Tense in LFG : Syntax and Morphology

Anette Frank and Annie Zaenen[1]

XRCE
Xerox Research Centre Europe
6, chemin de Maupertuis
38240 Meylan, France
{Anette.Frank,Annie.Zaenen}@xrce.xerox.com

1 The morphology–syntax interface in LFG

An important tenet of LFG is the lexical integrity principle which says that the leaves of c–structure trees are complete surface words. Given this principle, the morphological component is seen as distinct from the syntax. It can be modelled by sublexical rules as we will illustrate below but the principles that apply to these rules are different from those applying in the syntax (see Bresnan and Mchombo (1995) for discussion). The way LFG is set up allows single words and phrases to contribute the same or similar information to an f–structure. For example a form like *parla*, passé simple of *parler*, contributes information similar to that contributed by *a parlé*, the passé composé of the same verb. The framework allows a similar treatment for the two forms as well as the maintenance of lexical integrity and makes it possible to avoid word formation rules in the syntax without losing paradigmatic transparency (see Vincent and Börjars (1996) for discussion). These possibilities, however, are not always exploited as well as they could be, and using them transparently is made less easy than it could be by another architectural feature of LFG.

The distinction that the architecture of LFG makes between c–structure and f–structure was meant to embody the insight that word order and other constituent structure differences are not necessarily indicative of profound syntactic differences among languages. LFG follows here the distinction made e.g. in Keenan (1976) between coding properties and genuine syntactic characteristics. The f–structure allows us to abstract away from superficial word order differences to bring out the more fundamental syntactic similarities (or differences) among languages. This abstracting away from certain differences is theoretically important but also practically, e.g. in the context of translation. It makes the f–structure into a structure that comes close to the underspecified representation used in the Core Language Engine (see Genabith and Crouch (1996); (Alshawi (1992), Alshawi and Crouch (1992)), which can be argued to be, from a practical point of view, a good candidate for input and output of transfer rules (see Dorna et al. (1998)). But the traditional architecture gets us only half way: while it abstracts away from c–structure phenomena, it encodes all the morphological information in the f–structure. This information, however, is to a large extent as much encoding information as word order is.

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The way things stand in the traditional architecture, it is possible to get all the f–structure relevant information about *parla* and *a parlé* into the right place in the f–structure. But it is not possible for the f–structure to ignore the additional information needed to impose the right verbal form on *parlé* (past participle). In what follows we discuss some proposals made to remedy this and try to improve technically on them. We then use our tools to model the French auxiliary system.

1.1 Analyses of auxiliaries

Early analyses in LFG (Falk (1984), Bresnan (1982)) analyzed auxiliaries as raising verbs, assigning them a PRED value, e.g., 'perf' in the case of a temporal auxiliary. Later approaches (Bresnan (1995), King (1995), Schwarze (1996)) treat auxiliaries as non–subcategorizing elements, which contribute tense and aspectual information to the f–structure of the clause. Under this type of analysis, the main verb is the functional head of the clause. Among the arguments that are put forward for an analysis of auxiliaries as non–subcategorizing elements we find the following. Auxiliaries contribute essentially temporal and aspectual information, which indicates that they should belong to a different syntactic category than ordinary predicational verbs (see Butt et al. (1996a)). Even within a single language system – there may be analytic and synthetic tense forms which do not differ substantially in meaning (besides, of course, certain aspectual or temporal differences). If the analytic form is analyzed as contributing a PRED on top of the tense and aspect information whereas the synthetic form doesn't, we of course do not express the functional similarity between the two cases. The auxiliary in the analytic form should therefore not be analyzed as a PRED–bearing element, but only contribute its tense and aspectual information (see King (1995)). Butt et al. (1996a) consider cross–linguistic variation in (analytic vs. synthetic) tense formation as providing support for an analysis of temporal auxiliaries as non–subcategorizing elements. In recent work Bresnan (1995) treats auxiliaries as functional categories in an LFG framework and enforces an analysis in which tense auxiliaries as well as passive ones are non PRED–bearing elements.

1.2 The m–structure analysis of auxiliaries

In line with this movement towards a flat f–structure analysis of auxiliary constructions, Butt et al. (1996a) and Butt et al. (1996b) propose a unified analysis of auxiliaries in English, French, and German, with a flat f–structure for all three languages. Their emphasis is on problems of parallel grammar development and machine translation. In particular, one way of looking at their proposal is that – although morphology and c–structure make different contributions to the functional and semantic analysis of a sentence in different languages – the corresponding f–structure representations should not be distinct because their contribution to the meaning of the sentence is the same.
Their analysis differs from the previous ones in providing a clear separation between cross–linguistically invariant f–structure features of temporal constructions, and language specific differences in the way this information is encoded. Such differences are exemplified in (1): while in English and German future tense is formed analytically (*will turn/ wird drehen*), French has a synthetic future tense (*tournera*).

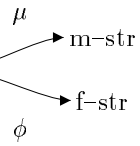
(1) a. The driver will turn the lever.

b. Der Fahrer wird den Hebel drehen.

c. Le conducteur tournera le levier.

In this analysis, a new projection is introduced, the morphological structure, or *m–structure*. The m–structure is, just like the f–structure, an attribute–value matrix, but – while f–structure is the level of syntax that encodes grammatical functions, like SUBJ, OBJ, etc., and the PREDicate with its subcategorization requirements – the m–structure is viewed as the level of representation that encodes information about idiosyncratic constraints on morphological forms. Thus, m–structure is the level of representation where the language specific differences in the morpho–syntax of tense formation are represented.
In much the same way as the f–structure is defined as the ϕ–projection off the c–structure, Butt et al. (1996a,1996b) define the m–structure as a μ–projection off the c–structure (2).

(2)



Syntax–morphology interface (Butt et al. (1996a,b))

In this projection architecture, the analyses assigned to the sentences in (3) will be isomorphic at the level of f–structure (4). The associated morphological structures will be distinct for English and German, where the future is an analytic tense form (5a.–b.), as opposed to French (5c), where future tense is formed synthetically by inflectional morphology. The phrase structure rule will of course also encode the differences in word order which are likewise ignored in the f–structure.[2]

(3) a. The driver will have turned the lever.

b. Der Fahrer wird den Hebel gedreht haben.

c. Le conducteur aura tourné le levier.

(4) a./b./c. ϕ

$$\begin{bmatrix} \text{PRED} & \text{'turn/drehen/tourner} \langle (\uparrow \text{SUBJ}) (\uparrow \text{OBJ}) \rangle' \\ \text{TENSE} & \text{FUTPERF} \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & \text{'driver/Fahrer/conducteur'} \\ \text{CASE} & \text{NOM} \\ \text{GEND} & \text{MASC} \\ \text{NUM} & \text{SG} \\ \text{SPEC} & \text{DEF} \end{bmatrix} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & \text{'lever/Hebel/levier'} \\ \text{CASE} & \text{ACC} \\ \text{GEND} & \text{MASC} \\ \text{NUM} & \text{SG} \\ \text{SPEC} & \text{DEF} \end{bmatrix} \end{bmatrix}$$

Structurally identical f–structures for English, German, French (3)

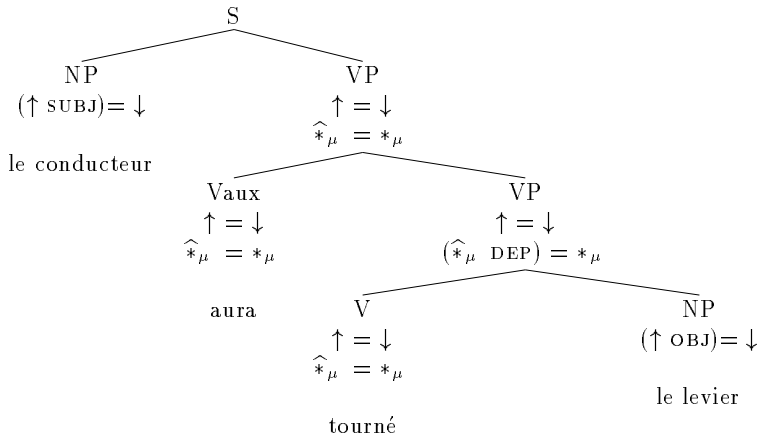
[2] We do not attempt to give semantically motivated features for tense and aspect in this paper. However, it is possible to define minimal semantic temporal conditions triggered by tense forms (like imparfait, passé simple, passé composé, etc.) in a semantic projection σ of ϕ. Kamp and Rohrer (1983) propose that such an encoding be based upon notions like Reichenbach's (1947) *temporal reference point*, etc. Further refinements for a Reichenbachian approach to the French tense system have been proposed by Kamp and Rohrer (1988) and Gosselin (1996). A substantial fragment of English is treated in Kamp and Reyle (1993).

(5) a.–b. μ $\begin{bmatrix} \text{FIN} & + \\ \text{AUX} & + \\ \text{DEP} & \begin{bmatrix} \text{AUX} & + \\ \text{VFORM} & \text{BASE} \\ \text{DEP} & \begin{bmatrix} \text{AUX} & - \\ \text{VFORM} & \text{PERFP} \end{bmatrix} \end{bmatrix} \end{bmatrix}$ *c.* μ $\begin{bmatrix} \text{FIN} & + \\ \text{AUX} & + \\ \text{DEP} & \begin{bmatrix} \text{AUX} & - \\ \text{VFORM} & \text{PERFP} \end{bmatrix} \end{bmatrix}$

Structurally distinct m–structures for English, German (a./b.) vs. French (c.)

Following the projection architecture displayed in (2), the morphological structures in (5) are defined in terms of c–structure annotations. We will use the notation $\widehat{*}_\mu$ to refer to the m–structure node projected from the mother node $\widehat{*}$ of the actual c–structure node *. In the same way, the traditional $\uparrow$ can be expressed by $\widehat{*}_\phi$. We will call such equations morphological equations.[3] (6) illustrates how structurally divergent m– and f–structures are projected from the c–structure: here the VP node of the auxiliary construction defines a hierarchical structure at the level of the μ–projection ($(\widehat{*}_\mu \text{ DEP}) = *_\mu$), whereas the functional equation of this node is a trivial one, $\uparrow$=$\downarrow$.

(6)



The lexical entries of auxiliary verbs and main verbs come with both functional and morphological equations, which define the language particular properties of morpho–syntactic tense formation, as well as the corresponding tense information, which is encoded in the f–structure. We briefly illustrate this with the two lexical entries used in (6), the future auxiliary *aura* (*will have*), and the participle verb *tourné* (*turned*).

The auxiliary is morphologically marked for future tense in French, and is constrained to combine with a past participle verb form, in its m–structure's DEP feature. The TENSE feature in f–structure can therefore be set to the value FUTPERF.[4]

[3] Butt et al. (1996a) misleadingly introduced the notation "$\mu\uparrow$" to refer to the m–structure of the actual node's mother node. This is in fact not the correct notation for the architecture displayed in (2): it defines m–structure to be projected off the f–structure.

In what follows we take the freedom to rephrase their approach in terms of the notation introduced above, which follows Butt et al. (1997). Alternatively, the annotations could equally well be restated in terms of the notation introduced in Kaplan(1987), where $\mu\mathcal{M}*$ refers to the m–structure node projected from mother node $\mathcal{M}*$.

[4] The main verb *avoir* is assumed to have a different entry and is not discussed in this paper.

(7)

aura:	Vaux	$(\uparrow$ SUBJ NUM$) =$ SG	tourné:	V $(\uparrow$ PRED$) =$ 'tourner$\langle(\uparrow$ SUBJ$)(\uparrow$ OBJ$)\rangle$'
		$(\uparrow$ SUBJ PERS$) = 3$		$(\widehat{*}_{\mu}$ AUX$) = -$
		$(\uparrow$ TENSE$) =$ FUTPERF		$(\widehat{*}_{\mu}$ VFORM$) =$ PERFP.
		$(\widehat{*}_{\mu}$ FIN$) = +$		
		$(\widehat{*}_{\mu}$ AUX$) = +$		
		$(\widehat{*}_{\mu}$ DEP VFORM$)=_c$ PERFP.		

1.3 Some problems of the current morphology–syntax interface

The syntax–morphology interface described above works very well for verbal morphology and the distinct temporal and aspectual constructions in the diverse languages described in the paper (see Butt et al. (1999)). Yet, one may have noticed that the m–structure (5c) for the sentence displayed in (6) does not contain features like NUM, PERS, GEND, or CASE, which prima facie should also be considered as morphological features. This raises the general question as to the distinction between morphological, functional syntactic, and finally also semantic information, and the distribution of these respective types of features over the various levels of representation assumed in the overall projection architecture of grammar.

If morphological features like number, gender and person are to be represented in m–structure, we cannot simply introduce them by means of trivial morphological equations $\widehat{*}_{\mu} = *_{\mu}$. Since the various arguments of the verb may instantiate conflicting values of number, person, and case, the m–structure must specify "blueprints" of the f–structural grammatical functions SUBJ, OBJ, etc., to host the respective morphological features. In the actual LFG grammar implementations of the ParGram project (see Butt et al. (1999) for information) the m–structure is defined to contain an attribute EXT-ARG (external argument), corresponding to the morphological structure of the f–structure's SUBJ, a set–valued feature INT-ARGS (internal arguments) for non–subject arguments (OBJ, OBJ2, OBL, etc.), a feature DEP corresponding to sentential arguments (COMP, XCOMP), and finally a set–valued feature NON-DEP for adjuncts.[5]

1.3.1 Defining subject verb agreement

This "blueprint" of the functional argument structure of a sentence would in fact allow us to move agreement and case features to the morphological representation level. The subject verb agreement constraints of, e.g., a finite third person singular verb can then be stated in terms of the following morphological equations:

$(\widehat{*}_{\mu}$ EXT-ARG NUM$) =$ SG and $(\widehat{*}_{\mu}$ EXT-ARG PERS$) = 3$.

With this extension, the m–structure for (6) would spell out as in (8):[6]

[5] The feature EXT-ARG, e.g., was introduced to account for the morphological selection of infinitival vs. finite sentential adjective SUBJects in cases like (i) and (ii). The verbal inflectional features FIN and INF being stated in m–structure, the morphological form of the sentential adjective SUBJ cannot be constrained in terms of these features without resorting to some EXT-ARG feature in m–structure. The distinction between finite and infinite sentential subjects could, alternatively, only be captured in terms of the f–structure attribute TENSE, which should then not be assigned in structures like (i) and (ii).

(i) Obtenir son accord n'est pas facile.
Getting her/his agreement is not easy

(ii) Avoir obtenu son accord est une victoire.
Having gotten her/his agreement is a victory.

[6] For ease of exposition INT-ARGS is not represented as a set-valued feature here.

(8) μ
$$\begin{bmatrix} \text{EXT-ARG} \begin{bmatrix} \text{PERS} & 3 \\ \text{NUM} & \text{SG} \end{bmatrix} \\ \text{FIN} \quad + \\ \text{AUX} \quad + \\ \text{DEP} \begin{bmatrix} \text{AUX} & - \\ \text{VFORM} & \text{PERFP} \end{bmatrix} \\ \text{INT-ARGS} \begin{bmatrix} \text{GEND} & \text{MASC} \\ \text{NUM} & \text{SG} \end{bmatrix} \end{bmatrix}$$

This, however, starts to look suspicious: the m–structure proposal was originally motivated by the wish to have a clean f–structure representation of what matters to semantic interpretation. But now we start to get an m–structure representation that repeats most of the information pertaining to f–structure. The morphological representation level now contains subcategorization information, which is functional in nature. It is becoming a complete "blueprint" for the functional structure. Besides this conceptual issue, it turns out that this approach is confronted with rather severe problems in the analysis of long–distance phenomena that involve morphological constraints.

1.3.2 The problem of long–distance dependencies

A typical example for a long–distance phenomenon in the morphology–syntax interface is past participle agreement in French. In object relative clauses (9) the past participle must agree, in number and gender, with the embedding head noun, as opposed to cases where the OBJ is realized in VP position, and where past participle agreement is illicit.

(9) a. Les enfants adorent les histoires qu'on leur a déjà raconté*(*es*) mille fois.
'Children are found of the stories that one has told them already a thousand times'

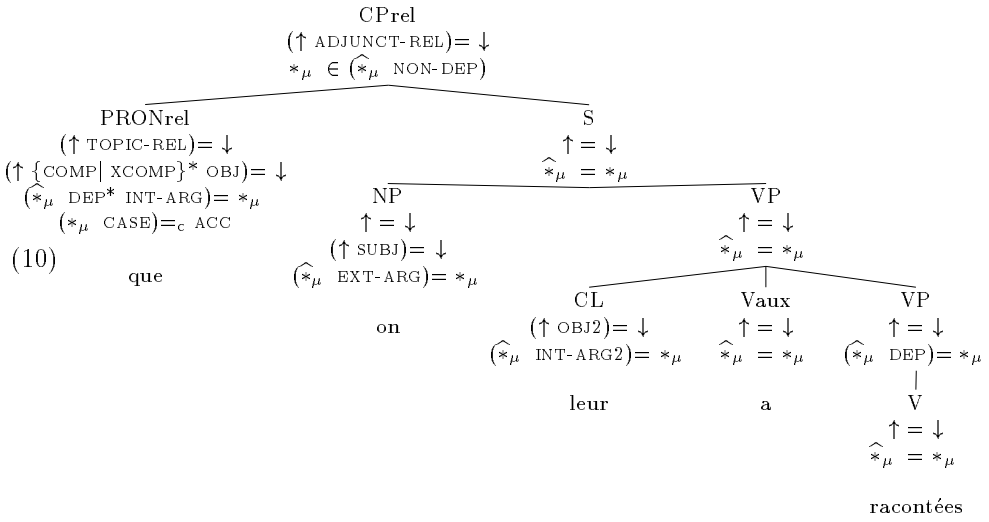
b. Les enfants adorent les histoires qu'on sait bien qu'on leur a déjà raconté*(*es*) mille fois.
'Children are fond of the stories that one knows perfectly (that) one has told them aready a thousand times'

The grammar assigns the relative pronoun the OBJect function, but can do so only in terms of a functional uncertainty equation, since relative clause constructions are unbounded in French (see (9b)). In order to trigger past participle agreement of the verb that subcategorizes for the object introduced by the relative pronoun, the morphological features of number and gender must be stated in the position of the relative pronoun,[7] yet have to be "transmitted" to the level of the subcategorizing past participle. In the architecture depicted in (2), this will only be possible if these morphological features are defined in terms of a functional uncertainty equation over the "f–structure blueprint" that is encoded in the morphological structure, in particular functional uncertainty over the DEP attribute (see (10) below).[8]
For concreteness, we add morphological equations to the annotations of the category PRONrel (for relative pronouns) in (10) that enforce the choice of the inflected participle form *racontées* (see (11)), which agrees with the head noun *histoires* in number and gender. The lexicon entry

[7] The relative pronoun is defined to agree in number and gender with the relative clause's head noun.
[8] Cf. Kaplan and Zaenen (1989) for functional uncertainty.

(11)[9] constrains this inflected form to syntactic contexts in which the OBJ *head-precedes* the verb:[10] (↑ OBJ) $<_h$↑.[11] . This constraint is fulfilled in (10), with the functional uncertainty {COMP|XCOMP}* resolved to ϵ.
The agreement constraints in (11) are stated via the "m–structure blueprint" of the OBJ function, INT-ARG. The corresponding morphological features are defined in the position of the relative pronoun, where the object function is realized (cf. (10)). As the relative clause construction can be nonlocal, the morphological equation $(\widehat{*}_\mu$ DEP* INT-ARG$)= *_\mu$ must involve the path definition DEP*.

(10)



(11)

racontées: V
(↑ PRED) = 'raconter⟨(↑ SUBJ)(↑ OBJ2)(↑ OBJ)⟩'
$(\widehat{*}_\mu$ VFORM$)=$ PERFP
$(\widehat{*}_\mu$ OBJ$) <_h$↑
$(\widehat{*}_\mu$ INT-ARG NUM$)=_c$ PL
$(\widehat{*}_\mu$ INT-ARG GEND$)=_c$ FEM.

In the local construction (10), with the m–structure path DEP* resolved to DEP, the morphological features NUM and GEND are appropriately instantiated to satisfy the local morphological constraints of the past participle (11).

However, in a construction like (12), which does not involve a past participle, the m–structure path DEP* in the annotation of PRONrel will not be uniquely resolved by the grammar. Since the m–structure argument features that correspond to grammatical functions in f–structure are not subject to coherence and completeness constraints, the morphological features of the head

[9] The lexicon entry (11) is oversimplified: it doesn't account for passive voice, and more refined constraints for past participle agreement are necessary. Also, we display a full form lexicon entry instead of sublexical rules in conjunction with a stem lexicon. Sublexical rules will be introduced in section 2.3.1.

[10] In French, object agreement only occurs in constructions where the object is realized in a preverbal position (as a clitic, or as a relative or interrogative phrase).

[11] *head precedence*, as implemented in the XLE system, is defined as follows (cf. XLE Documentation):
$f_1 <_h f_2$ is true iff f_1 and f_2 have heads and the head of f_1 precedes the head of f_2 in the c–structure.
For the purpose of this definition, the "head" of an f–structure is the constituent where the f–structure's PRED semantic form was instantiated if the constituent also maps via the ϕ–projection to the same f–structure. Alternatively, the precedence constraint could be stated in terms of *f–precedence*, following Zaenen and Kaplan (1995).

noun can be introduced as values of the feature INT-ARG at every possible level of embedding along the path DEP*. As a result, in cases like (12) we get multiple unwarranted ambiguities, with in fact inappropriate analyses.[12]

(12) Les enfants adorent des histoires qu'on ne veut pas vraiment leur raconter.
'Children love stories that one doesn't really want to tell them.'

To summarize, the morphology–syntax projection architecture (2) not only leads to an account where more and more information which is functional in nature has to be reproduced in m–structure; moreover, it is confronted with serious problems in the analysis of long–distance phenomena that involve morphological constraints.[13]
The principal problem is that the "blueprint" of f–structure grammatical functions that is reproduced at the level of m–structure is not controlled by completeness and coherence constraints. While in f–structure the functional uncertainty {COMP|XCOMP}* will be uniquely resolved in terms of completeness and coherence constraints, the same will not be true for the corresponding uncertainty path over DEP in m–structure. And, since the μ–projection is not directly related to the ϕ–projection, it is not possible to state the morphological constraints relative to the (resolved) f–structure without requiring the inverse function $\phi^{-} \circ \mu$. Importing the notion of completeness and coherence into the m–structure would of course make it even more f–structure-like and undermine the motivation for a separate projection further. In what follows we will try to solve the problem by proposing a leaner m–structure instead of a more complex one.

1.4 Moving towards a sequenced architecture

In the following we propose a projection architecture for the morphology–syntax interface that diverges from the proposal in Butt et al. (1996a,b) in that the μ– and ϕ–projections are not independent, parallel projections off the c–structure, but sequenced, in the way outlined in (13):

(13) $\text{c–str} \xrightarrow{\phi} \text{f–str} \xrightarrow{\mu} \text{m–str}$

Syntax–morphology interface (sequenced architecture)

[12] We could try to solve this problem by restricting the morphological equation $(\widehat{*_\mu}$ DEP* INT-ARG$)= *_\mu$ to those constructions where the subcategorizing verb is a past participle. I.e., we could replace the annotations of PRONrel in (10) by the following ones (where we use the variable %PATH-M to express constraints on the morphological uncertainty path):

PRONrel
(↑ {COMP|XCOMP}* OBJ)= ↓
(↑ TOPIC-REL)= ↓
%PATH-M = $(\widehat{*_\mu}$ DEP*)
{ (%PATH-M VFORM)=$_c$ PERFP
(%PATH-M INT-ARG)= $*_\mu$
| (%PATH-M VFORM)≠ PERFP}

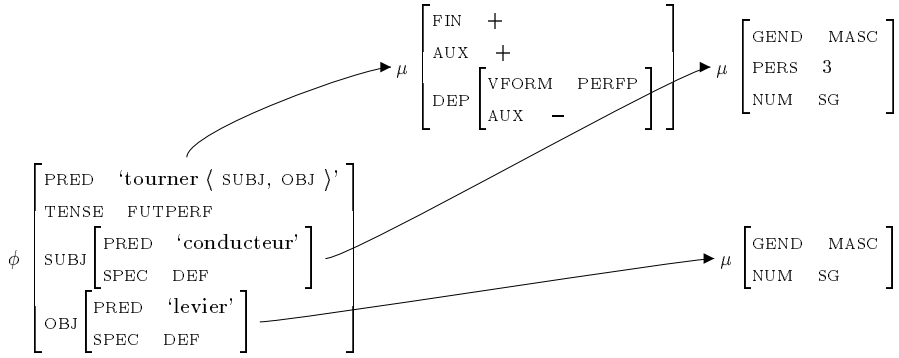
But this will not solve the problem. Note that in a case like (12) the second disjunct will be satisfied for every possible choice of %PATH-M. This is again a consequence of the fact that the m–structure argument feature DEP that corresponds to the f–structure functions COMP or XCOMP is not subject to completeness and coherence constraints. The grammar will therefore yield a two–ways spurious ambiguity for (12).

[13] Similar problems have been noted, in the context of the ParGram project, by Tracy King for English interrogative clauses, and by Jonas Kuhn for extraposition of *zu*–infinitives in German.

This picture is, at first sight, quite surprising, in that the m–structure is projected off the f–structure. Given that we tend to think of functional structure as being build *on the basis of* morphological information, we would expect the ϕ–projection to be projected off the m–structure, rather than the other way round.
Yet, the projection mechanism of LFG allows us to state the "dependency" of functional information on morphological information in a natural way in the architecture displayed in (13). For example the fact that in a language like German nominative case is indicative of the subject function can be expressed in terms of the equation, $((\uparrow \text{SUBJ})_\mu \text{ CASE}) = \text{NOM}$, or the pair of equations $(\uparrow \text{SUBJ}) = \downarrow$ and $(\downarrow_\mu \text{ CASE}) = \text{NOM}$ if they are annotations of the subject NP.[14]

The advantage of the projection architecture (13) for the morphology–syntax interface is that morphological constraints on syntax can be defined locally. The morphological information is closely tied to the partial f–structure that it contributes to identify. This can be clearly seen in (14), which displays the f–structure and its dependent μ–projections for the sentence (3c). The uppermost m–structure corresponds to the morphological information that is contributed by the verbal projection, and is referenced by the equation $\uparrow_\mu$, pointing to the verbal head's f–structure's μ–projection. Similarly, the morphological features contributed by the subject NP are identified in terms of the equation $(\uparrow \text{SUBJ})_\mu$, referring to the f–structure's SUBJect's μ–projection.

(14)



We will first illustrate how this analysis accounts for the basic types of agreement phenomena that have to be accounted for in the interface between morphology and syntax: local subject verb agreement, and past participle agreement in long–distance relative clause constructions. In Section 2.3 we will then build on this new architecture for the morphology–syntax interface, to investigate in more detail the analysis of auxiliary constructions and cliticization in French.

1.4.1 Defining subject verb agreement

The advantage of the sequenced architecture (13) is that both local and nonlocal agreement phenomena can be stated in terms of "morphological equations" which do not necessitate any duplication of essentially functional information in the m–structure. This is first illustrated for the simple example of subject verb agreement.

[14] We use the notation $(\uparrow \text{SUBJ})_\mu$ to refer to the m–structure projected from the f–structure's SUBJ value, and $\uparrow_\mu$ to refer to the m–structure projected from the f–structure referred to by $\uparrow$. Alternatively, we could refer to the m–structure projected from the mother node's f–structure by use of $\widehat{*}_{\phi\mu}$, and to the m–structure of the SUBJ by $(\widehat{*}_\phi \text{ SUBJ})_\mu$ (cf. fn. 3 section 1.2).

The lexical entry of a finite third person singular verb like *tournera* in (15) specifies morphological equations, which define a μ–projection off the ϕ–projection. The m–structure is defined to carry the feature FIN + by the equation $(\uparrow_\mu \text{FIN}) = +$. For finite verbs we require subject verb agreement, here in terms of the equations $((\uparrow \text{SUBJ})_\mu \text{ NUM}) = \text{SG}$ and $((\uparrow \text{SUBJ})_\mu \text{ PERS}) = 3$. Thus, the subject's m–structure is directly defined to carry the appropriate morphological features NUM= SG and PERS= 3.[15]

(15)
$$\begin{array}{ll} \text{tournera: V} & (\uparrow \text{PRED}) = \text{`tourner}\langle(\uparrow \text{SUBJ})(\uparrow \text{OBJ})\rangle\text{'} \\ & (\uparrow_\mu \text{ AUX}) = - \\ & (\uparrow_\mu \text{ FIN}) = + \\ & (\uparrow \text{TENSE}) = \text{FUTURE} \\ & ((\uparrow \text{SUBJ})_\mu \text{ NUM}) = \text{SG} \\ & ((\uparrow \text{SUBJ})_\mu \text{ PERS}) = 3. \end{array}$$

The result of these annotations is illustrated in (16), the f–structure and projected m–structures for sentence (1c). The local m–structures contain only morphological features, and do not duplicate any genuinely functional notions, like grammatical functions.

(16)
$$\phi \left[\begin{array}{ll} \text{PRED} & \text{`tourner} \langle \text{ SUBJ, OBJ } \rangle\text{'} \\ \text{TENSE} & \text{FUTURE} \\ \text{SUBJ} & \left[\begin{array}{ll} \text{PRED} & \text{`conducteur'} \\ \text{SPEC} & \text{DEF} \end{array}\right] \\ \text{OBJ} & \left[\begin{array}{ll} \text{PRED} & \text{`levier'} \\ \text{SPEC} & \text{DEF} \end{array}\right] \end{array}\right] \quad \mu \left[\begin{array}{ll} \text{FIN} & + \\ \text{AUX} & - \end{array}\right] \quad \mu \left[\begin{array}{ll} \text{GEND} & \text{MASC} \\ \text{NUM} & \text{SG} \\ \text{PERS} & 3 \end{array}\right] \quad \mu \left[\begin{array}{ll} \text{GEND} & \text{MASC} \\ \text{NUM} & \text{SG} \end{array}\right]$$

1.4.2 Defining long–distance constraints with local m–structures

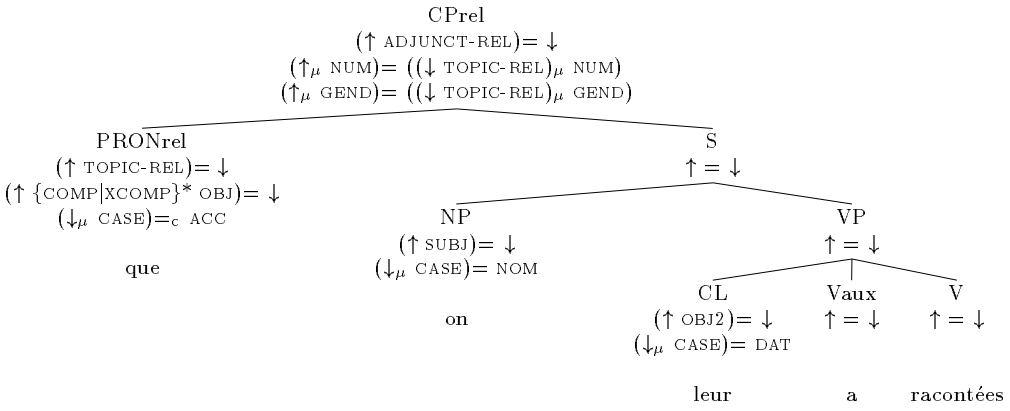
The advantage of defining morphological constraints as "dependent" on functional structure becomes even more compelling if we reconsider the problem of stating morphological constraints in long–distance constructions.
As we argued in Section 1.3.2, the basic problem of the "parallel architecture" of Butt et al. (1996a) is the fact that morphological constraints in long–distance constructions have to make use of uncertainty equations, which operate not on the functional structure, where the uncertainty is constrained by completeness and coherence conditions, but on a "blueprint" of f–structure information in m–structure. Since m–structure is not subject to coherence and completeness constraints, these uncertainty equations can in many cases not be uniquely resolved, leading to spurious ambiguities or inappropriate analyses.

To illustrate how long–distance phenomena can be treated in the "sequenced architecture" of the morphology–syntax interface, we take up our previous example, past participle agreement in French object relative clauses.
In the sequenced architecture we can assign an analysis to object relative clauses as illustrated in (17). Morphological equations define the case feature of the relative pronoun, as well as the

[15] Sections 2.3.1 and 2.3 will introduce the device of *sublexical rules*, which allows us to define morphological phenomena like subject verb agreement in a more general way.

morphological features NUM and GEND, which are unified with the head noun's morphological features. With the uncertainty {COMP|XCOMP}* resolved by f–structure constraints on completeness and coherence, the morphological features in the μ–projection of the OBJect relative pronoun will be defined at the appropriate level of embedding, where we find the OBJect subcategorizing verb. If the verb is a participle, it must satisfy the morphological constraints on gender and number agreement that are now stated as in (18).

(17) (Les enfants adorent les histoires) qu'on leur a (déjà) racontées (mille fois).



(18)

racontées: V	(↑ PRED) = 'raconter⟨(↑ SUBJ)(↑ OBJ2)(↑ OBJ)⟩'
	(↑$_\mu$ AUX)= −
	(↑$_\mu$ DEP* VFORM)= PERFP
	(↑ OBJ) <$_h$ ↑
	((↑ OBJ)$_\mu$ NUM)=$_c$ PL
	((↑ OBJ)$_\mu$ GEND)=$_c$ FEM.

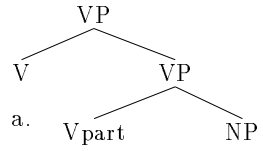
2 The morphosyntax of auxiliaries in French

Before proceeding to the formalization of auxiliary constructions in this new morphology–syntax projection architecture, we first have to decide on an appropriate c–structure for diverse types of auxiliaries in French. We will briefly summarize some arguments given by Abeillé and Godard (1996) and follow them in proposing a flat c–structure for temporal auxiliaries and an embedded VP for passive and copular structures. The architecture proposed here is, however, not dependent on the choice of this c–structure.

2.1 Temporal auxiliaries

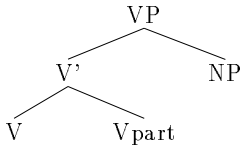
C–structure accounts of the verbal complex in French have proposed nearly all imaginable structures:

(19) a.



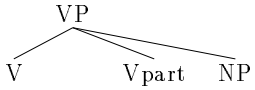
hierarchical VP

b.



verbal complex

c.



flat VP

The data that are used to motivate these structures depend in part on the theory adopted. Phrase structure does not play the same role in all syntactic theories. In LFG the role of phrase structure is rather limited but it is in general taken to account for local word order generalisations (see Kaplan and Zaenen (1989), King (1995); see in particular Bresnan (1999) and Dalrymple (1999) for more recent discussion of the type of generalisations to be captured by phrase structure rules in LFG.) The position of adverbs, occurrence of sub-constituents and coordination are the type of arguments that in an LFG context bear on the c–structure assignment.

Abeillé and Godard (1996) discuss various possible c–structures and observe the following:

1. Whereas structures with control verbs give some evidence for an embedded VP, auxiliary structures do not argue for a right branching hierarchical structure (19a) of the French complex tenses. In French the participle + complements do not occur separate from their auxiliary as illustrated with the following examples. The bad examples in (a) contrast with the grammatical ones in (b).[16]

(20) a. *Allé aux Etats-Unis, je ne (le) suis pas. (A&G)[17]
Gone to the US, I have not (it)

b. Aller aux Etats-Unis, je n'oserai jamais. (A&G)
Go to the US, I would never dare (it)

(21) a. *Ce que Jean a, c'est bu trop de vin. (A&G)
What John has, is drunk too much wine.

b. Ce que Jean voudrait, c'est partir immediatement. (A&G)
What John would like to, is leave immediately.

The only exception to this generalisation is coordination:

(22) Paul a parlé avec Marie et compris son erreur. (A&G)
Paul talked to Mary and understood his error.

[16] In fact, not all infinitival structures give this kind of distributional evidence for a VP structure either. Apart from the notorious *faire* construction, there are verbs like *courir*, *descendre*, etc. that cannot be clefted in the construction illustrated in (i) and (ii):

(i) Il court chercher le journal.
He runs get the newspaper.

(ii) *Ce qu'il court c'est chercher le journal.
What he runs is get the newspaper.

[17] Examples taken from Abeillé and Godard (1996) are marked A&G.

This structure can, however, also be derived via a rule that allows the auxiliary (or the tensed verb) to be gapped (see e.g. Sag et al. (1985) and Brun (1996) on gapping).

2. Adverb placement does not argue for either the VP adjunction or the V adjunction of adverbs in tensed constructions. The principles governing the placement of French adverbs are not completely worked out but a large class of adverbs can occur between auxiliaries and participles: e.g.

(23) Jean a attentivement écouté son professeur. (A&G)
John has listened carefully to his professor.

There is, however, no evidence that this type of adverb is VP initial in all types of VP's. In fact infinitival VP's do not allow this adverb to appear initially:

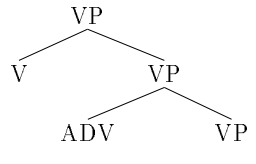
(24) a. *Il detestait attentivement prendre des notes. (A&G)
He detested carefully taking notes.

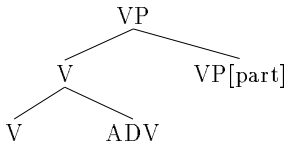
b. Il detestait prendre attentivement des notes. (A&G)
He detested taking notes carefully.

The scope of adverbs like *attentivement* also provides some evidence against the VP adjunction (to the left) or the V adjunction (to the right) of these adverbs. In a sentence like (25), *attentivement* takes only scope over the first conjunct:[18]

(25) Jean a (attentivement écouté son professeur) et (pris des notes). (A&G)
John has (carefully listened to his professor) and (taken notes).

An adjunction to VP or to V as shown in (26)correlates in general with scope over both.

(26) a.


b.


Of course, we can propose another way to map from this representation to scope assignment but this would further undermine the rationale for the hierarchical structure.

The facts summarized above can be accounted for if, following Abeillé and Godard (1996) we assume that manner adverbs have two positions in French, one in flat tensed clauses after the tensed element and before the participle, and another in some (but not all) VP's, left or right adjoined to them. In the next section we discuss some cases of embedded VP's, here we give a simplified phrase structure rule for the facts discussed above:

(27) VP → V[+tense] (Adv[+manner]) (V[+part]) ....

[18]Not all speakers agree with these judgements, which Abeillé and Godard restrict to manner adverbials, as opposed to temporal ones.

3. The verbal complex hypothesis (diagrammed in (19b)) does not allow a straightforward treatment of coordination with *ainsi que*: *ainsi que* can be used to coordinate complements and sequences of complements but not sentences or tensed VP's, as shown in (28):

(28) a. Cet été, Jean voudrait écrire une nouvelle ainsi qu'un petit roman. (A&G)
This summer Jean would like to write a short story as well as a small novel.

b. Paul donnera un disque à Marie ainsi qu'un livre à Jacques. (A&G)
Paul will give a record to Mary as well as a book to Jacques.

c. *Cet été, Jean écrira une nouvelle ainsi que Marie peindra des paysages.(A&G)
This summer John will write a short story as well as Mary will paint landscapes.

d. *Cet été Jean écrira une nouvelle ainsi que composera une petite sonate.(A&G)
This summer John will write a short story as well as will compose a small sonata.

The coordination in (29) can be taken to be the result of the auxiliary gapping rule, hypothesized above:

(29) Paul a mangé des fraises ainsi que bu du vin. (A&G)
Paul has eaten strawberries as well as drunk wine.

But this presupposes a flat VP and not one with a verbal complex. In the case of the verbal complex analysis one would have to complicate the conditions further to exclude sentences like (30):

(30) *Paul a mangé des fraises ainsi qu'a bu du vin. (A&G)
Paul has eaten strawberries as well as has drunk wine.

Under the analysis sketched above, coordination facts have then to be handled as nonconstituent coordination in all cases but the data about clefting and topicalization follow if we assume that only constituents can be clefted or topicalized.[19]

[19] Abeillé and Godard (1996) take cross-sentential pronominalization by *le* or by a null anaphor also to be a test for VP-hood. We do not follow them in this regard: it is well-known that *it* in English can refer back to entities that are not surface constituents as in

(i) The garbage had to be taken out. So Bill did it.

(See e.g. Hankamer and Sag 1976)
The same is true in French for both *le* and null anaphora as the following examples show:

(ii) Cet arbre est facile à abattre mais Jean ne le fera pas.
This tree is easy to fell but John will not do it.

(iii) Les ordures n'ont pas été sorties. Jean a oublie.
The garbage has not been taken out. John has forgotten

So the antecedent of *le* or the null anaphor does not have to be a VP. Could we claim that the anaphor itself has the category VP or replaces constituents of that type? This would need a detailed argumentation because we would need to investigate which semantic types *le* can have as an antecedent (see Asher (1993) for some discussion of English *it* in that respect) and which verbs subcategorize for *le*. In fact, accepted wisdom has it that *le* only occurs with verbs that allow also nominal complements (see e.g. Huot (1980)).

In any case in other languages, the argument for constituency based on topicalization and clefting does not correlate with the occurrence of *it* or null anaphors. In Dutch and German the preposing of participles with their dependents is grammatical but sentences like the following are as bad as they are in French:

(iv) *Jan heeft een brief geschreven en Piet heeft (het) ook.
John wrote a letter and Pete has (it) too.

We could also take the facts just discussed to show that clefting and topicalization only apply to dependent f–structure constituents, i.e. the preposed XP should be equipped with an equation like $(\uparrow \text{OBJ}) = \downarrow$ or $(\uparrow \text{XCOMP}) = \downarrow$. This is, however, not the case in other languages. E.g. in German or Dutch a sentence like (31) is perfectly ok.

(31) Aangekomen is hij nog niet.
Angekommen ist er noch nicht.
Arrived he isn't yet.

Moreover this view would make the facts discussed in the next section difficult to account for without substantial revisions in the account of passive.

In subsection 2.3 we will follow Abeillé and Godard (1996) and assume a flat VP structure.

The assumption of a flat c–structure (19c) for temporal auxiliary constructions does not invalidate the architecture proposed in Butt et al. (1996a). The m–structure equations will have to be slightly rewritten to account for VP rules with more than two V nodes (e.g. for surcomposed tenses as in *il a eu travaillé*). The respective V nodes will have to be annotated with equations $\widehat{*}_\mu = *_\mu$, $(\widehat{*}_\mu \text{ DEP}) = *_\mu$, and $(\widehat{*}_\mu \text{ DEP DEP}) = *_\mu$, respectively, to build up a hierarchical m–structure from a flat c–structure. In other words, there is no isomorphism between the c–structure and m–structure any more and the potential advantage of being able to encode the hierarchical m–structure without iteration of DEP annotations is no longer available.

2.2 Passive and predicational auxiliaries

Abeillé and Godard (1996) follow Couquaux (1979) in distinguishing the structure of passives and copular expressions from that for tense auxiliaries discussed above. With passive *être*, we find a different pattern of acceptability judgements from that found with the tense auxiliaries. This is illustrated by the following examples.

(32) Bien des bâtiments publics ne furent pas épargnés par les bombes, mais, heureusement, la cathédrale le fut. (A&G)
Several official buildings were not spared by the bombings but, luckily the cathedral was.

(33) Qu'est-ce qu'elle a été, la maison de Paul, détruite ou seulement touchée? (A&G)
What has Paul's house been, destroyed or only hit?

(34) Epargnées par les bombes, peu de bâtiments publics le furent, dans cette ville. (A&G)
Spared by the bombs few buildings were, in that town.

(35) C'est délestée de son portefeuille qu'elle a été, la malheureuse. (A&G)
It is robbed of her billfold that she has been, the unlucky woman.

Moreover VP adverbs can occur in the beginning of a passive complement as in (36):

(36) Attentivement écouté par tous les participants, l'orateur reprenait confiance en lui. (A&G)
Carefully listened to by all the participants, the speaker refound his self confidence.

In copular expressions like the following (37) Abeillé and Godard observe the same pattern of pronominalisation of the complement as with passive *être*:

(37) Paul est trés attaché à son choix. (A&G)
Paul is very attached at his choice.

One can also duplicate the preposing examples:

(38) Tres attaché à son choix, Paul l'est.
Very attached to his choice, Paul is it.

and the clefting ones:

(39) C'est très attaché à son choix qu'est Paul.
It is very attached to his choice that Paul is.

(40) Ce qu'est Paul, c'est très attaché à son choix.
What Paul is is very attached to his choice.

So, it seems reasonable to give the same representation to both these uses of *être*.

The copular and the passive construction seem to exhibit embedded VP structures, just like most infinitival complements. Abeillé and Godard note two kinds of differences between infinitival constructions and the complements of passive or copular *être*:

– With *être* we find partial topicalisation or clefting, as illustrated in (41):

(41) Rassuré il l'est sur mes compétences mais pas sur mon avenir.
Reassured he is about my competence but not about my future.

This contrasts with

(42) *S'adresser, il le veut au directeur et pas à la secrétaire.
Talk he wants it to the director and not to the secretary.

– Although manner adverbs can take scope over all conjuncts of a coordination as in (43)

(43) L'orateur sera attentivement écouté par ses amis et observé par ses adversaires.
The speaker will be carefully listened to by his friends and observed by his enemis.

this scope is not obligatory. (43) is ambiguous between a reading where *attentivement* has scope over both conjuncts and one where it only takes scope over the first conjunct.

Abeillé and Godard take this to be evidence that we need a double structure for passives and copular constructions. In LFG, this double structure is unnecessary. Given the way unification works with f–structure, partial topicalization is automatically allowed, and it occurs in certain languages, e.g. German. In cases where it is not allowed, LFG uses ordering rules insuring the right results (see Zaenen and Kaplan (1995) for discussion). This allows us to propose just one structure for passive and copular *être* as adverb scopes can be taken care of by allowing the manner adverb to occur before the embedded VP.

2.3 The LFG account

Problems with the parallel architecture of the morphology–syntax interface led us to a sequenced architecture, where m–structure is projected off the f–structure. In sections 1.4.1 and 1.4.2 we have shown that both local and long–distance agreement phenomena can be easily stated in this setup. In the previous section we have seen that empirical arguments favor a flat VP structure for tense auxiliaries in French, as opposed to the hierarchical structure proposed in Butt et al. (1996a). We now turn to investigate how to account for complex morphological constraints in the verbal complex within this new architecture.

2.3.1 Sublexical rules in the Xerox Linguistics Environment (XLE)

Before we enter the discussion of how to treat complex tense formation as well as passive and predicative auxiliary structures in the sequenced projection architecture, we want to introduce the *technical* morphology–syntax interface that is provided by the LFG grammar development platform XLE (Xerox Linguistics Environment). This interface will prove useful, later on, to define ordering constraints on the verbal elements in the sequenced architecture.

The XLE system provides so-called *sublexical rules*, which allow us to dispense with fully inflected LFG lexicon entries. These rules are designed to match the structure of the entries in a morphological lexicon, which is encoded as a finite–state transducer. These entries consist of a *lemma* followed by a sequence of word class specific *morphological tags*. E.g., the inflected verb *voit* can be looked up in morphology, and delivers the information: `voir +Pres +Sg +3rd +Verb`.

This structure of the morphological entries (a lemma followed by morphological tags) is recognized by the sublexical rules, which expand to the appropriate sublexical constituents. The resulting sublexical structure is not to be confounded with a genuine word–internal constituent morphological structure. What the sublexical structures represent is the interface to a *formal morphology lexicon structure* assigned to fully inflected forms. This device of XLE proves extremely helpful in designing generalized rules that specify which type of morphological, functional, or even semantic information can be associated with and projected from morphological information encoded in these entries. But it should be kept in mind that nothing hinges on this device. The formalization we propose in subsequent sections can be restated without sublexical rules, by using an LFG lexicon with fully inflected word forms.

The definition of subject verb agreement, dealt with in section 1.4.1, serves as a simple example to illustrate the usage of sublexical rules. Instead of fully inflected verb forms, the lexicon contains stem entries with category V (see (44a)), which matches the sublexical constituent V_BASE in the sublexical rule (44b). Morphological tags like +Pres, +Sg, and +3rd that are provided by the morphological transducer are defined in the sublexical lexicon (44c) to project the appropriate features in terms of functional or morphological annotations. Subject verb agreement can thus be defined locally, in a very general way, by annotations of the sublexical constituents VS_NUM and VS_PERS of finite verbs. By trivial functional equations in the sublexical rule (44b) the partial structures defined in (44c) are projected to the mother node of the sublexical rule, which constitutes the lexical V category of ordinary c–structure rules.

(44) a. tourner: V $(\uparrow \text{PRED}) = \text{`tourner}\langle(\uparrow \text{SUBJ})(\uparrow \text{OBJ})\rangle\text{'}$
$(\uparrow_\mu \text{ AUX}) = -.$

b. V → V_BASE: $\uparrow = \downarrow$;
TNS: $\uparrow = \downarrow$
$(\uparrow_\mu \text{FIN}) = +$
VS_NUM: $\uparrow = \downarrow$;
VS_PERS: $\uparrow = \downarrow$;
VERB .

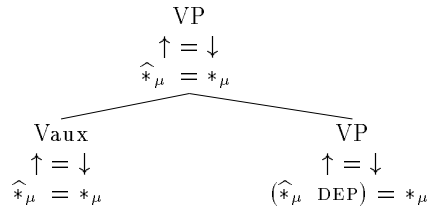
c.

+Pres	TNS:	$(\uparrow \text{TENSE}) = \text{PRESENT}.$
+Fut	TNS:	$(\uparrow \text{TENSE}) = \text{FUTURE}.$
...		
+Sg	VS_NUM:	$((\uparrow \text{SUBJ})_\mu \text{NUM}) = \text{SG}.$
+Pl	VS_NUM:	$((\uparrow \text{SUBJ})_\mu \text{NUM}) = \text{PL}.$
+3rd	VS_PERS:	$((\uparrow \text{SUBJ})_\mu \text{PERS}) = 3.$

2.3.2 The flat analysis of auxiliary constructions

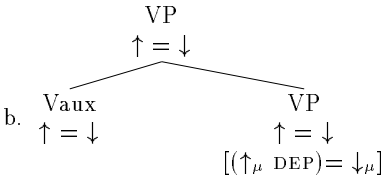
With the sequenced projection architecture (13) the analysis of auxiliary constructions as defining a monoclausal functional structure must differ substantially from the analysis proposed in Butt et al. (1996a). In the sequenced architecture, the hierarchical m–structure of complex auxiliary constructions cannot be defined in terms of c–structure annotations:
In the parallel architecture ϕ– and μ–projections are independent. It is therefore possible to project a monoclausal f–structure and a hierarchical m–structure from a single c–structure node, as depicted in (45a). This is not possible in the sequenced architecture, where the m–structure is defined off the f–structure. If we were to add the equation $(\uparrow_\mu \text{DEP}) = \downarrow_\mu$ to the right daughter node in (45b), as stated within brackets, we would obtain an unwarranted, cyclic m–structure.[20]

(45) a.



parallel architecture

b.

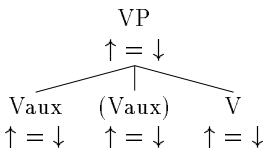


sequenced architecture

In section 2.1 we argued that the hierarchical tree structure is not motivated for French tense auxiliaries so that the proposal for a parallel morphology–syntax interface in Butt et al. (1996a) relies in fact on the wrong c–structure assumptions. Instead of (45b), we therefore assume the flat VP structure (46) for tense auxiliaries.

[20] For ease of exposition, we discuss this point by referring to the hierachical VP structure proposed by Butt et al. (1996a). But the argument carries over straightforwardly to a flat VP structure, such as the one adopted in (46).

(46)



sequenced architecture, flat c–structure

Due to the sequenced architecture, the hierarchical morphological structure of complex auxiliary constructions can only be defined in the lexicon. Below we illustrate how the lexical entries for *est* and *a* spell out in our analysis.[21]

The finite auxiliaries define their own morphological features AUX and FIN, and impose constraints upon the morphological features of their DEPendents. Furthermore, the constraints control the regularities of auxiliary selection and tense formation in French.

(47)

est:	Vaux	$(\uparrow_\mu$ AUX$)= +$	
		$(\uparrow_\mu$ FIN$)= +$	
		$(\uparrow_\mu$ DEP AUX$)= -$	
		$(\uparrow_\mu$ DEP AUX-SEL$)=_c$ ÊTRE	
		{ $(\uparrow_\mu$ DEP VFORM$)=_c$ PERFP	est venu; *a venu
		$(\uparrow$ PASSIVE$)= -$	
		$(\uparrow$ TENSE$)=$ PAST	
		| $(\uparrow_\mu$ DEP VFORM$)=_c$ PASSP	est vu
		$(\uparrow$ PASSIVE$)=_c +$	
		$(\uparrow$ TENSE$)=$ PRESENT }.	
a:	Vaux	$(\uparrow_\mu$ AUX$)= +$	
		$(\uparrow_\mu$ FIN$)= +$	
		$(\uparrow$ PASSIVE$)= -$	
		{ $(\uparrow_\mu$ DEP AUX$)= -$	
		$(\uparrow_\mu$ DEP AUX-SEL$)=_c$ AVOIR	a travaillé; *est travaillé
		$(\uparrow$ TENSE$)=$ PAST	
		| $(\uparrow_\mu$ DEP AUX$)= +$ }	a eu travaillé, a été arrivé
		$(\uparrow_\mu$ DEP VFORM$)=_c$ PERFP.	a été vu

In (47), both *est* and *a* constrain their DEPendent verbs to be main verbs, in which case their properties of auxiliary selection have to be met. In the lexicon, main verbs that select *être* for complex tense formation are marked by the feature $(\uparrow_\mu$ AUX-SEL$)=$ ÊTRE, those that select *avoir* introduce the equation $(\uparrow_\mu$ AUX-SEL$)=$ AVOIR. Thus, the constraining equation in the first disjunct of the entry for *est* captures the past tense formation for unaccusative verbs like *venir* (come). Correspondingly, the entry for *a* captures past tense formation for unergative verbs like *travailler* (work). The constraining equations further distinguish between two values for VFORM, PERFP and PASSP, the latter being restricted to passivized main verbs.[22] As in the original account of Butt et al. (1996a), the values of the functional feature TENSE can be defined in virtue of this type of morphological information: TENSE is set to PAST for tense formation with the perfect participle (*est venu*), and to PRESENT for the passive construction *est vu* (is

[21] In this section, the lexicon entries for auxiliaries are stated for fully inflected forms. See Section 2.3.4 for a more general treatment by way of sublexical rules.

[22] The f–structure feature PASSIVE is set to + in the passive lexical rule. We do not go into any further detail as to the treatment of passive.

seen), restricted to participles with VFORM= PASSP. Since *avoir* cannot be used to build passive constructions in the present tense, the entry *a* is missing a corresponding disjunct. By contrast, *avoir* can be used to build so-called "surcomposed" tense forms like *a eu travaillé* (has had worked), or *a été arrivé* (has had arrived). Here the auxiliary selection of the main verb is only observed by the embedded participle auxiliary, whereas both *été (être)* and *eu (avoir)* are embedded under the finite auxiliary *avoir* in this complex tense formation. It is therefore only the entry for (finite) *avoir* that allows for surcomposed tense formation, i.e., it allows its direct DEPendent to be a past participle auxiliary.

The most important difference with respect to the parallel architecture of Butt et al. (1996a) emerges when we turn to the annotations of participles, both main verb and auxiliary participles, that build such more complex constructions. As noted above, the hierarchical m–structure for verbal dependencies cannot be defined in terms of c–structure annotations. The entries for the auxiliary past participles in (48), since they occur in more deeply embeddeding constructions, specify the complete paths of DEP features that characterize these various constructions.

(48)

été:	Vaux	$(\uparrow_\mu$ DEP AUX$)=+$	
		$(\uparrow_\mu$ DEP DEP AUX-SEL$)=_c$ ÊTRE	
		{ $(\uparrow_\mu$ DEP DEP VFORM$)=_c$ PERFP	a <u>été</u> arrivé
		$(\uparrow$ PASSIVE$)=-$	
		$(\uparrow$ TENSE$)=$ PAST-ANTERIOR	
		| $(\uparrow_\mu$ DEP DEP VFORM$)=_c$ PASSP	a <u>été</u> vu
		$(\uparrow$ PASSIVE$)=_c+$	
		$(\uparrow$ TENSE$)=$ PAST }.	
eu:	Vaux	$(\uparrow_\mu$ DEP AUX$)=+$	a <u>eu</u> travaillé
		$(\uparrow_\mu$ DEP DEP AUX-SEL$)=_c$ AVOIR	
		$(\uparrow_\mu$ DEP DEP VFORM$)=_c$ PERFP	
		$(\uparrow$ PASSIVE$)=-$	
		$(\uparrow$ TENSE$)=$ PAST-ANTERIOR.	

+PaPrt	PART	{ $(\uparrow_\mu$ DEP* VFORM$)=$ PERFP
		| $(\uparrow_\mu$ DEP* VFORM$)=$ PASSP };
	AUXPART	$(\uparrow_\mu$ DEP VFORM$)=$ PERFP.

The auxiliary participle *eu* (of *avoir*) can only participate in the formation of the *passé surcomposé* of verbs selecting *avoir*. The corresponding constraints are now stated relative to the m–structure path DEP DEP, as opposed to the entry for *a* in (47), and we assign the f–structure feature TENSE= PAST-ANTERIOR.[23] The surcomposed form for unaccusative verbs (*a été arrivé*) is defined, in similar ways, in the entry for *été*. Finally, the second disjunct in this entry accounts for the past of the passive *il a été vu*, again restricting the main verb's morphological form to VFORM = PASSP.

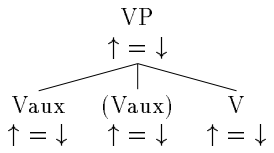
Finally, note that the functional annotations for main verb past or passive participles (characterized by the morphological tag +PaPrt and its sublexical morphological category PART in (48)) contain an uncertainty path over the m–structure attribute DEP. Since the participle can be embedded at various levels of embedding (*a vu*, *a été vu*, etc.), this "uncertainty" of the level of embedding is to be projected from the lexicon entry in terms of the uncertainty path DEP*: the participle must "reckon" with the fact that it can be embedded by an undetermined number of auxiliaries. The resolution of the m–structure path DEP* is however severely restricted by the various constraints on morphological form.

[23] Again, we do not attempt to give any semantic definition of tenses in this paper.

2.3.3 Ordering constraints in the sequenced architecture

The sequenced architecture has important implications for the definition of the linear order of auxiliaries in complex tense formation. Note that the grammar has to rule out ungrammatical sequences like **eu a travaillé* for 'surcomposed' tenses, or **été a vu* for the past of the passive.[24] Since the complex m–structure of auxiliary constructions is a projection of the monoclausal f–structure, we cannot simply constrain the first auxiliary node in (49) to be finite in terms of an annotation ($\downarrow_\mu$ FIN)= +: given the equation $\uparrow = \downarrow$ this constraint is satisfied by both the grammatical and the ungrammatical sequences.

(49)



sequenced architecture, flat c–structure

A solution to this problem is to introduce more specific c–structure categories for the respective finite or infinite verbal categories, in order to constrain their correct relative order in the c–structure rules. To capture the ordering constraints of French complex tense formation, we have to define more fine–grained c–structure distinctions between auxiliary and main verbs, as well as between finite, infinite and participle verb forms.[25]

Parameterized rules, a formal construct provided by the XLE grammar development platform, are an elegant device for defining such *complex categories*.[26] Ordinary phrase structure rules – both regular grammar rules, as well as sublexical rules in the syntax-morphology interface – can be formulated as *rule schemata* that take parameters as arguments. With instantiated parameters, these rule schemata are compiled into corresponding ordinary rules.
A simple example is given in (50). (50a) defines a parameterized rule, or rule schema for NPs with a singular or plural head noun. Due to the parameter `_num` with possible instantiations `sg` and `pl`, the parameterized rule represents the family of rules stated explicitly in (50b,c). A grammar rule that calls the complex category `NP[_num]` with the parameter `_num` instantiated to, e.g. `sg` (`NP[sg]`) effectively calls the instantiated rule (50b), with appropriate instantiation of both the embedded complex category `N[sg]` and the m–structure feature NUM= sg.

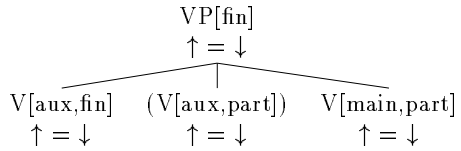
(50) a. NP[_num] → N[_num]: ($\uparrow_\mu$ NUM)= _num.
b. NP[sg] → N[sg]: ($\uparrow_\mu$ NUM)= sg.
c. NP[pl] → N[pl]: ($\uparrow_\mu$ NUM)= pl.

(52) shows how the crucial distinctions between auxiliary and main verbs, as well as finite, infinite and participle verb forms can be encoded in a system of parameterized (sublexical) rules. The two parameters used are `_type`, with possible values `aux` or `main`, and `_fin`, which allows for the values `fin`, `inf`, or `part` (for participle forms).

[24] The rule fragment for passive and predicational structures will be discussed in more detail below.
[25] In a language like English we would need further categories, in particular for progressive verb forms.
[26] The idea of using parameterized rules to formalize ordering constraints in terms of fine–grained categories was also suggested by John Maxwell. The notion of a *complex category* defined by parameterized rules is due to Ron Kaplan.

The important thing to note here is the effect of parameterization. Without any constraining parameter, any of the three alternative sublexical verb rules could be used to derive a V–category in grammar. With parameterization, however, it is possible to constrain certain positions in a grammar rule to specific complex V–categories. E.g., specifying `V[aux,fin]` in a grammar rule will constrain the V–category to *finite auxiliary* verbs, as defined in the sublexical rule for finite verbs in (52). In this way, reference to complex V–categories will allow us to hard-wire the relative order of main and auxiliary verbs in the flat VP structure, as illustrated in (51).

(51)



By trivial functional equations $\uparrow = \downarrow$ in the sublexical rules (52) the equations that are stated in the morphological lexicon (53) contribute to define partial f– and m–structures for the various complex V–categories.[27] Moreover, the sublexical constituents are annotated with equations that define, or instantiate the respective parameters. Thus, the complex V-type `V[main, fin]`, e.g., is restricted to sublexical structures with sublexical constituent TNS.
In virtue of the distinct morphological features AUX= − and AUX= +, projected from the lexicon, the `type` parameter of auxiliaries is correctly set to `aux` and, correspondingly, the parameter `type` is instantiated to `main` for main verbs. Finally, the distinction between main verb and auxiliary *participles* (cf. (48) above) is now captured in terms of the complex sublexical category `PART[_type]`, which is defined in the morphological lexicon for the respective types `main` and `aux` (see (53)).

[27] We are using the actual XLE syntax, where a trivial equation $\uparrow = \downarrow$ is added by default if no $\downarrow$ arrow appears in the annotation, but often state the trivial equation explicitly, for better readability.

(52)

V[_type, _fin] →	{	V_BASE:	{ _type = main ($\uparrow_\mu$ AUX)= − | _type = aux ($\uparrow_\mu$ AUX)= + };
		TNS:	$\uparrow = \downarrow$ _fin = fin;
		VS_NUM:	$\uparrow = \downarrow$
		VS_PERS:	$\uparrow = \downarrow$
		V_TAG	
	|	V_BASE:	{ _type = main ($\uparrow_\mu$ AUX)= − | _type = aux ($\uparrow_\mu$ AUX)= +};
		INF:	$\uparrow = \downarrow$ _fin = inf;
		V_TAG	
	|	V_BASE:	{ _type = main ($\uparrow_\mu$ DEP* AUX)= − | _type = aux ($\uparrow_\mu$ DEP AUX)= +};
		PART[_type]:	$\uparrow = \downarrow$ _fin = part;
		VPART_NUM:	$\uparrow = \downarrow$;
		VPART_GEND:	$\uparrow = \downarrow$
		V_TAG	}

Parameterized sublexical rules for complex V–category (preliminary version)

(53)

+Pres	TNS	($\uparrow$ TENSE)= PRESENT ($\uparrow_\mu$ FIN)= +.
+PaPrt	PART[main]	{ ($\uparrow_\mu$ DEP* VFORM)= PERFP | ($\uparrow_\mu$ DEP* VFORM)= PASSP };
	PART[aux]	($\uparrow_\mu$ DEP VFORM)= PERFP.
+Pl	VS_NUM	(($\uparrow$ SUBJ)$_\mu$ NUM)= PL.
+3rd	VS_PERS	(($\uparrow$ SUBJ)$_\mu$ PERS)= 3.
+Pl	VPART_NUM	{ (($\uparrow$ SUBJ)$_\mu$ NUM)=$_c$ PL | (($\uparrow$ OBJ)$_\mu$ NUM)=$_c$ PL } ...
+Fem	VPART_NUM	{ (($\uparrow$ SUBJ)$_\mu$ GEND)=$_c$ FEM | (($\uparrow$ OBJ)$_\mu$ GEND)=$_c$ FEM } ...

Morpho–syntactic annotations for sublexical constituents

Based on the parameterized V–category defined in (52) and the (partially stated) functional annotations for the morphological tags in (53) we can impose fine–grained distinctions on the order of verbal elements in complex verb phrases by explicitly stating the order of the respective instantiated complex verb categories in the c–structure rules.
The following (parameterized) c–structure rule for temporal auxiliary constructions encodes two possible structures for finite (`_fin = fin`) or infinite (`_fin = inf`) phrases.[28] The first disjunct allows for a single main verb of the appropriate finiteness-type. The second disjunct captures a verbal sequence consisting of an (obligatory) auxiliary of the instantiated finiteness type, followed by a participle main verb, and an optional intervening participle auxiliary.

[28] This rule does not take into account complex predicate formation, as e.g. with causative *faire*.

(54)
VP[_fin] → { V[main,_fin]
| V[aux,_fin] (V[aux,part]) V[main,part] }
. . . other VP-complements . . .

This rule accounts for the following sentence types. With `_fin` set to `fin`:

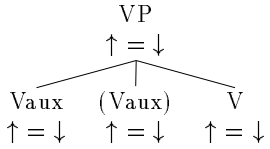
(55) a. Il vient.
b. Il est venu.
c. Il a eu travaillé.

with `_fin` set to `inf`: *Il peut ...*

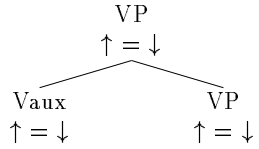
(56) a. ... venir.
b. ... être venu.
c. ... avoir eu travaillé.

2.3.4 Temporal auxiliary vs. passive verbal structures

Abeillé and Godard (1996) argue for the following distinction.

(57) a.


flat c–structure
(temporal auxiliaries)

b.


hierarchical c–structure
(passive, predicational constructions)

To account for both the flat VP structure for temporal auxiliaries, as well as the hierarchical VP structure for passive and predicational constructions, the rule system presented above has to be slightly refined because passive constructions are constrained to c–structure configurations with an embedded VP, as opposed to a flat VP structure for non–passive, temporal constructions.[29]

(58)
VP[_type,_fin] → { V[main,_fin]
| V[aux,_fin] (V[aux,part]) V[main,part]: (↑ PASSIVE)= −
| V[aux,_fin] (V[aux,part]) VP[main,part]: (↑ PASSIVE)=$_c$ + }
. . . other complements

The disjuncts in rule (58) are devised for the following construction types, respectively:

(59) a. il vient / de venir / venant / venu
b. il est venu / il a travaillé / il a eu travaillé
c. il est attendu / il a été attendu / d'avoir été attendu

[29] In the rule fragment given below, we restrict ourselves to temporal and passive auxiliaries. The predicative auxiliary *être* could either be defined as only contributing morphological and aspectual features, along the lines of the passive auxiliary, or else as a PRED-bearing element which subcategorizes for an XCOMP complement.

The order of the verbal elements in complex verbal structures is captured in c–structure by reference to complex (parameterized) verbal categories, which we defined in the sublexical rules (52) and (53). With these rules in place, the LFG verb lexicon will consist of entries for verb stems rather than fully inflected forms. The morphological features of inflected verb forms are projected from the annotations of the sublexical rules and sublexical constituents.

For auxiliaries of type **aux**, however, the lexicon has to encode a distinction between *participle* auxiliaries and other morphological forms. In order to define the correct formation of complex tenses, the participles *été* and *eu* must specify morphological annotations that are *distinct* from those of their finite (or infinitival) forms (recall this fact by reconsulting (47) vs. (48) above). At the same time, the annotations for these two auxiliary participles *été* and *eu* are also distinct, and must therefore be specified in the corresponding lexical (stem) entries. In the refined sublexical rule for verbs (61) we therefore define a complex stem category **V_BASE[part]** for (temporal) auxiliary participles.[30] This category shows up as the stem category V[part] in (60), the auxiliary stem lexicon for the *temporal* and *passive* auxiliaries *avoir* and *être*. It distinguishes participle forms **V[part]** from other morphological forms, which are covered by the category **V**. The annotations of the respective disjuncts correspond fully to the ones given for fully inflected forms in (47) and (48).

(60)

être:	V	$(\uparrow_\mu$ AUX$)=+$	
		$(\uparrow_\mu$ DEP AUX$)=-$	
		$(\uparrow_\mu$ DEP AUX-SEL$)=_c$ ÊTRE	
		{ $(\uparrow_\mu$ DEP VFORM$)=_c$ PERFP	est venu
		$(\uparrow$ PASSIVE$)=-$	
		$(\uparrow$ TENSE$)=$ PAST	
		| $(\uparrow_\mu$ DEP VFORM$)=_c$ PASSP	est vu
		$(\uparrow$ PASSIVE$)=_c+$	
		$(\uparrow$ TENSE$)=$ PRESENT };	
	V[part]	$(\uparrow_\mu$ AUX$)=+$	
		$(\uparrow_\mu$ DEP AUX$)=+$	
		$(\uparrow_\mu$ DEP DEP AUX-SEL$)=_c$ ÊTRE	
		{ $(\uparrow_\mu$ DEP DEP VFORM$)=_c$ PERFP	a été arrivé
		$(\uparrow$ PASSIVE$)=-$	
		$(\uparrow$ TENSE$)=$ PAST-ANTERIOR	
		| $(\uparrow_\mu$ DEP DEP VFORM$)=_c$ PASSP	a été vu
		$(\uparrow$ PASSIVE$)=_c+$	
		$(\uparrow$ TENSE$)=$ PAST }.	
avoir:	V	$(\uparrow_\mu$ AUX$)=+$	
		$(\uparrow$ PASSIVE$)=-$	
		{ $(\uparrow_\mu$ DEP AUX$)=-$	a travaillé
		$(\uparrow_\mu$ DEP AUX-SEL$)=_c$ AVOIR	
		$(\uparrow$ TENSE$)=$ PAST	
		| $(\uparrow_\mu$ DEP AUX$)=+$ }	a eu travaillé, a été arrivé
		$(\uparrow_\mu$ DEP VFORM$)=_c$ PERFP;	a été vu
	V[part]	$(\uparrow_\mu$ AUX$)=+$	
		$(\uparrow$ PASSIVE$)=-$	
		$(\uparrow_\mu$ DEP AUX$)=+$	a eu travaillé
		$(\uparrow_\mu$ DEP DEP AUX-SEL$)=_c$ AVOIR	
		$(\uparrow_\mu$ DEP DEP VFORM$)=_c$ PERFP	
		$(\uparrow$ TENSE$)=$ PAST-ANTERIOR.	

[30] We assume that **V_BASE** and **V_BASE[part]** are considered as distinct categories.

The sublexical rule for the complex category *verb* now reads as follows. Note that it differs from (52) only with respect to the parameterization of the stem category V_BASE for auxiliary participles.

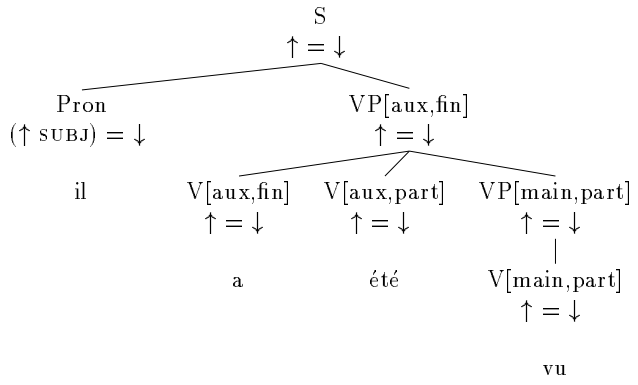
(61)

V[_type, _fin] →	{	V_BASE:	{ _type = main (↑$_\mu$ AUX)= − | _type = aux (↑$_\mu$ AUX)= + };
		TNS:	↑ = ↓ _fin = fin;
		VS_NUM:	↑ = ↓ ;
		VS_PERS:	↑ = ↓ ;
		V_TAG	
	|	V_BASE:	{ _type = main (↑$_\mu$ AUX)= − | _type = aux (↑$_\mu$ AUX)= + };
		INF:	↑ = ↓ _fin = inf;
		V_TAG	
	|	{ V_BASE:	_type = main (↑$_\mu$ DEP* AUX)= −
		| V_BASE[part]	_type = aux (↑$_\mu$ DEP AUX)= + };
		PART[_type]:	↑ = ↓ _fin = part;
		VPART_NUM:	↑ = ↓ ;
		VPART_GEND:	↑ = ↓ ;
		V_TAG	}

Parameterized sublexical rules for complex V–category (final version)

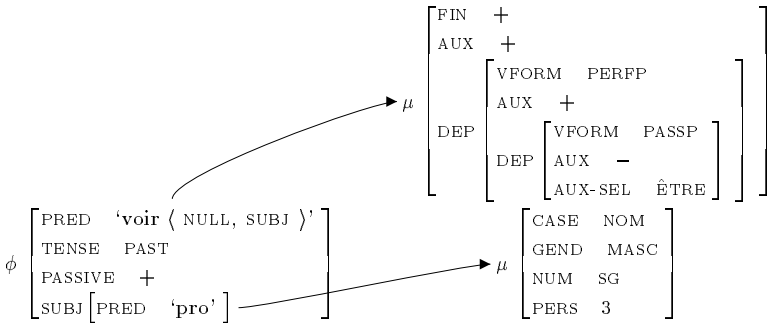
With the above rules and lexicon entries, we can now illustrate the relevant aspects of the analysis for *Il a été vu.* The finite VP rule instantiates the parameter `_fin` to `fin`. The finite auxiliary *a* can fill the first position in the second disjunct of rule (58). The categorial parameters and functional annotations of both *été* (`V[aux,part]`) and *vu* (`V[main,part]`) are appropriate to expand the structure further as given in (62).

(62)



The reader may verify, on this basis, the morphological and functional annotations that are defined by the lexical entries and sublexical rules in (60) and (61), and how they resolve to the wellformed morphological and functional structures (63).

(63)



The corresponding German sentence *Er wurde gesehen* will be assigned an equivalent f–structure representation, but a distinct m–structure, which misses one level of embedding. In German the tense information is introduced by a single *past passive* auxiliary *wurde*.

2.4 Some consequences and some possible extensions

2.4.1 Where do clitics go?

As the reader might already have observed, the proposed system allows us straightforwardly to do away with most cases of clitic climbing in French. Clitics are local arguments in the f–structure and their functional annotations reflect this. We will assume a phrase structure rule, introducing the clitics as independent words which are attached to the verb. We could also consider them to be part of the verb, in LFG nothing hinges on this.

(64)

$$
\begin{array}{lll}
\text{VP[\_type,\_fin]} \rightarrow & \text{(CL: \{ } (\uparrow \textsc{obj}) = \downarrow \\
 & \qquad\qquad (\downarrow_{\mu} \textsc{case}) =_{c} \textsc{acc} \\
 & \qquad \mid (\uparrow \textsc{obj2}) = \downarrow \\
 & \qquad\qquad (\downarrow_{\mu} \textsc{case}) =_{c} \textsc{dat}\}) \\
 & \text{(CL: } (\uparrow \textsc{obj}) = \downarrow \ \ldots) \\
 & \text{(CL: } (\uparrow \textsc{obj2}) = \downarrow \ \ldots)) \\
 & \text{V[\_type,\_fin]: } \uparrow = \downarrow .
\end{array}
$$

The annotations on the personal clitics will be as illustrated in (65).

(65)

$$
\begin{array}{ll}
\text{la : CL} & (\uparrow \textsc{pred}) = \text{'pro'} \\
 & (\uparrow_{\mu} \textsc{num}) = \textsc{sg} \\
 & (\uparrow_{\mu} \textsc{gend}) = \textsc{fem} \\
 & (\uparrow_{\mu} \textsc{case}) = \textsc{acc}.
\end{array}
$$

The above clitic rule can be integrated into the complex VP rule established above as in (67). It not only allows for the ordinary cases of "clitic climbing" with auxiliaries like (66a), but in fact prevents illicit clitic positions as in (66b).

(66) a. Il les a vu.
b. *Il a les vu.

(67)
VP[_type,_fin] → (CL: { (↑ OBJ) = ↓ ... | (↑ OBJ2)=↓ ...}
(CL: (↑ OBJ) = ↓ ...)
(CL: (↑ OBJ2) = ↓ ...))
{ V[main,_fin]
| V[aux,_fin] (V[aux,part]) V[main,part]: (↑ PASSIVE)= −
| V[aux,_fin] (V[aux,part]) VP[main,part]: (↑ PASSIVE)=$_c$ +}
...other complements

The equations of *y* and *en* will have to be more complicated as it is well known that they can represent material that is not a direct argument or even a direct adjunct of the main predicate of the sentence as for example in (68).

(68) J'en ai vu la première partie.
I saw the first part of it.

We do not go into that aspect of French syntax in this paper.

2.4.2 Possible extensions

The copular construction is not limited to *être* but can also occur with verbs like *sembler*, *rester*, etc. For those verbs we could not claim that they have no contribution to make beyond a morphological feature bundle and tense or aspect information. An explicit account of them is beyond the scope of this paper but sentences like the one in (69) indicate that the complex predicate approach proposed for causative constructions will need to be extended to them.

(69) Il lui reste fidèle.
He remains faithful to him/her.

If we do not want to complicate the clitic rules, these verbs will combine with their adjectival complements in the way *faire* combines with its verbal complements. LFG proposals for the treatment of complex predicates have been made, among others, in Alsina (1996), in Butt (1995) and for French in Frank (1996) and Dalrymple and Zaenen (1997). They need to be adapted to the proposal made here. This should not create any problems. The extension to *rester*, etc. should be straigthforward as these cases are simpler than the causative ones given that the subcategorization of the adjective does not change under the various types of embedding.

2.4.3 Possible problems

Problems for an approach that is uniform across languages arise, however, in several other cases. French has not only a synthetic future tense it also has synthetic modal e.g. *je travaillerais*, 'I would work'. Should the English conditional be analysed like the French one? We assume the answer is yes but a further type of problem is raised by the existence of tenses like the immediate future in French as illustrated in (70):

(70) Il va le faire.
He will do it.

The value of *aller* in this context is very similar to that of a verb like *will/shall* in English or a morpheme like *-ai/-as/-a/*etc. in French. Here, however, the clitic placement facts do not plead in favor of a flat f–structure solution, whereas the general consideration about the relation between syntax/morphology and semantics do. It would not be impossible to extend the proposal made above to this case but further investigations will show whether the advantages of bringing the f–structure closer to a semantic structure are compatible with a perspicuous description of the syntax of individual languages.

3 Open conceptual issues

Our proposal of a morphology–syntax interface that separates functional-syntactic from morphological information in a sequenced projection architecture raises a number of important conceptual issues.[31]

LFG has been very successful in abstracting away from order constraints and in that way bringing out the similarities between typologically distinct languages. As we stated in the introduction this is important, not only from a theoretical point of view but also from a practical one. The typological distinction between synthetic and analytic languages is also adressed within the theory. LFG accounts in a straightforward way for the fact that the same functional information can be encoded in one word in one language and spread over several words in another without giving up lexical integrity and without loosing the distinction between sentential syntax and word internal morphology (see e.g. Bresnan and Mchombo (1995)). However, as Butt at al. (1996a) observed the level of abstraction is pushed less far here. To push it further we need a careful study of what the informational content of various elements is.

Extending Butt et al. (1996a) we propose here an architecture that would make a distinction between coding projections, such as the c–structure and the m–structure and informational projections, such as the f–structure and the semantic structure. The c–structure manages the order constraints among syntactic elements whereas the m–structure manages the purely morphological dependencies between word forms. Of course the same element will typically play a role in various projections: the c–structure orders e.g. an NP before a VP but this does not prevent this NP from contributing the functional role of a subject, on the contrary, in a language like English it is by virtue of its position that it contributes this information. Similarly, the tense markers which can be independent words or affixes, play a role in the c–structure and/or the m–structure but of course also in the f–structure and the semantics. In this paper we have not discussed these issues but it is obvious that the main raison d'être of auxiliaries is not to take participle complements. What our proposal embodies is the claim that the functional contribution of the various morphological elements is not a one-to-one correspondence with the form of their encoding. As shown e.g. in Bresnan and Mchombo (1987) (on pronoun incorporation in Chichewa), the same morphological form can have different functional roles in one and the same language and across languages. Case has distinct functions across and within languages. In the spirit of several authors (e.g. T. Mohanan, A. Wierzbicka) we distinguish between morphological *content* and morphological *forms*. A same morphological form, e.g. a specific case

[31] We are grateful to Joan Bresnan, who raised several of the following issues.

can have a different content in different contexts. Under our proposal morphological form information would go into the m–structure whereas morphological content would contribute to the f–structure. The separation of representation levels lets us encode various kinds of mismatches across levels for features like number, person and gender in a straightforward and explitic way. Such a multilayered representation could also allow us to be more explicit about the presence or absence of morphological marking in a particular language.

It is not possible to give an a-priori answer to what belongs to the various projections without detailed analysis of morpho–syntactic phenomena across a variety of languages. A case in point is a puzzle in asymmetric agreement under coordination in Welsh, studied and discussed in Sadler (1999). One of the alternative approaches Sadler proposes to solve the problem is to postulate agreement features at both f–structure and m–structure, following the projection architecture proposed in the present paper.

A related but more formal issue arises from the proposed sequenced, as opposed to a parallel projection architecture. The sequenced architecture that we proposed implies a functional mapping from f–structure to m–structure. This architecture does not permit a single partial f–structure to map to distinct m–structures. Now, could we be confronted with languages where two expressions that bear distinct morphological markings unify at the level of f–structure? Such a one–to–many relation could not be represented in the sequenced projection architecture. Possible examples could be case attraction phenomena, for example with relative pronouns that appear in the case of the head noun, as opposed to the case of the syntactic argument they represent within the relative clause. Again, it has to be studied whether such cases can be accommodated by distributing inconsistent assignments over distinct levels of representation, or whether alternative approaches, such as the set–based feature theory of Dalrymple and Kaplan (to appear) – which is successfully applied to similar agreement problems – can accommodate such facts.

Complex predicate formation is another example where elements with distinct morphological (and functional) features are mapped to a single f–structure unit. This has been discussed in Frank(1996), where a restriction–based approach (including a parallel m–projection) was proposed to account for various problems in the standard LFG treatment of complex predicate formation.

In general, constructions which involve expressions with distinct morphological markings that are unified to the same f–structure unit are difficult to handle in the standard LFG architecture. The sequenced m–structure architecture can only handle such configurations if the mismatching elements are appropriately distributed over the distinct levels of representation, or else by adopting additional formal devices, such as the restriction operator originally introduced by Kaplan and Wedekind (1993), or the set–based approach to feature resolution by Dalrymple and Kaplan (to appear).

Finally, and on a more technical note, one might wonder whether the formal device of complex c–structure categories that we used above to capture order constraints in the sequenced architecture could be extended to an approach where all morphological constraints are encoded in terms of complex c–structure categories. A separate level of representation for morphological constraints would then be unneccesary. At first glance it seems, though, that not all morphological distinctions can be naturally encoded in terms of c–structure categories. In the case of the French auxiliary system, for example, one has to express certain restrictions on tense formation which preclude ungrammatical constructions like **est eu travaillé* as opposed to the

well-formed *a eu travaillé*, and similarly for **est été arrivé* as opposed to *a été arrivé*. To capture these restrictions, an analysis that relies on purely c–structure categorial distinctions will have to encode the lexical form of the auxiliary, *être* vs. *avoir*, as a c–structure parameter of auxiliary categories. Here we would have to decide whether this kind of lexicalization is still within the range of a natural complex c–structure category.

4 Conclusion

In this paper we have proposed a new architecture for the μ–projection in LFG. Our proposal has the advantage that it does not need to reproduce essentially functional information about syntactic arguments in the m–struture. We illustrated our approach with the description of a substantial fragment of the French auxiliary system and in doing so we showed that the problem of stating ordering constraints in the sequenced μ–projection architecture can be solved in a rather elegant way through the use of parameterized rules. The discussion of the French data elaborates further on the advantages of the μ–projection approach advocated by Butt et al. (1996a) but it also points to further phenomena that need to be investigated to get to a crisper view of what the division between language specific and universal aspects of syntax should be. The approach raises numerous interesting and intricate theoretical questions about the partitioning of linguistic features across the various levels of representation.

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