Non-constituent coordination and other coordinative constructions as Dependency Graphs

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Abstract

This paper proposes a new dependency-based analysis of coordination that generalizes over existing analyses by combining symmetrical and asymmetrical analyses of coordination into a DAG structure. The new joint structure is shown to be theoretically grounded in the notion of connections between words just as the formal definition of other types of dependencies. Beside formalizations of shared dependents (including right-node raising), paradigmatic adverbs, and embedded coordinations, a completely new formalization of non-constituent coordination is proposed.

1 Introduction

Coordination is a special case of paradigmatic phenomena which extend to reformulation and disfluency. A *paradigmatic phenomenon* occurs when a segment Y of an utterance fills the same syntactic position as X.[1] For example in (1) to (3), *apply to* offers a position that has been conjointly taken by several nouns, called the *conjuncts*.

(1) A similar technique is almost impossible to apply to **cotton**, **soybeans** and **rice**.
(2) A similar technique is almost impossible to apply to **cotton**, uh **high quality cotton**.
(3) A similar technique is almost impossible to apply to **cotton**, (or) maybe **linen**.

Sentence (1) is an example of a coordination, (2) of a reformulation, (3) is an intermediate case on the continuum between the two as shown in Blanche-Benveniste et al. (1984). We consider

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[1] The term *paradigmatic* is commonly used to denote a set of elements that are of the same paradigm because they can replace one another. We prefer this term to *paratactic* used by Popel et al. (2013) following Tesnière 1959 chap. 133 who opposes *hypotaxis* (= *subordination* in modern terms) and *parataxis* (= *coordination*) because today *paratactic* commonly refers to cases of coordination without conjunction (= *juxtaposition*).

that a formalization of coordination must be extensible to other paradigmatic phenomena in particular to cases where two elements occupy the same syntactic position without being connected by subordinating conjunctions (Gerdes & Kahane 2009). The conjuncts of such paradigmatic structures form the layers of a *paradigmatic pile* whose dependency structure will be laid out in this article.

This article proposes and justifies a new, comparably complex, dependency analysis of coordination and other paradigmatic phenomena that goes beyond the commonly assumed tree structure of dependency. We are concerned with the formal and linguistic well-foundedness of the syntactic analysis and each node and each link of the syntactic structure should be motivated exclusively and falsifiably by syntactic criteria. The goal is not to provide a minimal and computationally simple structure that simply expresses the necessary semantic distinctions. We believe that theoretical coherence of the analysis is always an advantage, including for machine learning.

In section 2, we recap the difficulties of representing coordination in dependency and other frameworks. Section 3 exposes the notions and criteria at the basis of our new analysis. Section 4 is dedicated to simple coordinations, Section 5 to shared dependents (including right-node raising), Section 6 to non-constituent coordination. We then turn to paradigmatic adverbs in Section 7 and embedded coordination in 8. Before concluding we show cases of coordinations that are not paradigmatic phenomena in Section 9.

2 Coordination and dependency

It is a well known fact that function, rather than constituent type are relevant for coordinative constraints.[2] We will provide further evidence for

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[2] *He is an architect and proud of it* is explained by the shared predicate dependency rather than the

the adequateness of dependency rather than phrase structure for the description of coordination.

Nevertheless, dependency grammars (just as other syntactic theories, including categorial and phrase structure) are "head-driven" in the sense that syntax is mainly considered as the analysis of government.[3] However, paradigmatic phenomena are by definition orthogonal to government structures and their integration into dependency structures is up for debate because commonly, dependencies express head-daughter relations.

Existing dependency annotation schemes differ widely on the analysis of paradigmatic phenomena, thus reflecting important underlying syntactic choices, which often remain implicit. Ivanova et al. (2012), while comparing different dependency schemes, note that "the analysis of coordination represents a well-known area of differences" and even on a simple example like *cotton, soybeans and rice*, "none of the formats agree."

The high frequency of paradigmatic phenomena also implies that the choice of their syntactic analysis has important ramifications on the structure as a whole: Dependency distance and government-dependent relations both vary significantly with the type of representation given to paradigmatic phenomena, see Popel et al. (2013) for measures on the impact of the choices for coordination.

Syntactic analyses of coordination can generally be divided into two families of symmetrical and asymmetrical analyses (and mixed forms can be placed on a scale between these two families). *Symmetrical analyses* aim to give equal status to each conjunct. *Asymmetrical analyses* on the contrary give a special status to one, commonly

the first, of the conjuncts, and iteratively place the other conjuncts below the special one.

A symmetrical analysis (Tesnière 1959, Jackendoff 1977, Hajič et al. 1999:222) constitutes a higher abstraction from the surface because the tree structure is independent of linear order of the conjuncts. However, placing the conjuncts on an equal level poses the problem of choice of the governor among the different participants in the coordination.[4]

Some work on coordination in dependency grammar, while showing the usefulness of dependency trees for the expression of the constraints, never actually propose a dependency structure for the coordination itself (Hudson 1988, Osborne 2006, 2008). Some even argue against any kind of dependency analysis of coordination on the basis that it is a different phenomenon altogether: "The only alternative to dependency analysis which is worth considering is one in terms of constituent structure, in which the conjuncts and the conjunction are PARTS of the whole coordinate structure." (Hudson 1988)

An asymmetrical analysis, in its Mel'čukian variant (Mel'čuk 1988, used in CoNLL 2008, Surdeanu et al. 2008) and in its Stanfordian variant (de Marneffe & Manning 2008), on the contrary, represents better the surface configuration: The coordinating conjunction usually forms a syntactic unit (cf. Section 3) with the following phrase (*and rice* in the above example) and only an asymmetrical analysis contains this segment as a subtree.

X-bar type phrase structures just as dependency annotations that only allow trees, therefore excluding multiple governors for the same node, have to make a choice between a symmetrical and an asymmetrical analysis. Some annotation schemes, however, do not want to make this choice. The notion of "weak head", introduced

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common constituent type of *an architect* and *proud of it*.

[3] We call *government* the property of words to impose constraints on other words, which can be constraints on their nature (e.g. their part of speech), their morphological and syntactic markers, or their topological (linear) position. For example, in English, a verb imposes on its direct object to be a noun phrase (or, if verbal, to be transferred into the infinitive form, Tesnière 1959), to carry the oblique case in case of pronouns, and to take a position behind the verb. A word, called *governor*, offers a syntactic position for each series of constraints it can impose on other words.

[4] Under the condition that the resulting structure has to be a dependency tree, the coordinative conjunction is the only possible choice of governor. Some treebanks (Hajič et al. 1999) then go as far as using punctuation like commas as tokens that head a conjunction-less paradigmatic structure. We consider that punctuation plays a role in transcribing prosodic breaks, but certainly does not correspond to a syntactic unit and is therefore not part of the syntactic structure.

If the tree structure condition is relaxed the result can combine the conjuncts as co-heads (Tesnière 1959, Kahane 1997).

by Tseng 2002 and put forward by Abeillé 2003, to designate coordinating conjunctions, for example *and*, implies selective feature sharing between the other conjuncts and e.g. *and* as well as *rice*. Recent work by Chomsky (2013) equally assumes "that although C [the conjunction] is not a possible label [of the resulting coordinated structure], it must still be visible for determining the structure." A result, of course, is a more general "weakening" of the notion of "head" as a whole, while dodging the underlying central question about the limits of head-driven syntax.

3   Criteria for syntactic structures

In order to justify our choices of representation, it is necessary to recall the basic objectives of any syntactic structure.

Firstly, syntactic structures indicate how different words of the sentence combine. Government is one mode of combination, but not the only one – dependencies do not always correspond to government. In the case of a pile, an element Y takes the same position as an element X that precedes. Even if the two conjuncts X and Y are in a paradigmatic relation (they can commute and each conjunct alone can occupy the position), they are in a syntagmatric relation: they combine into a new unit, which must be encoded by a dependency.

Secondly, the syntactic representation is intermediate between meaning and sound. The syntactic representation thus has to allow us to compute on one hand, the semantic representation including the predicate-argument relations between lexical meanings, and on the other hand, the topological constituents observed on the surface (Gerdes & Kahane 2001).

Thirdly, the representation constrains the possible combinations of the words: A certain number of combinations are eliminated by the impossibility to associate them with a phonological or semantic representation , but equally the impossibility to associate a syntactic structure to an utterance constitutes a strong filter on the allowed combinations (from a generative point of view, this is even the primary filter). Consequently, a good syntactic representation has to be sufficiently constrained so that most badly formed utterances cannot obtain a syntactic representation (while, of course, all well-formed utterances have to obtain a syntactic representation). Recall that we propose a performance grammar and

from our point of view, disfluent utterances (such as (2)) are considered well-formed. Our syntactic representation is also designed for the extraction of a grammar that holds constraints on each type of dependencies: Constraints on the orientation of the dependency (head-initial or head-final), constraints on the POS of the governor and of the dependent including sub-categorization constraints attached to the governor of the dependency relation (e.g. the constraint that a dependent object can only depend on a transitive verb). This set of constraints has to allow telling ungrammatical from well-formed utterances.

We will adopt the following principles. We consider that any part of a sentence that can stand alone with the same meaning is a *syntactic unit*. As soon as a syntactic unit can be fragmented into two units X and Y, we consider that there is a *syntactic connection* between X and Y (Gerdes & Kahane 2011). *Syntactic dependencies* are oriented connections linking a *head* with its *dependent*. The notation X → Y means that Y depends on X. Note that we distinguish the terms *head* and *governor*: if Y depends on X, then X is the governor of Y and X is the head of the unit XY. So the head of a unit U belongs to U, while the governor of U is an element outside U and connected with U.

4   Syntactic structure of coordination

In a coordination like *onions and rice*, the segment *and rice* forms a syntactic unit, because it can stand alone:

(4)   I want onions. And rice.
(5)   Spk1: I want onions. Spk2: And rice?

This data implies that *and* and *rice* are connected by a dependency. We can contrast this with *onions and*, which cannot stand alone. In other words, coordination is syntactically asymmetrical.

The choice of the head of the phrase *and rice* is not trivial. For instance Mazziota (2011) argues that in Old French the junctor[5] is optional,

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5   Junctor is a more general term than "coordinating conjunction", introduced by Blanche-Benveniste et al. (1990) and Ndiaye (1989), as a variant of the term "jonctif" used by Tesnière (1959). Cf. also the term "pile marker" used by Gerdes & Kahane (2009). We prefer to avoid the term *coordinating conjunction* because junctors can also appear in paradigmatic piles other than coordination, like Fr. *c'est-à-dire* 'that is'.

which is a good argument in favor of *and* as a dependent of the conjunct. Equally, the Stanford Dependency scheme (SD, de Marneffe & Manning 2008) and subsequently the Universal Dependency Treebank (McDonald et al. 2013) describe junctors as adjuncts. Nevertheless, generally, a phrase like *and rice* does not have the same distribution as *rice*, which is sufficient to consider that *and* controls the distribution of the phrase and is a head. But the distribution of the phrase depends also on the conjunct: *and rice* can combine with a noun (*onions and rice*) but it cannot combine with a verb (**Peter eats and rice*). This means that both elements bear head features (see the notion of *weak head* in section 2). In a dependency-based analysis this means that both elements should be linked to the governor of the phrase, which is not possible in a standard dependency analysis using a tree structure.

We will slightly relax the tree constraints and consider two kinds of dependencies: *pure* (or primary) *dependencies* and *secondary dependencies*. We adopt the following principles:

- Principle 1: There is exactly one pure dependency between two units that combine.

- Principle 2: As soon as X combines with Y and a subset A of Y controls the combination of X and Y, there is a dependency between X and A.

In consequence, if Y = AB and both A and B control the combination of X and Y, there will be either a pure dependency between X and A and a secondary dependency between X and B or the reverse. As A and B are also connected, the structure is no longer necessarily a tree but a DAG.

We apply our principles with X = *onions*, A = *and*, and B = *rice*. As the junctor *and* can be absent (*onions, rice, beans …; onions, maybe rice*), we consider that B is the main head of AB and postulate a pure dependency between the two conjuncts, that we call a *paradigmatic link*. This link is doubled by a secondary link between *onions* and *and*, which is the secondary head of *and rice*. The secondary status of this link is also justified by the fact that *onions and* is not a syntactic unit. We call such a link a *bequeather*.

As *and* and *rice* are co-heads of *and rice*, we do not have clear arguments to decide which one governs the other. As soon as we suppress one of the two dependencies between *onions* and *and rice* and favor one of the two co-heads, the link

is automatically oriented and we either obtain the Mel'čukian analysis (*onions → and → rice*) or Mazziotta's analysis (*onions → rice → and*). As *rice* is the semantic argument of *and* and an obligatory complement of *and*, we decide to treat *rice* as the dependent of *and*.

Let us now consider the combination between the pile and its governor:

(6) I want onions and rice.

We remark that both conjuncts can form a unit with *want*, the governor of the pile (*I want onions*; *I want rice*). This allows us to postulate that both conjuncts have head features which licenses a connection with the governor. We consider that the first conjunct opens the potential connection with the governor and is the main head. Consequently, *onions* receives a pure (object) dependency from *want*, while *rice* receives a secondary dependency, which we call an *inherited dependency* (Fig. 1).
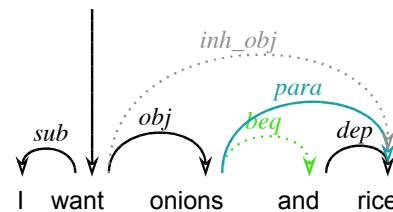

Figure 1: Analysis of a simple coordination

Secondary dependencies, represented by dotted arrows, double pure dependencies, but while a bequeather link anticipates a pure dependency, an inherited link is inherited from a pure dependency (Fig. 2).
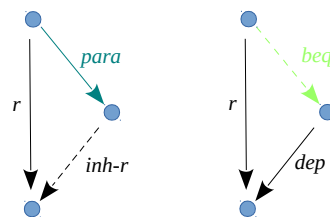

Figure 2: Two types of secondary dependencies

5 Shared dependent (including Right Node Raising)

A pile can have syntactic dependents shared by several conjuncts. In (7), *Peter* and *houses* are shared by the conjuncts *buys* and *sells* (Fig. 3).

(7) Peter buys and sells houses.

In dependency grammar, the subject and the object are encoded in a completely symmetrical way. For Generative Grammarians, the stipula-

tion of a VP makes the case of *houses* particularly complicated, a configuration which is known as "Right Node Raising" (Postal 1974).[6]
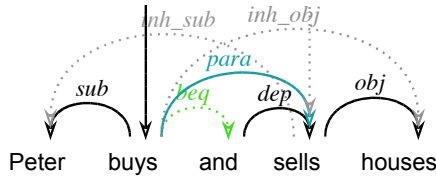

Figure 3: Shared dependents

Sharing cannot be easily modeled by a dependency tree.[7] Mel'cuk (2015:vol. 3, 493) considers different solutions for distinguishing individual from shared dependents and settles finally for "groupings" where the nodes involved in the conjunction are grouped together excluding the shared dependent: old←[men→and→women]. Tesnière (1959: ch. 143-145) analyzes sharing by multiple heads, as we propose: A dependent shared by several conjuncts is governed by each of them. We modify this analysis by considering that only one of these dependencies is a pure dependency. We consider that the shared dependent is above all the dependent of the nearest conjunct, because they can form a prosodic unit together. The dependency between a conjunct and a shared dependent is inherited by the other conjuncts and we annotate that by an inherited dependency, which allows us to disambiguate cases like (8). In both cases, *old* is a dependent of *men*,
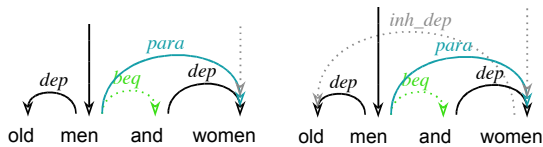

Figure 4: Optionally shared dependent

but the relation is optionally inherited by *women* (Fig. 4).

(8) old men and women

This encoding, following the asymmetrical analysis of coordination, allows us to compute the desired syntactic and prosodic units. Each word that is governed both by a pure dependency and an inherited dependency is a shared dependent. Each conjunct is the projection of the word linked by the paradigmatic links with the exclusion of shared dependents and the pile is the projection of the first conjunct without the shared dependents. We thus obtain the units:

> a. ((old men) and (women))
> b. old ((men) and (women))

No satisfying phrase structure representation exists for piles where the shared dependent does not modify the head of each conjunct, as for example in (9):

(9) Congratulations to Miss Fisher and to Miss Howell who are both marrying their fiancés this summer. (*www.st-peters.kent.sch.uk*)
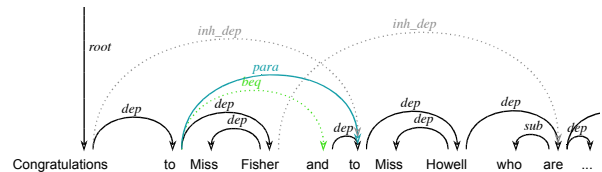

Figure 5: Shared dependent of a non-head

Here, the PPs *to Miss Fisher* and *to Miss Howell* are coordinated but only the NPs *Miss Fisher* and *Miss Howell* are modified by the relative phrase. The analysis of this example is unproblematic in our annotation scheme.

Following our principles, we have only one pure dependency between *to Miss Fisher* and *to Miss Howell*, which is a paradigmatic link between the heads of the two PPs, that is, the two *to*. We introduce a *lateral paradigmatic link*, which is a secondary dependency, between *Fisher* and *Howell*, because they share a dependent (the relative clause).[8] This link is justified for two reasons: First, we think that the piling of

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[6] In English, there is nevertheless an asymmetry since the left sharing (***Peter buys buildings and sells apartments***) is better than simultaneous right and left sharing (as in (7)) which again is easier than only right sharing ([?]*Peter sells and Mary buys **houses***) These preferences can be taken into account without postulating a VP, by penalizing right sharing without left sharing.

[7] Sharing can be represented in a symmetrical analysis (Hajič et al. 1999) by placing the shared dependent as a dependent of the junctor, which itself is the head of the conjuncts. Not only do we reject the symmetric analysis and the junctor as the head (in particular because a paradigmatic pile does not need a junctor), but also a link between the junctor and the shared dependent violates our principles, since these two elements do not combine to form a syntactic unit.

[8] Lateral dependencies are a third case of secondary dependencies. While an inherited dependency doubles a pure dependency with the same governor and a bequeather, a pure dependency with the same dependent, a lateral dependency doubles a pure dependency more or less parallelly. It only occurs if at least one of the elements sharing a common dependent is a non-trivial nucleus (i.e. it has more than one node).

two units is supported by parallelism and that the elements of a pile tend to forge secondary lateral links. Second, the lateral link allows us to separately state the following constraints (Fig. 6):

- Constraint 1: Governors of a shared dependent must be linked by a (eventually lateral) paradigmatic link.

- Constraint 2: Each lateral paradigmatic link has a corresponding plain paradigmatic link, and the chains from the plain to the lateral paradigmatic link form nuclei.
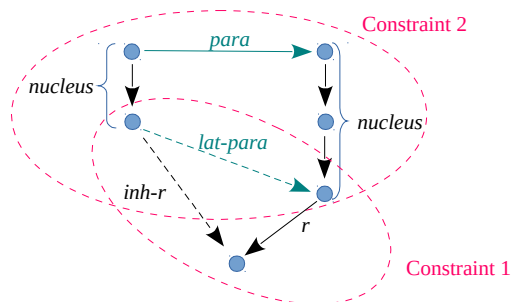

Figure 6: Configuration of shared dependents

Nuclei have been introduced in Kahane (1997, see also Osborne 2008 who calls them predicate chains). A *verbal nucleus* is a chain of words that behaves like a single verb in some constructions, such as extraction or coordination. A link in a verbal nucleus can be a complex verbal form (*is talking*), but also V-Vinf (*can talk*), V-*to*-Vinf (*want to talk*), V-Adj (*is easy*), V-N, especially in light verb constructions (*have the right*), and even V-*that*-V (*think that X talks*). A governed preposition can also form a nucleus with its governor in languages allowing preposition stranding like English (*talk to*, but not *parler à* in French, see footnote 12). A *nominal nucleus* is a chain of nouns and prepositions. A link in a nominal nucleus can be Prep-N (*to Miss Fisher*) or N-Prep-N (*the end of the movie*).

In example (10) (Osborne 2006), *admire* is conjunct of the nucleus *think → that → distrust* and the lateral paradigmatic link between *admire* and *distrusts* validates the sharing of the object *this politician*.

(10) [Some people admire], but [I think that many more people distrust] this politician

Constraint 2 excludes cases where the "path" between the head of a conjunct and a shared dependent is not a nucleus like in ???*Peter* (*plays on*

and knows the guy who owns) *this piano* (*knows → guy → who → owns* is not a nucleus).[9]

6 Non-constituent coordination

Non-constituent coordination (NCC) can be illustrated by:

(11) Peter went to *Paris yesterday* and *London today*.

This construction is problematic for constituency-based formalisms, as well as dependency-based ones, because there is only one coordination with a unique junctor (*and*) involving two phrases with two different syntactic functions, *Paris* and *yesterday*. But while it is questionable to consider that *Paris* and *yesterday* form a syntactic unit together, it is difficult not to consider that *London* and *today* form one, because the latter words can stand alone (with the junctor):

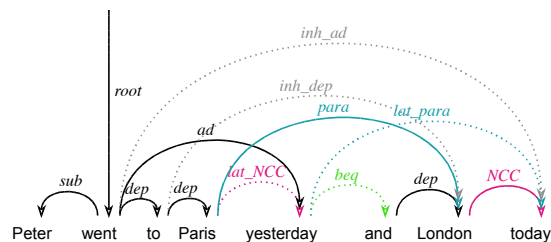(12) Peter went to Paris yesterday. And London today.

Figure 7: Non-constituent coordination

We thus consider that there is a pure dependency between *London* and *today* we call a NCC dependency. The two elements linked by a NCC dependency pile on two independent elements, here *Paris* and *yesterday*, which supposes that we have two lateral piles (Gerdes and Kahane 2009). But following our principles, we postulate only one pure dependency between *went to Paris yesterday* and *London today*, which means that we have a standard paradigmatic link between *Paris* and *London* and a lateral paradigmatic link between *yesterday* and *today*. The junctor is analyzed as a marker of the main paradigmatic link, which give us the structure of Fig. 7.

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9 RNR is rather common in reformulations, which are also paradigmatic piles. In (i) *is* is reformulated in *may appear*, which is a nucleus:

(i) { what I'm saying here is | what I'm saying here may appear } very pessimistic (translation from the Rhapsodie treebank)

We analyze (i) with a main paradigmatic link between *is* and *may* and a lateral paradigmatic link between *is* and *appear*.

We also introduce a lateral NCC dependency between *Paris* and *yesterday*. This secondary link is justified 1) by the fact that *Paris yesterday* tend to receive a prosodic shape similar to *London today*, which are linked by a NCC dependency,[10] and 2) because it allows us to express the constraints on the introduction of a NCC dependency in two steps (Fig. 8):

- Constraint 1: A NCC dependency between X' and Y' is only possible if there is a configuration with X –para→X', Y –lat-para→Y', and X –lat-NCC→X'.

- Constraint 2: X and Y can be linked by a lat-NCC dependency only if they depend on the same nucleus.[11]
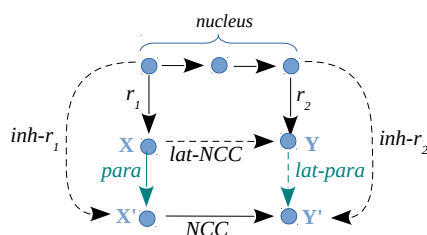

Figure 8: Configuration of NCC: X X' and Y Y' e.g. giving X to Y and X' to Y'

Constraint 2 is verified in our example, because *went to* is a verbal nucleus.[12] The following examples from Sailor and Thoms (2013) confirm that the governor must be a nucleus :

(13) a. I claimed that I was a spy to impress John and an astronaut to impress Bill
b. * I taught the guy that knows Icelandic how to dance and Faroese how to sing.

c. The witness will testify to whether John knew Icelandic tomorrow and whether he knew Faroese next week.
d. * The witness will testify to whether John knew Icelandic tomorrow and he knew Faroese next week.

In a, the governor is the nucleus *claimed → that → was*, and in b, the nucleus *will → testify → to → whether → knew*. Conversely, *taught → guy → that → knows* in b is not a nucleus due to the link *guy → that*, nor *will → testify → to → whether* in d, because a complementizer like *whether* can only be part of a nucleus with the verb it complementizes (as in c).

In the same vein, the case of gapping as in (14) can be described as a special case of NCC with two lateral piles (*Peter → Mary* and *firemen → police*) and a NCC dependency between *Mary* and *police*.

(14) Peter wants us to call the firemen and Mary the police.

The constraints are similar and (14) is possible because *Peter* and *firemen* depends on the same verbal nucleus *wants → to → call*. We see on this example that some elements of the nucleus can have dependents that are not involved in the piling (here *us*).[13] The same property holds with the object *a book* in the next example:

(15) Peter gave a book to John and Mary to Ann.

7 Junctors and paradigmatic adverbs

Next to the conjuncts, a pile can contain two kinds of elements we want to distinguish:

- *Junctors* are the elements that connect the conjuncts of a pile. Junctors have a role only inside the pile, i.e. if we only conserve one layer of a pile, junctors cannot be maintained:

(16) All I can remember is black beans, onions, **and maybe rice**. (source: web)
(17) *All I can remember is **and** rice.

- *Paradigmatic adverbs* (Nølke 1983, Masini & Pietrandrea 2010), on the contrary, can be maintained:

(18) All I can remember is **maybe** rice.

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10 The placement of double junctors like *either ... or* shows that the coordination is indeed between the "non-constituents" (Sag et al. 1985):
(i) Il donnera soit le disque à Susanne, soit le livre à Marie 'He will give either the disk to Susanne or the book to Mary'

11 Bruening (2015) postulates that the governor of the two lateral piles (here *went to*) is a prosodic unit. We agree but go further, considering that such a segment is actually a syntactic unit, even if it is not a constituent. Kahane (1997) proposed to explicitly introduce this unit, the nucleus, in the syntactic structure by way of bubbles.

12 Note that the same construction is not possible in French, which does not accept preposition stranding:
(i) a. Pierre était à Paris hier et à Londres aujourd'hui.
b. ??Pierre était à Paris hier et Londres aujourd'hui.

13 As opposed to that, conjuncts involved in NCC cannot share a dependent, see Osborne (2006):
(i) * Susan repairs old [bicycles in winter] and [cars in summer]

Traditionally, in a sentence like (18), the adverb *maybe* is analyzed, as any common adverb, as a modifier of the verb (is → maybe), but in (16) the layer *and maybe rice* clearly forms a phrase (it can be uttered alone for instance). In fact we think that *maybe rice* forms a phrase even in (18). Paradigmatic adverbs clearly have scope over one particular element of the sentence:

(19) a. Peter will maybe give the book to Mary (unless he will only lend it)
b. Peter will give maybe the book to Mary (or maybe something else)
c. Peter will give the book maybe to Mary (or maybe to another person)

In a sentence like c, *maybe to Mary* forms a semantic and a prosodic unit, which suggest a link between the adverb and the following phrase.[14] We stipulate that such adverbs always take a phrase as argument, even if no overt second conjunct is present. Thus, the types of syntactic relations of *maybe* in (16), (18), and (19) are identical and very different from *quickly* in (20).

(20) Peter will quickly give the book to Mary.

We conclude that *maybe* and *rice* are connected in (16) and (18). Moreover, they both have head features: If the distribution of *maybe rice* is similar to the distribution of *rice*, it is nevertheless restricted by *maybe* (for instance *maybe rice* cannot be the complement of a preposition: **She spoke about maybe rice*). As for the junctor, we decide that *rice* is the dependent of *maybe* and that the dependency from the governor of *maybe rice* (here *and*) is attributed to *rice* and doubled by a bequeather link to *maybe*.
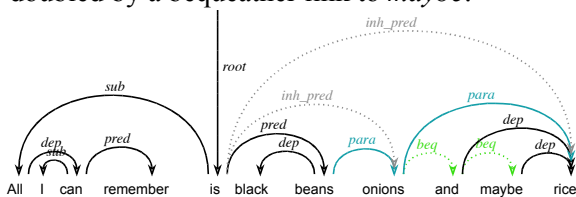
Figure 9: Paradigmatic adverbs

Even if junctors and paradigmatic adverbs have a similar representation, they restrict the distribution of their argument in a different way, which can be easily encoded by different constraints on a bequeather link governing one or the other.

[14] In a V2 language like German, *vielleicht der Maria* 'maybe to Mary' can go to the initial position, which identifies the combination of *vielleicht* and *der Maria* as a constituent.

8 Embedded Piles

It is well known that a tree-based asymmetrical dependency analysis of coordination cannot catch nested coordinations (cf. note 7). Consider a classical example like :

(21) We are looking for someone who speaks French and German or Italian.

Two interpretations are possible :

a. { French | and { German | or Italian } }
b. { { French | and German } | or Italian }

In our analysis, in both cases we have the third layer (*or Italian*) attached to the second layer (*and German*) : French → and → German → or → Italian.[15] But in case a, *Italian* inherits a dependency from *and* because it is coordinated with the dependent *German* of *and*, while in case b, *or Italian* is a shared dependent and *or* inherits a dependency from *French*, which is coordinated with *German*.
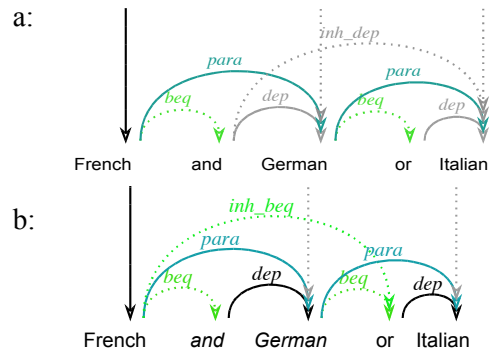
Figure 10: Embedded piles

Fig. 11 gives the two interpretations of (22) with their corresponding syntactic structures. At the semantic level, the junctor is the head of a coordination and takes the conjuncts as arguments (Mel'čuk 2015: vol. 1, 237). In the case of embedding, one junctor will be the argument of the other. We can see how the semantic dependency between the two junctors is distributed on the conjuncts at the syntactic level.

[15] Mel'čuk (1988) proposes, in case b, to attach *or Italian* to the head of the group *French and German*, that is to *French*. We disagree with this analysis because *or Italian* is a shared dependent of both *French* and *German*, and as usual it must be attached to the last conjunct it modifies, that is *German*. In any case, in the tree Mel'čuk obtains, *French* has two dependents : *German ← and ← French → or → Italian*. This tree is semantically ambiguous and correspond also to (*French or Italian*) *and German*, which is not at all equivalent to the b interpretation of our example.
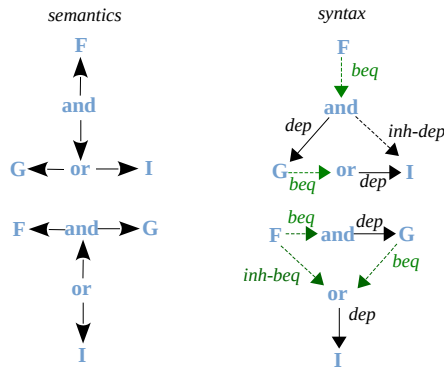
Figure 11: Semantics and syntax of embedded piles

9 Coordination without pile

Coordination is not always a paradigmatic phenomena piling two elements of the same kind.[16]
(22) Mary speaks English and well.
In cases like this, the second conjunct (*well*) does not hold the same syntactic position as the first conjunct (*Marys speaks English*). We consider that we have here a coordination between illocutionary units. In fact, the speaker makes two assertions in (22) (*Mary speaks English* and *She does it well*) in one dependency structure consisting of two illocutionary units. We model these coordinations without the use of ellipsis, only by distinguishing dependency structure spans and illocutionary units (Kahane et al. 2013). The junctor in (22) is analyzed as usual with a bequeather and a pure dependency between the junctor and the conjuncts (*speaks → and → well*). Yet, we do not consider this construction to be a pile and we analyze this sentence without paradigmatic or inherited links.

10 Conclusion

We have proposed a dependency grammar formalization of several cases of coordination, arguing for multiple governors, and thus a DAG structure. Two types of links are considered, primary and secondary links. The primary links induce a tree structure.[17] Three types of secondary links are considered: inherited, bequeather, and lateral dependencies, each of them corresponding to a different arrangement of primary links.

Following Gerdes & Kahane (2009), we argue for a paradigmatic link, which is present in all paradigmatic phenomena, involving junctors or not, ranging from simple coordination, over juxtapositions, to phenomena that are more typical for spoken language like disfluency and reformulation. Conversely, we have shown that junctors can be involved in non-paradagmatic phenomea (section 9).

We have proposed a completely new formalization of NCC. We consider that, although NCC involves two parallel paradigmatic piles filling two different syntactic positions, the second layer forms a syntactic unit. Such a unit can only be formed by the second layer of a coordination and cannot appear outside of a paradigmatic construction.[18]

We have also proposed a formalization of paradigmatic adverbs, a frequent sight in paradigmatic phenomena but rarely considered in the studies on coordination.

However, from a theoretical and practical point of view, it is important to note that we have a structure that is much more complex than a simple dependency tree. It remains to be shown that such a complex annotation scheme can be machine-learned and thus automatized. We think that doubling some links as we do allows distributing and relocalizing the constraints on smaller configurations, which could improve the model. Orféo, the ongoing follow-up project of Rhapsodie started in 2013, will have to answer that question as the new project attempts to realize these annotations on large amounts of spoken and written data.

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[16] In the Rhapsodie treebank (Kahane et al. 2013), a 33,000 word dependency treebank of spoken French we have a dozen of such examples such as:
(i) on veut bien parler avec vous mais après le déménagement 'we are willing to talk with you but after the moving'

[17] More precisely primary dependencies governed by a bequeather link must be inverted to obtain a tree.

[18] This includes so-called partial utterances:
(i) Spk1: I go to Paris on Monday.
Spk2: And London when?
We consider that the second speech turn is governed by the first one and we have here a typical NCC. The only specificity of this NCC is to be distributed on two illocutionary units. Such a description implies that we do not have to consider the second speech turn as an elliptic utterance. It is simply an utterance that pursues the syntactic construction of the previous utterance. Such continuations are very common in our corpus of spoken French.

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