# X'-Structure and Minimalism

**Jairo Nunes (Universidade de São Paulo)**

## 1. Introduction

A fundamental property of natural languages is that words combine into larger units with hierarchical structure (see e.g. Helasvuo this volume). The sentence in (1), for example, does not simply involve a bag of words, for it can be chopped off into smaller grammatically significant units such as *the proposal*, *this hypothesis*, *on this hypothesis,* or *relies on this hypothesis*.

(1) The proposal relies on this hypothesis.

One of the major goals of the generative enterprise has been to properly characterize this hierarchical structure. In the *Aspects* model (Chomsky (1965)), for instance, the structure of syntactic constituents like *relies on this hypothesis* in (1) was captured by phrase structure rules of the type illustrated in (2a), coupled with information regarding the subcategorization features of the lexical items along the lines of (2b). (2a) states that a verb phrase is composed of a verb optionally followed by a noun phrase, which may in turn be optionally followed by a prepositional phrase, whereas (2b) informs that the verb *rely* selects for a prepositional phrase. The combination of (2a) and (2b) ensures that in grammatical structures, a verb like *rely* is inserted in a verb phrase that has been rewritten as *V PP* and not as *V NP PP* or simply *V*.

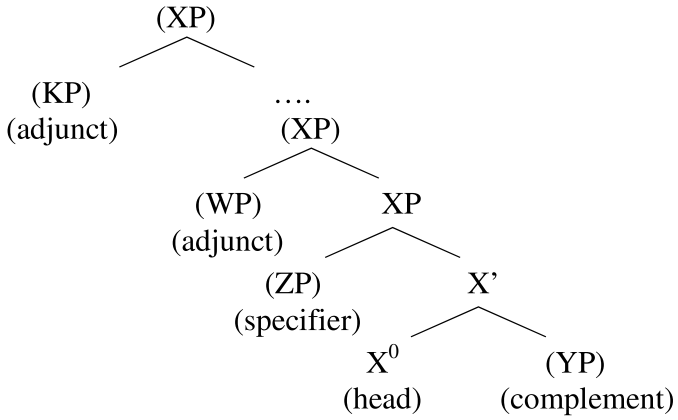
(2) a. VP → V (NP) (PP)

b. *rely*: [__ PP]

However successful in describing the broad structure of natural languages, this approach faces a couple of problems.[1] On the one hand, it is redundant in the sense that the information that a verb may form a constituent with a PP is encoded twice: in the phrase structure rules and in the lexical entry of verbs like *rely*. On the other hand, it fails to capture some generalizations that cut across structures. For instance, a verb phrase must obligatorily have a verb in the same way a noun phrase must be obligatorily have a noun. Similarly, the verb *rely* forms a constituent with a PP in the same way the related noun *reliance* does. However, these two generalizations come out as completely accidental in an approach that adopts mechanisms such as (2), for there is nothing in the format of the rules that has an overarching coverage across categories.

The development of X'-Theory within the *EST* and *GB* models (see e.g. Chomsky 1981) aimed at overcoming these sorts of problems. Phrase structure rules were eliminated and the subcategorization information of the lexical items was mapped into a general phrasal skeleton along the lines of (3) below.[2] In (3) *X*, *Y*, *Z, W*, and *K* are place holders for any major lexical category (V, N, P, A, etc.), capturing the endocentricity property of natural languages, that is, the fact a verb phrase must have a verb, an adjectival phrase must have an adjective, etc. (3) also captures the fact that the combination of the verb *rely* with its complement and the combination of *reliance* with its complement result in structurally comparable structures.

(3)




(3) in fact embodies many other claims about syntactic constituents. For instance, it purports to show that syntactic constituents involve binary branching and that there can only be one specifier per head. In the sections that follow, we will consider some of these claims within *GB* and discuss how and why they have been reanalyzed within the Minimalist Program.

## 2. Some properties of X’-structure

### *2.1. Bar-levels*

One distinctive property of the X’-template is that it takes syntactic constituents to be structured around three different levels of complexity: the head ($X^0$), the intermediate projection (X’), and the maximal projection (XP). The bar-level symbols “$^0$”, “ ’ ”, and “P” appended to X are taken to be intrinsic features of the syntactic skeleton that determine their behavior in the computation. For instance, heads and maximal projections can be targeted for movement purposes, but intermediate projections cannot.

The bar-level features also provide a recipe for interpreting the constituent that is the sister of a bar-level projection. Thus, if a given constituent C is the sister of a zero level category X, C will be interpreted as the complement of X; if the sister of a maximal projection XP, C will be interpreted as an adjunct of X; and if the sister of an intermediate projection, C will be interpreted as the "specifier" of X, a loose notion that encompasses both arguments (as is the case of the specifier of VP, for instance) or other elements that enter into grammatical relations such as agreement (as is the case of the specifier of IP, for example).

According to the schema in (3), there are also two important distinctions between arguments and specifiers, on the one hand, and adjuncts, on the other. First, the number of complements and specifiers is restricted to one each per head, but there is no fixed limit on the number of adjuncts. This distinction is empirically based on the observation that clauses prototypically have one subject and transitive verbs prototypically have one complement, for instance, but there is no prototypical number of adjuncts a given projection have may take. Second, when complements and specifiers are introduced, the resulting structure has a different bar-level specification (a head combined with a complement yields an intermediate projection and an intermediate projection combined with a specifier yields a maximal projection). By contrast, adjuncts do not change the bar-level specification of their target. If *saw the star* is a VP, the addition of the adjunct *with the telescope* leaves the bar-level of the resulting structure unaltered: *saw the star with a telescope* is also a VP.

*2.2. Binary branching*

Another property that (3) encodes is binary branching. Research since the 80's triggered by Kayne's (1984) influential work has led to a wholesale reevaluation of ternary or *n*-ary branching structures previously assumed for different categories. The structure of the clause, for instance, was reanalyzed from the ternary branching structure [$_S$ NP INFL VP] to the binary branching structure [$_{IP}$ NP [$_{I'}$ $I^0$ VP]] (see e.g. Chomsky 1986). Similarly, ditransitive structures previously analyzed as [$_{VP}$ V NP PP] were reconceived as binary branching structures with the format [$_{VP}$ NP [$_{V'}$ V PP]] with an additional movement of V to the left of NP (see e.g. Larson 1988). Underlying the move in this direction were several empirical observations that pointed to the conclusion that the internal constituents of a given structure must be organized in terms of asymmetric, rather than symmetric c-command and this is compatible with binary branching structures, but incompatible with flat structures. Take the sentences in (4), for instance. If the two arguments of *give* stood in a mutual c-command relation, both the sentences should be acceptable, for the negative polarity expression headed by *any* would be locally c-commanded by the negative expression headed by *no*. The contrast between (4a) and (4b) thus indicates that the first complement must asymmetrically c-command the second one and this can be captured by a binary branching structure along the lines of [$_{VP}$ NP [$_{V'}$ V NP]] (followed by movement of the verb).

(4) a. I gave nobody anything.

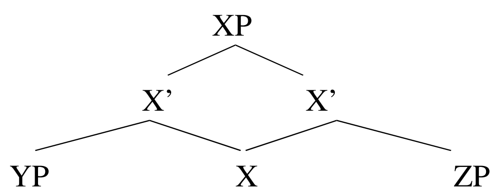
b. *I gave anybody nothing.

The two reanalyses mentioned above had far-reaching consequences as they set the basis for additional reanalyses of other projections or the postulation of new projections. It has now become the null hypothesis that for any new head H that one postulates, the projections of H will organize themselves in a binary branching fashion.

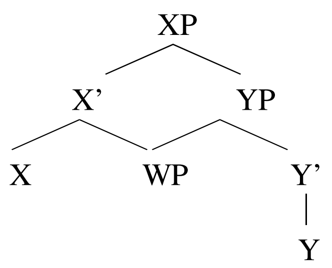
*2.3. Uniqueness of mother nodes*

The X'-template in (3) also embodies the idea that the structure of the constituents of natural languages is such that it prevents a given element from being immediately dominated by more than one node. That is, (3) excludes structures like (5a), where X takes YP and ZP for complements and projects an intermediate projection in each case, or (5b), where WP is simultaneously the complement of X and the specifier of Y.

(5) a.




b.




*2.4. Endocentricity*

Finally, the X'-template captures the fact that there is an asymmetry between the immediate constituents $C_1$ and $C_2$ of a given syntactic object $\Sigma$ in the sense that only one of them determines the (categorial) properties of Σ. Take the syntactic object *eat apples*, for instance. The combination of *eat* and *apples* results in a constituent that is verbal and not nominal, as can be seen by the fact illustrated in (6) that distributionally, *eat apples* may occupy positions that can be occupied by verbs

(6) I will [run]/[eat apples]

The endocentricity encoded in the X'-template thus ensures that whenever we find syntactic constituents larger than a single lexical item, their properties must be determined by one of its immediate constituents. This in turn led to the complete elimination of phrase structure rules, for even clauses, whose phrase structure was exocentric (S → NP INFL VP), were realized as projections of a given functional head ($[_{IP}$ NP $[_{I'}$ $I^0$ VP]).

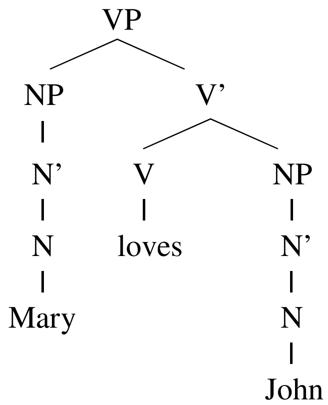
**3. Bare phrase structure**

With the emergence of the Minimalism Program in the 90's, a wholesale conceptual evaluation of the technical apparatus made available in *GB* took place and X'-Theory was one of the components that was targeted for a close examination. The aim of this inspection is, on the one hand, to distinguish the properties of X'-structures that reflect true properties of phrase structure in natural languages from the ones that are tied to the formal notation used and on the other, to investigate if such properties can be derived from deeper properties of the language faculty. Let us then consider how and why X'-structures came to be reanalyzed in terms of what Chomsky (1995) called *bare phrase structure*.

*3.1. Functional determination of bar-levels*

Consider the X'-structure in (7).

(7)




(7) illustrates three properties that may raise minimalist qualms. The first one involves a redundancy between the terminal nodes and the lexical items that they dominate. Arguably, the lexical entry of *Mary*, for instance, includes the information that it is a noun. Hence, there is nothing that the node N dominating *Mary* encodes that is not already encoded by the latter. To put it differently, by introducing a distinction between $X^0$ heads and lexical items, X'-structures bring seemingly unnecessary redundancy to the system. At first sight, the distinction may seem useful in determining projection; after all, one has to capture the fact that the constituent *loves Mary* is verbal and not nominal. However, all that is strictly required is that the resulting object has the relevant properties of one of its immediate constituents and not necessarily that its categorial feature must be encoded.

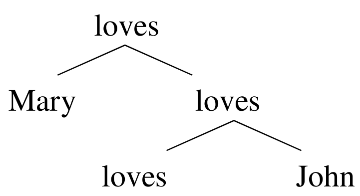
The second problem regards vacuous projections. Recall that complements and specifiers are in principle optional (cf. (3)) and their presence is determined by the properties of the lexical item inserted under the $X^0$ head. In the case at hand, *Mary* and *John* do not have the relevant selectional features and, accordingly, they do not have a specifier or a complement. However, under the assumption that bar-levels are intrinsic features of the X’-skeleton, they must still project an N’. This is an unfortunate result, though, for intermediate projections arguably cannot move and both *Mary* and *John* can undergo movement.

The bar-level themselves are also suspicious from a minimalist perspective. Chomsky’s (1995) has proposed that the syntactic computations should be subject to the Inclusiveness Condition, which requires that syntactic objects be built from the features present in the lexical atoms that feed the derivation. As mentioned above, the features “$^{0}$”, “ ’ ”, and “P” are tied to the X’-skeleton and, as such, cannot be construed as lexical features. All things being equal, a system that eschews such features is on better conceptual grounds. Chomsky then proposes that the projection status of a given syntactic object should be determined not in terms of extrinsic features but in terms of relational notions along the lines of (8).

(8) a. *Minimal Projections*: lexical items that feed the computation.
b. *Maximal Projections*: syntactic objects that do not project.
c. *Intermediate projections*: syntactic objects that are neither minimal nor maximal projections.

Given the considerations above, the structure in (7) can be simplified along the lines of (9) below, where (i) there is no redundant distinction between terminal nodes and lexical items; (ii) there are no vacuous projections; and (iii) each syntactic object can have its phrasal status determined in virtue of its relations with the other syntactic objects; hence, *Mary* and *John* are minimal maximal projections (they are lexical items that do not project), the lowest instance of *loves* is a minimal nonmaximal projection, the highest instance of *loves* is a nonminimal maximal projection, and the instance immediately dominating *loves* and *Mary* is an intermediate projection, as it is neither minimal nor maximal. The repetition of *loves* is a notational device to encode that the lexical item *loves* is the item that ultimately determines the grammatical properties of the larger syntactic objects *loves John* and *Mary loves John*. Derivatively, one may also define complements and specifiers in terms of (8): complements are sisters of minimal nonmaximal projections and specifiers are sisters of intermediate projections.

(9)




Notice that (9) also captures another property encoded in (3): that specifiers and complements must be maximal projections. In X'-structures this is a stipulative property. By contrast, in a representation such as (9), this follows from the relation among the syntactic objects; since *Mary* and *John* do not project, they are necessarily maximal projections.

Before closing this section, it is worth observing that the elimination of vacuous projections does not face any obvious empirical challenges. Take the structural difference between the unaccusative and unergative verbs under X'-structures, for instance, which was captured by means of a vacuous intermediate projection of V so that the internal argument of unaccusative structures was mapped inside V' (e.g. $[_{VP}$ $[_{V'}$ arrived John]]) and the external argument of unergative structures was mapped outside V' (e.g. $[_{VP}$ John $[_{V'}$ sneezed]]). With recent developments of the fine structure of VP, the two structures may be distinguished in terms of whether the argument is the sister of V or the sister of a null light verb projection ($[_{vP}$ v $[_{VP}$ arrived John]] *vs.* $[_{vP}$ John $[_{v'}$ v $[_{VP}$ sneezed]]), with no need to resort to vacuous intermediate projections.

*3.2. The operation Merge*

In the previous section, we discussed properties of phrasal syntactic objects but left aside the question of how such objects are created once phrase structure rules have been abandoned. Trying to keep the number of assumptions minimal, what we need is an operation that combines lexical items and complex objects built from lexical items and specifies the relevant properties of the resulting structure. Chomsky (1995) calls this operation *Merge*. Applied to two lexical items $\alpha$ and $\beta$, Merge creates the complex syntactic object $\{\gamma, \{\alpha, \beta\}\}$, where $\gamma$ is the label of the resulting structure informing the computation of its relevant grammatical properties. Thus, by merging *loves* and *John*, we obtain the syntactic object {loves, {loves, John}}, whose syntactic properties are determined by *loves* (hence, we say that *loves John* is a verbal projection). As Merge can apply iteratively, it can target *Mary* and the complex object {loves, {loves, John}}, yielding as the result {loves, {Mary, {loves, {loves, John}}}}, which is also a verbal projection as its properties are determined by *loves*.

One question that arises is how the label of a given complex syntactic object is determined. We have already seen that from an empirical point of view, it is the case that one of the immediate constituents determines the properties of the resulting structure, but what prevents the system from projecting *John* when it merges with *loves*, for example? In the best of possible worlds, the relevant information should be locally available in order for computational complexity to be reduced. Fortunately, there seems to be an independent asymmetry between *loves* and *John* which may be used to determine the label of the resulting structure. It is a property of *loves* that it requires a complement, but it is not a property of *John* that it requires a verb to be the complement of. If something along these lines is correct, a head will have as many projections as necessary to have its requirements met.

This brings the issue of whether the number of specifiers must be restricted to one. The original empirical motivation for this assumption was that certain designated heads "closed off" certain projections. For instance, determiners were taken to be specifiers of NP because they were the highest elements of the nominal domain. However, this fact has been reanalyzed in a more streamline fashion in accordance with the X'-template in (3) as a reflex of D taking an NP for its complement and projecting a DP. Thus, in absence of evidence to the contrary, the number of specifiers should not be specified, which is exactly what the bare phrase structure system leads us to expect. And multiple specifiers may in fact be independently required. Chomsky (1995), for instance, has reanalyzed overt object movement as movement to the "outer" specifier of vP.

Another question is whether Merge can target any two syntactic objects. Under minimalist inspirations, economy considerations encompassed by Last Resort demand that there can be no superfluous applications of a given operation in a convergent derivation. Applied to Merge, these considerations have two consequences worth noting. First, two syntactic objects can undergo merger only if one satisfies requirements of the other. Given the lexical items *Mary*, and *John,* for example, they cannot be merged as neither satisfies requirements of the other. Importantly, this information is made locally available either by the lexical item itself or by the label determined by it in the case of phrasal constituents.

The same reasoning prevents the creation of vacuous projections. Under bare phrase structure, vacuous projection can only be derived if a given syntactic object can be merged with nothing, that is, if Merger can apply to a single term. But it is arguably the case that one such application of Merge does not (locally) satisfy any requirements of the term it targets; hence, it is blocked by Last Resort and no vacuous projections are derived.

The above discussion leads to the conclusion that a successful application of Merge will target at least two terms. But why must it stick to two? Why can't it apply to three terms, for instance? One possibility is that this is an optimal solution to the question of how much the system needs to create complex syntactic objects and get recursive structures. If two is the minimal number of terms required for Merge to operate with, an optimal solution may simply take the upper limit to be two, as well. If this suggestion is on the right track, binary branching follows. It would be a by-product of the general strategy of trying to do the most with the least.

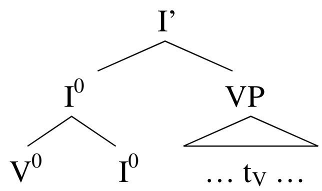
Finally, let us consider the claim that in natural languages a given syntactic object cannot be immediately dominated by more than one node (see section 2.3). Chomsky (1995) has argued that computational complexity may be considerably reduced if Merge can only operate with root syntactic objects (the Extension Condition). If so, Merge cannot target a constituent that is dominated by another and structures such as (5) are ruled out.

### *3.3. Adjunction*

In the sections above we have focused on the syntactic representation of structures containing complements and specifiers within the bare phrase structure system. Let us now see how adjuncts are to be represented.

It is fair to say that the bare phrase structure system inherited the conceptual problems regarding adjunction found in X'-structures. Let us consider some of these problems by inspecting the X'-structure in (10), formed by adjunction of a moved verb to the Infl head.

(10)




Given that further I-to-C movement should piedpipe V, we must conclude that [$_{I^0}$ $V^0$ $I^0$] in (10) is a syntactic constituent. On the other hand, under the standard assumption that a moved element must c-command its trace, it must be the case that the type of constituenthood produced by adjunction is such that it does not prevent the adjunct from c-commanding out of the adjunction structure; otherwise, the moved V in (10) will not be able to c-command its trace. Within *GB*, this problem was accommodated by distinguishing two types of integrative relations: containment and dominance (see e.g. Chomsky 1986). Once adjuncts do not change the bar-level of their hosts, the idea was that adjunction did not create new projections but extended the projection of their host in more segments. Under this view, containment is looser than dominance: α contains β if β stands in an integrative relation with *some* segment of α, whereas α dominates β if β stands in an integrative relation with *all* the segments of α. If c-command is to be defined in terms of dominance rather than containment, the adjoined V in (10) does c-command its trace as it is only contained but not dominated by $I^0$.

Notice that adjunction is also exceptional in that it apparently need not satisfy the Extension Condition. In (10), for instance, the moved verb does not merge with a root syntactic object. In face of problems such as this, Chomsky (1995) has suggested that the Extension Condition should in fact not hold of adjunction structures.

But the most problematic issue is how to capture the idea that adjunction preserves that bar-level status of the relevant host if phrasal status is to be functionally determined, as discussed in section 3.1. Take the phrase *speak Portuguese well*, for instance. Merger of the verb and the noun yields the syntactic object K = {speak, {speak, Portuguese}}, which under the functional interpretation of phrasal status is a nonminimal maximal projection. What is now the structure resulting from adjoining the adverb to K? It should at least be a set containing K and the adverb. The question is what kind of label the resulting structure has. We know that it should be determined by *speak* as it is a verbal projection. However, if the verb projects yielding L = {speak, {{speak, {speak, Portuguese}}, well}}, K within L will be interpreted as an intermediate projection (it is not a lexical item and it projects) and, consequently, the adverb will be interpreted as a specifier and not an adjunct of K. To keep the distinction between adjuncts and specifiers, Chomsky (1995) in a sense resurrected the distinction between segments and categories and suggested that adjunction involves a different kind of label, which is determined by the head of the construction but leaves the original structure unaltered as far as its phrasal status goes. The notation Chomsky uses for this label is an ordered pair based on the head of the constructions: $\{\langle\gamma, \gamma\rangle, \{\alpha, \beta\}\}$, where $\gamma$ is again determined by either $\alpha$ or $\beta$. In the case at hand, *speak Portuguese well* should be represented as {<speak, speak> {{speak, {speak, Portuguese}}, well}}.[3] It is very likely that the two types of complex objects formed by Merge may actually be the output of two related but different operations. Chomsky (2001) has termed the operation that adds a new category to the computation yielding objects of the form $\{\gamma, \{\alpha, \beta\}\}$ *set-merge* and the one that only adds a segment to its host yielding objects of the form $\{<\gamma, \gamma>\gamma, \{\alpha, \beta\}\}$ *pair-merge*.

**4. Concluding remarks and current issues**

In this chapter we have seen how X'-structures have been reanalyzed in terms of general architectural properties of the language faculty as conceived of in the Minimalist Program. To recap some of the results, the bar-level features “$^{0}$”, “ ' ”, and “P” have been abandoned in favor of a functional interpretation of the relations established among the components of a syntactic object. General economy considerations led to the elimination of vacuous projections and the redundancy between terminal nodes and lexical items. Finally, it was suggested that the properties of binary branching and uniqueness of mother nodes can be grounded on general consideration of computational efficiency.

This change of perspective also left many problems unsatisfactorily handled, as is the case with adjunction structures, and paved the way for the formulation of deeper questions such as why syntactic objects are endocentric. These issues have generated an effervescent area of investigation. To name a few, Kayne (1994) has raised the influential hypothesis that linearization considerations may determine many of the properties of phrase structure in natural languages. Another possibility that has been productively explored is that the movement can be conceived as a sort of internal-merge and as such, it is not restricted to root syntactic objects (see e.g. Citko 2005). More recently, Hornstein (2009) has argued that Merge should in fact be conceived as the output of two different operations Concatenate and Label and Hornstein and Nunes (2008) have proposed that adjunction only involves Concatenate and not Label (see also Chametzky 2003). There have also been proposals to eliminate labels all together (see Collins 2002). The above is definitely just a sample and is in no way is meant to be a comprehensive list of the exciting works on bare phrase structure that have been recently explored (see e.g. Chametzky 2000 and Boeckx 2008 for relevant discussion). All that it does is to illustrate how productive it has been to evaluate the technical apparatus assumed in *GB* under minimalist lenses.

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[1] See e.g. Lyons (1968), Chomsky (1970), and Jackendoff (1977).

[2] For purposes of exposition I will put aside for now the possibility of adjunction to heads and intermediate projections (see sections 3.3 and 4 below for discussion).

[3] For the relevant definitions of dominance, containment, and c-command under bare phrase structure objects, see Nunes and Thompson (1998).

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KEY TERMS

*adjunction*: structure building operation that preserves the phrasal status of its target

*bar-level*: identification of a given syntactic object as a head, an intermediate projection or a maximal projection

*binary branching*: property of syntactic structures in which mother nodes immediately dominate two constituents

*containment*: type of constituenthood relation

*dominance*: type of constituenthood relation

*endocentricity*: property of syntactic objects that requires that every projection must be headed

*label*: element that identifies the relevant grammatical properties of phrasal syntactic objects

*Merge*: structure building operation

*vacuous projection*: syntactic projection that has solely one immediate constituent