *or*
    iii. a constituent of a partial derivation.

Notice that for the derivation of one sentence, a number of partial derivations must be produced. For instance, the subject of a predicate is often complex, and adverbial phrases as well. These phrases must be derived before they can be attached to the 'main' structure. Thus, at a given point of time, the syntactic work space contains a number of partial derivations.

Let us see which different applications of Merge are allowed by the system laid down in (1) through (7) above. Table 1 summarizes the four most common ones. The differences are the consequence of the varying sources of input. Here, for ease of exposition the simplifying assumption is made that heads are taken from the lexicon, and phrases (hence partial derivations) from the syntactic work space.

Table 1. Merge(X(P),Y(P))…

#	X(P)		Y(P)	*abstract example*	*usually named*
1	lexicon		lexicon	[X Y]	Merge
2	lexicon	($\leftrightarrow$)	partial derivation	[X YP] *or* [XP Y]	Merge
3	partial derivation		partial derivation	[XP YP]	Merge
4	constituent of YP	($\leftrightarrow$)	partial derivation	$[X(P)_i [_{YP} \ldots t_i \ldots]]$ *or* $[[_{XP} \ldots t_i \ldots] Y(P)_i]$	Move

Interestingly, Table 1 does not exhaust the possibilities. Nothing in the system so far prevents the options in Table 2.

Table 2. …Merge(X(P),Y(P)) *(continued)*

#	X(P)		Y(P)	*abstract example*	*usually named*
5	constituent of ZP	($\leftrightarrow$)	lexicon	$[X(P)_i Y]$ *or* $[X Y(P)_i]$	?
6	constituent of ZP	($\leftrightarrow$)	partial derivation	$[X(P)_i YP]$ *or* $[XP Y(P)_i]$	?
7	constituent of WP		constituent of ZP	$[X(P)_i Y(P)_k]$	?

These may be interpreted as 'interarboreal movement', which is the subject of the next section. However, see Sections 5 and 6 for a different perspective on this matter.

4. Interarboreal movement

The idea of interarboreal movement is illustrated in (8):

(8)
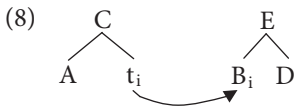
One might decide right away that this is an unwanted possibility. If so, (8) can be excluded by assuming the condition in (9):

(9) *Exclude interarboreal movement:*
     A moved (=remerged) object must c-command its original position.

This condition requires that the system recognizes the concepts 'remerged', 'c-command' and 'original position'. First, it seems to me that c-command is independently needed; it can be defined as in (10), inspired by Epstein (1999):

(10) *C-command (dynamic):*
      If Merge(A,B) then A c-commands B and every constituent included in B.

Second, awareness of the original position requires some notion of trace and/or chain. Third, how does Merge know that an input constituent is going to be remerged? Do merged constituents have a check mark, or does the system perform a quick check to see if an input object is already included in another object?

Whatever solution is taken, it should be clear that a condition with the effect of (9) is a considerable complication of the theory. (Moreover, (9) overlaps with the strict cycle condition in (6) in the case of regular movement.) Therefore, the following questions are justified: do we really want to exclude interarboreal movement? Is there a sensible interpretation of 'iMove'?

There are no definitive answers to these issues, but I would like to mention two works from the literature that make a case for iMove. First, Bobaljik & Brown (1997) suggest that it is a possible solution for head movement, which would otherwise be countercyclic (that is, if it involves adjunction — see Chomsky 1995).[2] The idea is very simple:

– Perform Merge until the target head is the next head to be merged.
– Select the target head from the lexicon.
– Remerge the head to be moved with the new target head, but in an independent partial derivation (this is iMove).
– Then merge the combination of heads with the original structure.

Thus, even though the final representation of head movement looks counter-cyclic, the step-by-step derivation is strictly cyclic.

Second, Nunes (2001) argues that iMove ('sideward movement' in his terms) is a possible solution for the additional gap in parasitic gap constructions and across-the-board movement. Consider (11), for example:

(11)   [Which paper]$_i$ did you file [~~which paper~~]$_i$ without reading [~~which paper~~]$_i$?

Although Nunes' theory is very different from Bobaljik & Brown's, in the derivation of (11) he makes use of the same basic idea of iMove:

– Merge until *reading* [*which paper*].
– Select *file* and copy+remerge *which paper* with it in an independent partial derivation (this is iMove).
– Complete partial derivation 1: [$_{PP}$ *without reading which paper*].
– Merge partial derivation 2 until vP: *you file which paper*.
– (Right-)adjoin derivation 1 to derivation 2.
– Merge until C'; copy+remerge *which paper* (the object of *file*) in SpecCP.
– Two chains are formed: the highest *which paper* with the copy in the object position, and (separately) with the copy in the PG position. Only the highest copy is pronounced. (The two gaps do not c-command each other, but the highest *wh* sees them both.)

In this way, the two gap positions are related during the derivation, but in the final representation they are out of each other's reach.

Clearly, much more discussion is necessary for a full assessment of these ideas — in fact, I am not defending the two mentioned here — but the general point should be clear: it may be a little too hasty to exclude iMove a priory, since (i) a condition to exclude iMove is a complication of the theory, and (ii) there may be sensible interpretations of iMove.

5. Multidominance

Let us turn to another unconventional possibility that is not a priori excluded by the basic theory in (1) through (7). Suppose we Merge A and B, and then remerge B with some D without moving it. This gives either (12a) or (12b):

(12) a.

    C   E

   A   B   D

b.

          E

   C   D

 A   B

(Unfortunately, the second possibility causes some complications for drawing.) What is special about the configuration in (12) is that B has two mother nodes. This is called 'multidominance'. Seen from another perspective, the structure involves 'sharing': B is shared by C and E.

    One might decide right away that multidominance is an unwanted possibility. If so, it must be explicitly excluded, e.g. by the condition in (13):

(13) *Exclude multidominance:*
   The output of Merge is an independent syntactic object.

Now, the concept of 'independence' must be defined (this is not so easy):

(14) *Independence:*
      Node A is independent iff A is not included in any other node, and every node included in A is not included in a node that is not included in A.

Note that (13) is a complicated version of the strict cycle condition in (6). Again, the question arises whether this complication of the theory is necessary, or that it is justified to look for a sensible interpretation of multidominance.

    In fact, the latter has already been proposed by McCawley (1982). He suggested, among other things, that backward conjunction reduction (or Right Node Raising) can be analyzed as sharing of a constituent between two conjuncts. This idea is illustrated in (15):

(15)
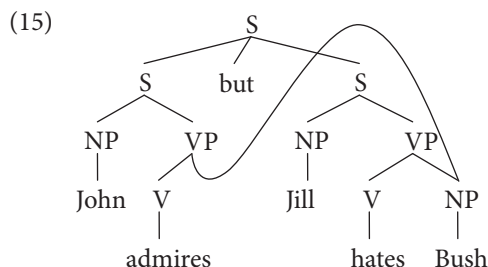
In (15) the direct object *Bush* is the sister of both *admires* and *hates*: it is part of both conjuncts.

Sharing in the case of RNR has received support by various authors; see De Vries (2005) for an overview. One argument for an analysis in terms of sharing instead of movement or deletion is the fact that RNR shows nonlocal behavior; see e.g. the contrast between (16a) and (16b), assuming the rather standard view that gapping does involve deletion:

(16)   a.   Pete said that John ADMIRES _ but I know that Ken claimed that Jill
            HATES *Bush*.   [RNR]
       b.   *Pete said that John *admires* BUSH, and I know that Ken claimed that
            Jill _ KERRY.   [gapping]

The pattern in (16a) — which appears to violate the locality condition called Right Roof Constraint by Ross — can be explained as follows. In a configuration involving sharing, a 'bypass' is created (here, between the two lowest verb phrases). Consider the abstract picture in (17):[3]

(17)
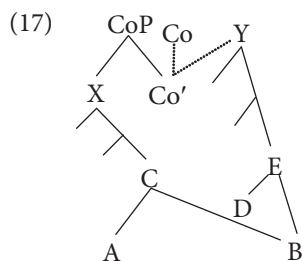
No matter how complex the conjuncts X and Y are, the shared constituent B is locally related to both A and D.

Similarly to the situation with respect to interarboreal movement, I conclude that the exclusion of multidominance can only be obtained by adding a complicated condition to the theory; moreover, there is a possible interpretation of multidominance.[4]

## 6. Syntactic notation and the interpretation of remerge

What is the relation between interarboreal movement and multidominance? In both cases a constituent is merged again. The answer to this question is not straightforward. Therefore, let us go back to the basics first.

If the syntactic objects X and Y are merged (say, into a complex object called Z), what does this mean? Does it mean that a set $<_Z X,Y>$ is created, or a tree structure $_X/^Z\backslash_Y$, or perhaps a bracket structure $[_Z X Y]$? Actually, there is no deeper truth in these notations; they are just what they are: notations. The operation Merge is defined such that if X and Y are selected as the input, the output is a single object (Z = X+Y) that includes X and Y, which are combined in an asymmetrical way. Thus, there are two basic relations: inclusion ($\equiv$ dominance) and an asymmetry, which can be called abstract precedence. Therefore, the effect of Merge is that it establishes three local relations: here, X precedes Y, X is included in Z (= X+Y), and Y is included in Z. Subsequent applications of Merge lead to a growing list of basic local relations.

As long as Merge is restricted to simple ('external') cases, all notations are equivalent, and the above may seem an academic issue. However, if a certain object is *re*merged, complications arise. Suppose the following sequence of mergers is performed:

(18) Merge (A,B) → C
      Merge (B,C) → D

The second merger is 'internal', and it implies movement of B. This leads to one of the following representations:

(19) a.
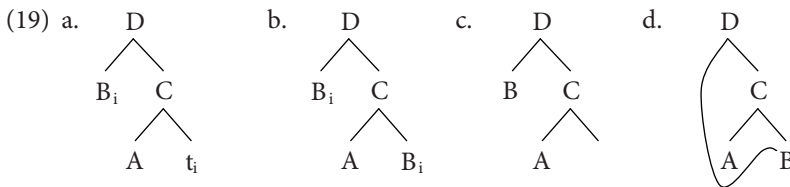
In (19a), movement leaves a trace (as in the Government & Binding framework); in (19b) it leaves a copy (as in Chomsky 1995). In (19c), B is simply merged again, in a new position; there is no copy or trace. For instance, Zhang (2004) argues that copies are unwanted theoretical artefacts, which cause trouble at PF, etc.; therefore, "Move is [just] Remerge". Another possible representation of a theory without copying is (19d), where B's engagement in a new relationship is indicated by means of multidominance; see Gärtner (2002), or Frampton (2004).

The last representation cannot be translated into a set notation (at least not in any straightforward way). Does this mean that the set notation is wrong? Not necessarily; as I said, there is no deeper truth in notations. The truth is in the operation of Merge itself and the (list of) basic relations it creates. Nevertheless, (19d) reflects the fact that B is engaged in two sets of relations ('triads' in Koster's 2004 words) very well.

At this point, let us complicate things somewhat further, and assume the following sequence of mergers:

(20)   Merge (A,B) → C
       Merge (B,D) → E

The second application of Merge involves 'external remerge'. One might ask if (20) means (21a) or (21b):

(21) a.   C   E   b.   C   E
          /\   /\   /\   /\
         A   B   D   A B D
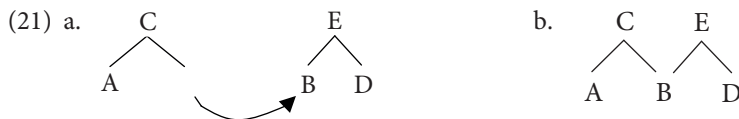
Here, (21a) represents interarboreal movement and (21b) multidominance. However, if what I said above is right, the question is wrong. The *notation* suggests iMove or mDom, but that does not mean anything. What is relevant is that B is engaged in two triads. Thus, the conclusion, perhaps surprisingly, is that multidominance and interarboreal movement are actually the same. The basic idea is that external remerge is possible.

Let me recapitulate the example of head movement from Section 4. There, it was described in terms of interarboreal movement. In (22), a possible representation in terms of in terms of multidominance is given. Here, the head X is moved and adjoined to the higher head W.

(22)   WP
              /   \
            W   XP
           /\   / \
          W   ZP   X'
                   \   /\
                    X   YP
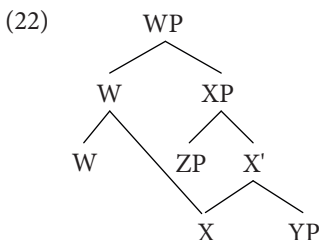
But what is actually relevant is the sequence of mergers in (23):

(23)   Merge (X, YP) → X′
       Merge (ZP, X') → XP
       Merge (W, X) → W$^+$ [external remerge: iMove or mDom]
       Merge (W$^+$, XP) → WP

The third step of Merge is an instance of external remerge.

Finally, notice that external remerge automatically creates a 'hydra', i.e. there are two top nodes — see e.g. (21b). Since the derivation must eventually converge into one object with one top node, there must be a uniting instance of Merge at some point. This is also clear in a set notation. For instance, in (23) the following series of sets is derived (from left to right); see (24):

(24) $<_{X'}$ X,YP>   ⇒ $<_{XP}$ ZP,$<_{X'}$ X,YP>>
                                    ⇒ $<_{WP}$ $<_W$ W,X>,$<_{XP}$ ZP,$<_{X'}$ X,YP>>>
       $<_W$ W,X>

Upon external remerge, an independent set is created (here, $<_W$ W,X>). The two separate sets are combined in the last step. In the final representation, it appears that X is displaced.

7.   Conclusion

The syntactic operation Merge combines syntactic objects. By definition, it is structure building, it creates a hierarchy, it is binary, and it is asymmetrical. Furthermore, Merge is subject to certain boundary conditions on the input and output, e.g. the strict cycle condition and the selection of input objects. I showed that, on fairly standard assumptions, not only the regular types of Merge and Move are available, but also the perhaps unexpected possibilities that have been called interarboreal movement and multidominance. At the cost of additional constraints, these can be excluded, but I also showed that there are possible interpretations of these operations. In a discussion on the notation of syntactic objects, I concluded that the two are actually equivalent. What is relevant is that both concepts involve *external remerge*; the rest is syntactically meaningless association on the basis of the notation alone.

Depending on the boundary conditions, we can define several possible grammars. Three important ones are the following:

Possible grammar I. The input for Merge is restricted such that only roots are selected, i.e. partial derivations and material from the lexicon, but not subconstituents of these. As a consequence, remerge is completely excluded, and

derivations are automatically strictly cyclic. Thus, there is no Move (internal remerge), no head adjunction, and no interarboreal movement or multidominance (i.e. external remerge). This type of grammar is defended in e.g. Koster (2004). He claims that only unmerged objects can be merged; movement is redundant because we already have pied piping.

Possible grammar II. The input for Merge is free, but there is a complicated restriction such as (13/14), with the effect that only simple Move is possible. There is no head adjunction and no external remerge. This grammar is close to what is standardly assumed.

Possible grammar III. The input for Merge is free. There are no limiting stipulations, or at most a simple strict cycle condition such as in (6). As a consequence, both internal and external remerge is possible.

Notes

1. It has been claimed that the linear order can be derived from the syntactic hierarchy alone (e.g. Kayne 1994, Fukui & Takano 1998). However, these theories create an asymmetry between sister nodes indirectly, e.g. by postulating the 'invisibility' of X-bar nodes; see De Vries (2004:7ff) for comment.

2. An interesting version of the idea is Bobaljik (1995), where the possibility of iMove is related to the way the syntactic work space operates. Bobaljik suggests that it is an expanding list of terms, all of which remain accessible to the operation of Merge (which creates a new term).

3. The coordination phrase is rendered three-dimensionally here, in accordance with De Vries (2004, 2005). The nodes Co and Y are behind Co'. As such, this alternative view of parataxis is of little importance to the present discussion. However, De Vries (2005) argues that multidominance only survives in 'parallel structures' that do not c-command each other, because of potential c-command paradoxes. For reasons of space, I will leave this matter aside.

4. Van Riemsdijk (1998) suggests a number of constructions (next to RNR) that may involve what he calls 'grafting' (the entanglement of different structures), e.g. so-called transparent free relatives.

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