Despite extensive theoretical work carried out on coordination during the last three decades, much research is still devoted to proving the merits of one model over another. In our article, we will show how the coordination process in French (with using the conjunction \textit{et} (and)) can be explained through Applicative and Combinatory Categorial Grammar (ACCG).

Keywords: Categorial grammars; combinatory logic; coordination.

1. Coordination

Although much theoretical research has been devoted to coordination over the three last decades, this phenomenon remains a major challenge for linguistic theory and all formalisms of natural language processing. Moreover, the research models used claim to encompass the various forms coordination can take. In French the coordinating conjunction \textit{et} (and) appears to be the tenth most frequently used.\cite{Grevisse1993}

\citeauthor{Grevisse1993} (1993) define coordination as an explicit or implicit relation which links elements of the same sort: sentences, or linguistic units which have the same function. It is expressed explicitly by markers (of coordination) which are in fact conjunctions, such as mais (but), ou (or), \textit{et} (and), donc (therefore), ni (nor), car (because), or (but). In this article, we focus entirely on the marker \textit{et}.

The coordinated elements are generally of the same nature and fulfill the same function (In example (vii), coordination is non-distributive. The statement does not
mean: *Le drapeau canadien est rouge et le drapeau est blanc* (The Canadian flag is red and the flag is white): 

(i) *Jean admire [les hommes courageux]* et *[les femmes cultivées]*
(Jean admires the courageous men and the cultivated women)

(ii) *[j']N enlace et [je]N berce son âme*
(I embrace and soothe his soul)

(iii) *[Jean]* et *[Paul]*N admirent les talents de Marie
(Jean and Paul admire Marie’s talents)

(iv) *[Jean cuit]*S/N et *[Marie mange]*S/N les haricots
(Jean Cooked and Marie ate the beans)

(v) *Jean [court vite]*S/N et *[saute haut]*S/N
(Jean runs fast and jumps high)

(vi) *[Jean]*N aime [Marie]N et *[Paul Sophie]*N-N
(Jean loves Marie and Paul Sophie)

(vii) *Le drapeau canadien est [blanc]*N\N et *[rouge]*N\N
(The Canadian flag is white and red)

However, it is not rare to encounter cases of coordination of elements that are different in nature though identical in function, as in the following examples:

(viii) *Mon [avocat]*N et *[moi]*N sommes de l'avis du témoin
(My lawyer and I are of the opinion of the witness)

(ix) *Le touriste regarde ce lion [toujours immobile]*N\N et *[qui semble dormir]*N\N
(The tourist looks at this lion, still motionless and which seems to be asleep)

(x) *Il avait cru [à son empoisonnement]*N et *[qu'il allait mourir]*N
(He had believed that he had been poisoned and that he was going to die)

(xi) *Un président élu[démocratiquement](N\N)\(N\N) et *[sans violence](N\N)\(N\N) est digne de confiance*
(A president elected democratically and without violence is worthy of confidence)

There are also cases of coordination of elements of different natures and different functions:

(xii) *Pat est [un républicain]*N et *[fier de l'être]*N\N
(Pat is a republican and proud of it)

xiii) *Pat est [stupide]*N\N et *[un menteur]*N
(Pat is stupid and a liar)

(xiv) *[Un petit tour au casino]*N, et *[tu te trouves ruiné]*S
(A brief stop at the casino, and you end up ruined)

(xv) *Un pas de plus et je tire*
(One more step and I shoot)
The conjunction *et* used to coordinate elements differing in function frequently expresses **causality or temporality**. Although this is not the focus of this article, it is nevertheless interesting to point out that the use of *et* in examples (xiv) and (xvi) illustrate the semantic value of causality. In (xiv), the group *un petit tour au casino* entails the result *tu te retrouves ruiné* (*You end up ruined because of your brief stop at the casino*). In (xvi) *un rayon de soleil* accounts for the fact *ta journée s’embellit* (*Your day is made because of the ray of sun*). In examples (xvii) and (xviii) *et* expresses temporality. In (xvii), the statement embodies two phases: *je te dis un mot* (*I’ll say a word*) then *je m’en vais* (*I’ll leave*). In example (xv) *et* is ambiguous. It can express both causality and temporality.

Although the previous distinctions are important to determine the scope of the model, they are insufficient for the researchers who focus on yet another distinction: coordination of constituents versus coordination of non-constituents. For example, in (vi), the element of the coordination [*Paul Sophie*] is a non-constituent because *Paul* is subject whereas *Sophie* is object. This type of construction is unusual. The subject is normally followed by the verb, not by the object. Moreover, *Jean* is not followed by *Marie* in the first member of the coordination. On the other hand, in (i) [*les femmes cultivées*] is a constituent just as [*les hommes courageux*], both, constructing noun phrases. Consequently, explaining coordination of non-constituents becomes a very significant challenge. For coordination of both “constituents” and “non-constituents”, the general rule according to traditional sources can be summed up as follows: when there are identical elements in the coordinated conjuncts, the natural tendency is not to repeat these common elements, a rule examined by generativists and transformationists grammar but readily discarded because of the significant theoretical problems encountered.\(^3\), \(^4\) The syntagmatic models appeared more promising based on the arguments advanced by Pollard, Sag, and Beavers for the process of coordination with ellipses using an HPSG Grammar,\(^2\), \(^5\) they do not seem to yield general rules for treating all types of coordination. This is why the TCCG was proposed for treating English coordination.\(^6\) The challenge facing TCCG is to use certain Categorial Grammars rules while keeping the HPSG grammar base. The model of Categorial Grammars in its various versions offered interesting perspectives but was criticized for “over-generation” mainly because of type raising rules\(^7\) and its incapacity to account for certain constructions in which the elements coordinated are not of comparable nature or do not fulfill the same function.\(^2\), \(^6\) The English counterexamples chosen by Sag and Beavers respectively are given below:
(xix) Pat is [a republican] and [proud of it]
(xx) Jan [travels [to Rome tomorrow], [to Paris on Friday]] and [will fly to Tokyo on Sunday]

Similar examples in French:

(xxi) Pat est [un republican] et [fier de l’être]
(xxii) Jean ira [à Rome demain] et [à Paris vendredi] et [sera à Tokyo samedi]

In the case of the example (xix), the coordinated elements a republican and proud of it do not fulfil the same function. A republican is an argument of the verb is whereas proud of it acts as an argument of the verb but also as a backward modifier whose argument is Pat. On the other hand, Beavers and Sag state that the obvious incapacity of Categorial Grammars to explain example (xx) stems from the fact that to Rome tomorrow can be coordinated rather easily with to Paris on Friday since they are similar elements but cannot be coordinated with will fly to Tokyo on Sunday since the latter segment is an intransitive verb, and this is not the case with to Paris on Friday. We will show thereafter that these assertions are debatable.

Another limit of the capacity of Categorial Grammars to process coordination is mentioned by Yatabe. This limit is morphological. In fact, Yatabe criticizes a morphological approach to coordination proposed by Steedman, a point we will not discuss here.

2. Introduction to Applicative Combinatory Categorial Grammar

The model of Applicative and Combinatory Categorial Grammar (ACCG) as most of categorial models falls under a paradigm of language analysis that favors complete abstraction of grammatical structure from its linear representation due to the linearity of the linguistic signs and a complete abstraction of grammar from the lexicon.

Concretely, ACCG, assigns syntactical categories to each linguistic unit in order to express its function. Syntactical categories are orientated types developed from basic types and from two constructive operators ‘/’ and ‘\’.

(i) N (nominal syntagm) and S (sentence) are basic types.
(ii) If X and Y are orientated types then X/Y and X\Y are orientated types.

A linguistic unit u with orientated type X will be designated as ‘[X : u]’.

For instance the verb court (runs), in Jean court (Jean runs), is associated with the category S\N. This means that court is considered as a function whose argument Jean is a noun (N) positioned to the left (\) of the verb in syntagmatic

As Beavers and Sag (2004) observe: The problem for Categorial Grammars (CG) posed by this example is easily understood. Assuming (with CG) that all conjuncts are constituents and that only like-constituents can coordinate, then the first conjunct’s status as a constituent is paradoxical.
linearity. The result of the application of the function of court to its argument Jean is a sentence of category S.

Finally, inferential calculus applied to the categories using ACCG rules is substituted for a syntagmatic analysis to check the proper syntactic organization of the statement and to facilitate functional semantic interpretation construction.

According to the framework of Applicative and Cognitive Grammar\cite{ApplicativeCognitiveGrammar} and Applicative Universal Grammar,\cite{ApplicativeUniversalGrammar} language analysis has to postulate three levels of representation: the phenotype, the genotype and the cognitive level. In this paper we are interested only in the first two levels. The particular characteristics of coordination (such as word order, ellipsis, non-constituent conjuncts, etc., all obeying the syntagmatic rules of the language concerned) are expressed at the phenotype level with concatenated expressions. Functional semantic interpretations underlying at the phenotype level are expressed at the genotype level by means of (a) applicative expressions in which the words that serve as operators are followed by words that act as their operands; (b) combinators, which are abstract used to express complex concepts. According to Ref. 17 each combinator is associated with a $\beta$-reduction rule (that acts as an elimination or an introduction rule). For instance, we present combinators $\Phi$, $B$, $C*$ with the following rules (U1, U2, U3 are typed applicative expressions):

$$\begin{align*}
((\Phi \ U1 \ U2 \ U3) \ U4) &\Rightarrow (U1 \ (U2 \ U4) \ (U3 \ U4)) \\
((B \ U1 \ U2) \ U3) &\Rightarrow (U1 \ (U2 \ U3)) \\
((C* \ U1) \ U2) &\Rightarrow (U2 \ U1)
\end{align*}$$

The combinator $\Phi$ makes it possible to distribute the application of two typed applicative expressions U2 and U3 (that function as operators) to the typed applicative expression U4 (that functions like an operand).

The combinator $B$ allows the composition of two typed applicative expressions U1 and U2 (U1 and U2 function as operators). The result ($B \ U1 \ U2$) would then be the complex operator of the typed applicative expression U3 (U3 functions like an operand).

The combinator $C*$ is applied to a typed applicative expression U1 (U1 functions as the operand of U2). This makes it possible to build the complex operator ($C* \ U1$) to be applied to the typed applicative expression U2.

According to the Church-Rosser Theorem, these rules establish a relationship which is independent of the meaning of the arguments between an expression with combinators and a single expression (if it exists) without combinators equivalent to the first (from a certain point of view) and called the normal form. In the ACCCG Model, normal forms represent functional semantic interpretation. In addition, a paraphrastic reduction to a normal form is also possible.

In addition to elementary combinators, there are complex combinators constructed from the elementary ones. We have for example the complex combinator: $B \ B \ C*$. The action of the complex combinators is determined by the application of the elementary combinators starting from the one on the left.
The expression obtained in step 4 is the normal form of the combinatory expression in 1. According to the Church-Rosser Theorem the normal form, if it exists, is unique.

Phenotype expressions are explicitly connected to their subjacent functional semantic interpretation in the genotype by means of ACCG rules. The rules used in this paper are discussed below.

Certain applicative combinatory categorical rules

<table>
<thead>
<tr>
<th>Rule Description</th>
<th>Expression</th>
</tr>
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<tbody>
<tr>
<td>Forward Applicative rule (&gt;)</td>
<td>([X/Y : u1] - [Y : u2])</td>
</tr>
<tr>
<td></td>
<td>([X : (u1u2)])</td>
</tr>
<tr>
<td>Backward Applicative rule (&lt;)</td>
<td>([Y : u1] - [X\backslash Y : u2])</td>
</tr>
<tr>
<td></td>
<td>([X : (u2u1)])</td>
</tr>
<tr>
<td>Forward Type-Raising rule (&gt;T)</td>
<td>([X : u])</td>
</tr>
<tr>
<td></td>
<td>([Y / (Y\backslash X) : (C\ast u)])</td>
</tr>
<tr>
<td>Forward Composition rule (&gt;B)</td>
<td>([X/Y : u1] - [Y/Z : u2])</td>
</tr>
<tr>
<td></td>
<td>([X/Z : (B\ast u1u2)])</td>
</tr>
</tbody>
</table>

The premises of each rule is that concatenations of linguistic units with oriented types are considered as operators or operands. The consequence of each rule is an applicative typed expression with possible introduction of one combinator. The type-raising of one unit \(u\) introduces the combinator \(C\ast\); the composition of two concatenated units introduces the combinator \(B\).

The general steps of an ACCG based analysis are as follows:

(i) A first step entails assigning syntactic types to the lexical units. These are dictionary entries in which each unit is associated with one or more types.

(ii) A second step entails applying the rules of ACCG to ascertain syntactic correctness on the one hand and progressively to construct the applicative structures by introducing combinators in the syntactic process. Two results are obtained at the end of this step. The first one is the type \(S\) (or another basic type) confirming the syntactic correctness of the analyzed statement. The second is the applicative expression with combinators which, after their reduction, give the functional semantic interpretation in which each operator is followed by its operands. This analysis resembles a compilation process.
Although not fully explained or rigorously applied here, to avoid encumbering the text, an incremental analysis strategy (from left to right) with an “intelligent” backtrack supplements the GCCA model to help solve the problem of the pseudo-ambiguity which consists of a multitude of syntactic derivations (equivalent from a functional semantic point of view) for the analysis of the same statement corresponding to the same semantic interpretation.

3. Applicative Combinatory Categorial Grammar and Coordination

All Categorial Grammars consider that coordination applies to two linguistic units of the same function. The linguistic unit produced also inherits this function. In Ref. 9 two rules are proposed, one for distributive coordination, the other for non-distributive coordination. Let us provide these two rules and show how they work (for non-distributive coordination examples, see Ref. 9):

Coordination rules

<table>
<thead>
<tr>
<th>Distributive coordination</th>
<th>Non-distributive coordination</th>
</tr>
</thead>
</table>

Jean aime Marie et Paul Sophie (Jean Loves Marie and Paul Sophie)

5. \([ CONJD : et] - [S/S(N)] : (C* Paul) - [N: Sophie] \)
6. \([ CONJD : et] - [S/S(N)] : (C* Paul) - [S/S(N)] \)
7. \([ CONJD : et] - [S/S(N)] : (B (C* Paul) (C* Sophie)) \)
8. \([B : (C* Jean) (C* Marie)] - [CONJD: et] - [B (C* Jean) (C* Marie)] - [CONJD: et] - [B (C* Jean) (C* Marie)] \)
9. \([S/S(N) : N aime] - [B : (C* Jean) (C* Marie)] - [CONJD: et] - [B (C* Jean) (C* Marie)] \)
10. \([S/S(N) : N aime] - [S/S(S(N))] : (\Phi et (B (C* Jean) (C* Marie) (B (C* Paul) (C* Sophie)) aimed)) \)
11. \([S : (\Phi et (B (C* Jean) (C* Marie) (B (C* Paul) (C* Sophie)))) aimed] \)
12. \([\Phi et (B (C* Jean) (C* Marie) (B (C* Paul) (C* Sophie)) aimed) \)
13. \([\Phi et (B (C* Jean) (C* Marie)) aimed) (B (C* Paul) (C* Sophie)) aimed) \)
14. \([\Phi et (\Phi et (B (C* Jean) (C* Marie)) aimed) (B (C* Paul) (C* Sophie)) aimed) \)
15. \([\Phi et (\Phi et (B (C* Jean) (C* Marie)) aimed) (B (C* Paul) (C* Sophie)) aimed) \)
16. \([\Phi et (\Phi et (B (C* Jean) (C* Marie)) aimed) (B (C* Paul) (C* Sophie)) aimed) \)
17. \([\Phi et (\Phi et (B (C* Jean) (C* Marie)) aimed) (B (C* Paul) (C* Sophie)) aimed) \)
18. \([\Phi et (\Phi et (B (C* Jean) (C* Marie)) aimed) (B (C* Paul) (C* Sophie)) aimed) \)
19. \([\Phi et (\Phi et (B (C* Jean) (C* Marie)) aimed) (B (C* Paul) (C* Sophie)) aimed) \)
Steps 2 to 4 show successive application of the rules (\(>\text{T}\)), (\(>\text{B}\)) and (\(>\)) before encountering the conjunction \textit{et} resulting in the construction of an incomplete constituent ((\(\text{B} (\text{C* Jean}) \ aime) \ Marie)). Steps 5 to 7 enable the second member of the coordination to be constructed. The non-constituent (\(\text{B} (\text{C* Paul})(\text{C* Sophie})\)) is of the type \(S/(S/(S/N))\). This means that the second member of the coordination functions as an operator which acts on the verb to produce the sentence. Type raising rules are not applied as a simple "juggling of categories". The application of the rule (\(>\text{T}\)) in 5 shows that \textit{Paul} is considered as subject of the elided verb \textit{aime}, whereas the application of the rule (\(<\text{T}\)) in 6 makes it possible to consider \textit{Sophie} as object of the elided verb \textit{aime}. The complex operators obtained (\(\text{C* Paul}\)) and (\(\text{C* Sophie}\)) are composed in 7 though the rule (\(>\text{Bx}\)). Steps 8 and 9, by means of structural reorganization and decomposition (see Ref. 9), enable the extraction of the first member of the coordination from the incomplete constituent obtained in 4. According to Ref. 9 the constituent ((\(\text{B} (\text{C* Jean}) \ aime) \ Marie)) is equivalent to ((\(\text{B} (\text{C* Jean}) (\text{C* Marie})) \ aime) where the sub-constituent (\(\text{B} (\text{C* Jean}) (\text{C* Marie})\)) is the first member of the coordination. The second member of the coordination (\(\text{B} (\text{C* Jean}) (\text{C* Marie})\)) functions as an operator acting on the transitive verb and constructing a type S sentence. In step 10, the two members of the coordination are known, the application of the distributive coordination rule is therefore allowed. It results in the coordinated constituent (\(\Phi \ et \ (\text{B}(\text{C* Jean})(\text{C* Marie}))(\text{B}(\text{C* Paul})(\text{C* Sophie}))\)). Here, the combinator \(\Phi\) is used because of its capacity to distribute the two members of coordination to the verb \textit{aime} (see the \(\beta\)-reduction rule of \(\Phi\)). Finally, steps 12 to 19 are at the genotype level. They reduce combinators in order to construct the functional semantic interpretation where, as shown in 19, \textit{aime} is repeated to express the fact that \textit{Jean aime Marie} (\textit{Jean loves Marie}) and \textit{Paul aime Sophie} (\textit{Paul loves Sophie}).

Let us now deal now with the sentence \textit{Jean ira à Rome demain et à Paris vendredi et sera à Tokyo samedi} (\textit{Jean travels to Rome tomorrow, to Paris on Friday and will fly to Tokyo on Sunday}), which proponents of HPSG claim Categorial Grammars are unable to explain. This example contains two coordinations. The first one connects the non-constituent [\(\text{à Rome demain}\)] to the non-constituent [\(\text{à Paris vendredi}\)]. The second connects the expression [\(\text{ira à Rome demain et à Paris vendredi}\)] to [\(\text{sera à Tokyo samedi}\)]. Beavers and Sag seem to suggest why this example cannot be treated by Categorial Grammars: it cannot connect [\(\text{à Rome demain}\)] with [\(\text{sera à Tokyo samedi}\)] since the former must be of the same function as the latter to effect the first coordination and cannot thus be of another function compatible with that of [\(\text{sera à Tokyo samedi}\)] which is an intransitive verb.

\textit{Jean ira à Rome demain et à Paris vendredi et sera à Tokyo samedi}

1. [\(N : \text{Jean}\)-\((\text{S})(\text{N})/\text{N} : \text{ira}\)-\((\text{N}/\text{N} : \text{à}\)-\([\text{N} : \text{Rome}]/\text{S} : \text{demain}]-\{\text{CONJD} : \text{et}\}-\text{N}/\text{N} : \text{à}]-\text{N} : \text{Paris}]-\text{S} : \text{Vendredi}]-\{\text{CONJD} : \text{et}\}-\[(\text{S})(\text{N})/\text{N} : \text{sera}\]-\text{N}/\text{N} : \text{à}]-\text{N} : \text{Tokyo}]-\text{S} : \text{Samedi}]}
Steps 2 to 6 consist of successive application of the rules (＞T), (＞B), (>), and (<) before encountering the first conjunction et, the result being the con-
struction of an incomplete constituent \((\text{demain } (\text{B } (\text{C* Jean} \text{ ira}) \text{ à} \text{ Rome}))\).

Steps from 7 to 9 enable construction of the second member of the first coordination. The non-constituent \((\text{B} \text{ vendredi } (\text{C*} \text{ (à Paris)}))\) is of type \(S\backslash(S/N)\). Step 8, by taking into account the equivalence of \((X (\text{B } (\text{B } (\text{C* Y} \text{ Z}) \text{ T} \text{ U})) \text{ with } (\text{B X} (\text{C*} (\text{T U})) \text{ B } (\text{C*} \text{ Y} \text{ Z})))\), applies the structural reorganization of \((\text{demain } (\text{B} \text{ (C* Jean} \text{ ira}) \text{ à} \text{ Rome}))\) which gives \((\text{B demain } (\text{C*} \text{ (à Rome)})) \text{ (B (C* Jean) ira)})\). In step 9, this reorganization enables the expression \((\text{B demain } (\text{C*} \text{ (à Rome)}) \text{ (B (C* Jean) ira)})\) to be decomposed into the concatenation of the two expressions \((\text{B (C* Jean) ira})\) and \((\text{B demain (C* (à Rome)})\), this last element being the first one of the first coordination. The distributive coordination rule is applied in step 12 and the combinator \(\Phi\) is introduced. Steps 14 to 16 consist of the construction of the second member of the second coordination \((\text{B samedi } (\text{B sera à} \text{ Tokyo}))\) of type \(S\backslash N\). Structural reorganization (details of this operation are given below) is also applied in step 17 to allow the extraction of the first member of the second coordination which is \((\text{et (B demain (ira (à Rome))}) \text{ (B vendredi (ira (à Paris)})))\) of \(S\backslash N\) type and not \([à Rome demain] \text{ nor } [à Paris vendredi}\) as suggested by Beavers and Sag in Ref. 5. Steps 21 to 28 entail reducing combinators in order to construct the functional semantic interpretation.

Let us now discuss details of the structural reorganization of the expression \((\Phi \text{ et (B demain (C* (à Rome))) (B vendredi (C* (à Paris))) (B (C* Jean) ira)})\).

Each step presents an applicative expression with a combinator equivalent to that of the preceding one. Each step involves the elimination (2 to 10) or the introduction (11 to 14) of a combinator.

So far we have presented only examples of coordination of elements having the same function. Let us now consider sentences like : \(\text{Pat est [un républicain]/N et }\)
fier de l’être | N \ N. The rules which follow make it possible to generalize categorial analysis and apply it to the coordination of elements of different functions.

Coordination rules

<table>
<thead>
<tr>
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<th>Non-distributive coordination</th>
</tr>
</thead>
<tbody>
<tr>
<td>(&lt; CONJD &gt;)</td>
<td>(&lt; CONJN &gt;)</td>
</tr>
<tr>
<td>[(XvY) : (Φ et u1u2)]</td>
<td>[(XvY) : (et u1u2)]</td>
</tr>
</tbody>
</table>

These two rules retain the properties of the two preceding ones, because the type of coordination of two elements of the same categorial type X, would be (X v X) in other words X. Let us look at the broad analysis of the counterexample of Sag.

Pat est un républicain et fier de l’être

1. \[N : Pat\]-\[((S/N)/(N/N)) v ((S/N)/(N/N))\] : est]-[N : (un républicain)]-\[CONJD : et]-[N : (fier de l’être)]
2. \[N : Pat\]-\[((S/N)/(N/N)) v ((S/N)/(N/N))\] : est]-\[CONJN : et]-\[N : (fier de l’être)]
   
3. ... \[((S/N)/(S/N)) : (C* (un républicain))\]-[CONJD : et]-... (<T)
4. ... \[((S/N)/(S/N)) : (C* (un républicain))\]-[CONJN : et]-... (<T)
5. ... \[((S/N)/(S/N)) : (C* (un républicain))\]-[CONJD : et]-... (<)
6. \[N : Pat\]-\[S : ((Φ et (C* (un républicain)) (C* (fier de l’être))) est]\] <
7. \[S : ((Φ et (C* (un républicain)) (C* (fier de l’être))) est) Pat]\] <
8. \[((Φ et (C* (un républicain)) (C* (fier de l’être))) est) Pat]\] <
9. \[((et ((C* (un républicain)) est) ((C* (fier de l’être)) est)) Pat)\] Φ
10. \[((et (est (un républicain)) ((C* (fier de l’être)) est) Pat)\] C*
11. \[((et (est (un républicain)) (est (fier de l’être))) est) Pat\] C*

It is worth noting that in the expression obtained in step (11) the conjunction of coordination et connects the two members est un républicain (is a republican) and est fier de l’être (is proud of it) which both function as intransitive verbs. As a result, even if at the phenotypical observable level coordination seems to connect two members of different functions and of different natures, with its subjacent applicative structure at the genotype level, coordination is restored to its general form which consists in connecting two members of the same function.

On the other hand, as can be observed, ACCG gives can account for this type of coordination. We must point out, nevertheless, that it is very important to monitor the addition of the operator v and to study its impact. For example an implicit rule
was essential to our formalism (see step 5):

\[(X \setminus Y) \lor (X \setminus Z) \iff X \setminus (Y \lor Z).\]

Finally, according to the diversity of the languages involved, it is necessary to study possible hierarchy between the two categories X and Y.

4. Conclusion

We have just shown that, from a theoretical point of view, Categorial Grammars, especially Applicative Combinatory Categorial Grammar with its use of Combinatory Logic, is a formalism that is not only very coherent but also very solid and efficient. Although it provides broad coverage, it does not require a specific rule for each form of coordination. The addition of the two new coordination rules (which are a generalization of the old ones) makes it possible to deal with the French translation of Sag’s counterexample.

From a practical point of view, the software, that we developed, analyzes not only the examples which we have presented in this paper, but also other examples that cover other forms of coordination. Many of these examples appear in Ref. 9.

Of particular significance is the fact that the model of Applicative and Combinatory Categorial Grammar is very flexible and very efficient. With a limited number of rules, it is possible to cover a spectrum of different statements using coordination. These results confirm our findings resulting from the analysis of French subordination in Refs. 18 and 19. Indeed, it would appear that the coordination (as in the case of subordination) is introduced by an operator which introduces coordination. We can consequently claim that Categorial Grammars in their applicative combinatory version enable a functional analysis of the markers such as *et, que, qui*, etc.

Acknowledgments

This research was supported by the Natural Sciences and Engineering Research Council of Canada (NSERC).

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