

# **Syntactic alternations at the confluence of syntax and semantics : the case of natural language generation.**

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Syntactic alternations have been studied extensively for English (Levin 93), and to a much lesser extent, but often within the same philosophy, for German, Spanish, Italian, Catalan and French. An alternation, roughly, describes a change in the linguistic realization of the argument structure of a verb with respect to a postulated base form. An alternation is described at the lexical level, in contrast to grammatical phenomena such as left-extraposition, NP-movement, coordination, etc. which are viewed either as movements or as long distance dependencies. Modifiers as well as arguments are considered in alternations. Alternations involve argument deletion, argument movement, possibly with preposition change for PPs, and merging of an argument into another one. (Goldberg 94), in the Construction Grammar framework, establishes the principle of non-synonymy of grammatical forms : ‘a difference in syntactic form always spells a difference in meaning’. A major consequence of this statement is a revision of the principle of compositionality where the meaning of an expression depends not only on the meaning of its constituents but also on the syntactic form of the expression.

In this paper, we analyse three major aspects of alternations in the relation with the syntax-semantics interface which have an impact on natural language generation : (1) what are the semantic constraints on verbs that licence an alternation, and to what extent can they be predicted ? (2) what are the semantic aspects conveyed by alternations and how are they used to produce novel expressions ? (3) can alternations be used in metonymies or in metaphorical uses of verbs ? The examples studied here will be either in French or in English to have a wider coverage of phenomena. In a second stage, these considerations are applied to natural language generation. Syntactic alternations are of much importance in language generation at the level of aggregation and micro-planning for the choice of the predicate, and for the organization of the surface realization of its arguments, in relation with semantic aspects proper to alternations (e.g. focus, aspect, etc.). Alternations also contribute to make more explicit various phenomena such as generalizations, incorporation and constraints relaxation. Language generation requires a very accurate analysis of alternations in order to guarantee that the NL expressions are correct and that they accurately reflect the meaning conveyed at the ‘conceptual’ level.

## **1. Semantic constraints on alternations**

Let us consider a few examples that illustrate the type of meaning components that a verb must have to undergo a given alternation. This has been studied quite extensively by (Pinker 89), (Levin 93) and (Goldberg 94), among many others, for English. These components can be quite subtle to characterize.

The idea, with respect to natural language generation, is to show the type and form of restrictions imposed on arguments that allow an alternation to be used. Another major point is to identify

how and why an alternation can be used to introduce additional meaning in a proposition, meaning which, in particular, cannot be easily or concisely lexicalised. For example, as shall be seen below, some alternations allow for the introduction of an (unexpected) agent in anticausative constructions.

The dative alternation (which does not exist in French) applies to a number of transfer of possession verbs (*John hands the child a book*). Its basic meaning is : X CAUSE Y to HAVE Z focussing on the possession facet and the possessor, in contrast with the basic semantic template of transfer of possession verbs : X CAUSE Z to GO TO Y which rather focuses on the transfer itself, with a notion of movement in the possession domain (*John hands a book to the child*). This is clearly and unambiguously implemented in the Lexical Conceptual Structure (Jackendoff 90). From a number of observations, we can deduce that the dative alternation applies to verbs where the agent acts on a recipient or a destination in such a way that causes him to possess something. In contrast, verbs like *push*, where someone causes something to go to someone else do not undergo this alternation since the possession facet is not present or too weak. In French, the dative requires the preposition *à* whereas the latter case (push) required the preposition *vers*, which is fundamentally directional. The dative alternation can be transposed to other groups of verbs such as communication verbs, in *John asks Mary the book*, where the message uttered by John can metaphorically be viewed as an object given to Mary.

Another interesting alternation is the conative construction (characterized by the adjunction of *at* to the object NP in English). A quite large set of verbs undergo this alternation in English, and a much smaller number in French, where it is mainly introduced by the preposition *sur*, as in *Marie tire sur la chaise* (Mary pulls at the chair). This construction characterizes those actions which are attempted but not necessarily realized. In French, mainly pulling verbs, where a certain effort is required, undergo this alternation.

Finally, a number of intransitive verbs can be transformed into causative transitives, with the semi-auxiliary *faire* in French (Saint-Dizier 99), as in *le soleil fait fondre la glace* (the sun makes the ice melt). There are three main groups of verbs that undergo this alternation in French : (1) verbs describing an intrinsic change of state (*fondre, raccourcir, ouvrir, fermer, jaunir*, etc. (melt, shorten, open, close, yellow)), (2) verbs of motion with a certain manner (*glisser, rouler, flotter, atterrir, décoller*, etc. (slide, roll, float, land, take off)) and (3), contrary to English, verbs of internally caused actions (*boire, manger, chanter, courir*, etc. (drink, eat, sing, run)). In this latter case, the subject is in general an agent. The introduction of *faire* introduces a kind of initiative agent (following Dowty's terms), while the original subject undergoes the action, to a certain extent.

## 2. Semantics of alternations

As analysed in (Goldberg 94), alternations convey a semantic content by themselves. Contents can be quite diverse and may have a more or less important semantic impact on a proposition. For French, in (Saint-Dizier 99), we identify 51 different purely syntactic alternations ('purely' indicates, contrary to Beth Levin, that our alternations contain only syntactic criteria). Some are widely used, like passive, whereas others have very restricted uses, such as the use of the impersonal pronoun *il* whose goal is to weaken the agentive character of the subject.

In addition to the cases studied in the previous section, let us consider here a few more alternations which have various types of semantic impact on the proposition. The passive construction introduces a change in focus. The object gets the focus, whereas the agent, if present, is in the background : *the apple is eaten by John* focuses on what happens to the apple. A number of passives can be agentless : *the apple is eaten* focussing then on the resulting state. The deletion of the direct object argument in transitive constructions has an impact on aspect since it introduces an ability or a habit, as in *John eats*.

If we consider again the last example of the previous section, intransitive verbs transformed into causative transitives introduce a causality, which can be represented as follows :

X CAUSE Y to 'ORIGINAL VERB'(Y) (e.g.: *the pilot CAUSE the plane to LAND(plane)*)

We also have the opposite situation where the cause is removed because it cannot be clearly identified or because it is too weak. In that case, focus is rather on the resulting state or possibly on the process at stake. This is e.g. the case for a variety of inchoative forms. For example, verbs such as *basculer, cadrer, dériver, bourrer, remplir*, etc. in constructions such as :

*Jean bascule le meuble sur le sol* → *Le meuble bascule sur le sol*

or *Jean remplit la cruche d'eau* → *L'eau remplit la cruche.* (Water fills in the jug)

In this case, the original form of the verb which is :

X CAUSE Y TO Pred(Y,Z) becomes Pred(Y,Z),

e.g. John CAUSE the jug TO FILL-IN(water, jug) becomes FILL-IN(water, jug).

The semantics of an alternation can complement the semantics of a verb; it can also range over it or override it. For example, verbs not supposed to undergo an alternation may be 'incorporated' into an alternation, then, the meaning it conveys occurs within the alternation semantics, without altering it. A well-known example is : *Edith baked John a cake* where the meaning of *bake* is embedded into the alternation semantics, indicating that *Edith causes John to have a cake, that she baked (for him)*. In French, we have cases such as : *Edith autorise un bonbon à chaque enfant* (Edith permits a sweet to every children) which equally combines the semantics of *autoriser* (permit) with the semantics of the dative construction (= allow a transfer of possession).

### 3. Alternations and metonymies and metaphors

Alternations are sensitive to metaphors and metonymies. These two phenomena abound in language, and they must be taken seriously into account even in simple applications. While a number of alternations can be used in various ontological domains (if this is a definition for metaphors), others are blocked. For example, an utterance such as : *John begins a book* is a perfectly acceptable metonymy (from, e.g. *John begins reading a book*), but *\*a book begins* is ruled out, probably due to aspectual constraints (while the full form is acceptable: *the reading of a book begins*).

We also observe inverse situations where a metaphorical use can undergo a certain alternation which is ruled out in direct uses. For example, let us consider the passive construction applied to movement verbs such as *reculer, repousser* while :

*Jean recule/repousse la chaise* is acceptable (John pushes back the chair),

*\*la chaise est reculée/repoussée par Jean* is not.

However, an utterance such as *les limites de la science sont reculées/repoussées par la recherche*

is perfectly acceptable (literally: the limits of science are ‘pushed back’ by research). So far, we do not see any clear explanation or any relatively systematic way to predict when metonymies and metaphors, even very regular ones, are ruled out by alternations. At this level, our strategy is to encode in the lexicon the different uses of verbs, either direct or metaphorical.

#### 4. The syntax-semantics interface in natural language generation

In a large majority of parsing systems, alternations are parsed via different approaches, among which : lexical redundancy rules, dedicated TAGs, meta-rules, etc. In general, little control is made on the acceptability of alternations (same e.g. for morphology) and the semantics they convey is seldom taken into account, except, possibly, when parsing questions.

This is not the case for natural language generation where constructions (and agreement) must be treated in great detail. In spite of its interest and major importance, very little work has been done in this area (REFS). The syntax-semantics interface in natural language generation is treated by at least three main functions, which are, by large, intertwined :

- **lexicalisation** : choice of an appropriate lexical item, of the appropriate syntactic category, for example a predicative form or a relation in the input semantic representation of a generation system can be lexicalised as a verb, a predicative noun or a preposition,
- **aggregation** : production of NPs, PPs, propositions in basic form, noun complements, etc., and
- **micro-planning** : integration of alternations and of various grammatical devices such as coordination and references.

Let us now show the prominent role played by these functions in close cooperation with alternations for the generation of cooperative responses. Examples from WEBCOOP, extracted mainly from FAQ and forums questions, are studied in more depth. We first outline the importance of aggregation in NP realization and then show how this combines with alternations.

##### 4.1 The different forms of aggregation and lexicalisation

Let us assume that the starting point of the generation process is a simple logical form, which is a logical implementation of a simplified version of the Lexical Conceptual Structure (LCS hereafter). The formula :  $\text{chalet}(X) \wedge \text{person}(Y) \wedge \text{capacity}(X, N) \wedge N \leq 10$  can be expressed in natural language (in French) by various forms, among which :

1. *La capacité d'un chalet est inférieure à 10 personnes.*
2. *La capacité maximum d'un chalet est de 10 personnes.*
3. *Un chalet a une capacité inférieure à 10 personnes.*
4. *Un chalet (accueille / contient) (au maximum / moins de) 10 personnes.*

The predicates in the formula are considered as concepts. In the language realizations, note that focus is different for each proposition, that two terms are used to express the operator  $\leq$  : *maximum* or *inférieure à*, and that the concept ‘capacity’ can be expressed by a noun or a verb (e.g. *accueillir*, *contenir*). These examples are 4 schematic natural language patterns of the above formula. They involve different lexicalisations and argument organizations, and result in a slightly different global meanings. Between [ ] is the focus, object is *chalet*, relation is  $\leq$  and value is 10, between quotes are predefined NL terms :

1. [ property ] 'de' object relation value.
2. [ property + inverse relation ] 'de' object 'est de' value.
3. [ object ] 'a' property relation value.
4. [ object ] lexicalisation as verb(property) inverse relation / relation value.

Note that the difference between 3 and 4 is mainly a different lexicalisation of the property, which then entails a different argument realization.

#### 4.2 *Aggregation and lexicalisation in interaction with alternations*

If we now consider alternations, such as the passive form, 4. can be realized as :

4bis : *Un maximum de 10 personnes sont accueillies / \*contenues dans un chalet.*

The focus is then the relation in inverse form (maximum). Since the original subject is a metonymy (un chalet for the owner of a chalet), it must be realized as a locative PP introduced by the preposition *dans* (in) in the passive form (metonymy is no longer acceptable). The verb *contenir* cannot undergo this construction, therefore constraining the lexicalisation process to select the verb *accueillir*.

Besides these situations, which are quite numerous, alternations are also used 'by default' in natural language generation when arguments are missing in the input form, of no importance (e.g. *breakfast is served from 7 to 9 am*, where it is unnecessary to specify who is serving and for whom), or too vague. For example, when looking for local dishes of Midi-Pyrénées, a response of the following form is produced :  $\text{cook}(X, Y) \wedge \text{food}(Y) \wedge (Y = \text{'roast duck'} \vee Y = \text{'cassoulet'})$ ... where the subject X is underspecified (by default a human in the lexical entry of the verb 'cook'). The object Y is then realized as the subject, where the disjunction of dishes is realized as an conjunction, since this is the way lists of items are conjoined in French : *Le canard rôti et le cassoulet sont cuisinés en Midi-Pyrénées*. This response is more elegant than the use of the impersonal pronoun *on* to lexicalise the variable X. If one wants to insist on the fact that these dishes are very popular, it is then appropriate to use an alternation with a middle reflexive (with the middle reflexive *se* in French and the introduction of a frequency or an evaluative adverb; this alternation does not exist in English) : *Le canard rôti et le cassoulet se cuisinent souvent/facilement en Midi-Pyrénées*. (roasted duck and cassoulet are often/easily cooked in MP).

Finally, alternations may be used to give an intentional character to a question, by enlarging its scope. For example, the following questions : *Pouvons nous payer la chambre avec une carte de crédit ?* (can we pay the room with a credit card ?) in the context of a hotel-restaurant-bar..., can be answered by a more generic utterance where the object is omitted : *Oui, on peut payer avec la carte de crédit* (yes, one can pay with a credit card).

#### 4.3 *Alternations to manage the general form of a response*

A first criteria is the management of the main focus. This highly depends on the question structure, but also on the contents of the response. To the question : *Votre piscine est-elle chauffée ?* (is your swimming pool heated?), it can be responded in two ways :

(1) *Non, la température extérieure détermine seule la température de l'eau.* (no, the outside temperature determines alone the water temperature) with focus on the means, indicating that it is the only means,

(2) *Non, la température de l'eau est fonction de / est déterminée par la température extérieure seulement.* (no, water temperature is function of / is determined by the outside temperature only) with focus on the result.

Both responses are acceptable with respect to the question whose focus is ambiguous in cooperative contexts: the fact that it is heated (and how) or the resulting state (the temperature). This form of cooperation in question-answer pairs is very common.

Another one, which requires the use of an ontology to establish a link between the resulting state and the means used to reach that state, is the following : *Vos chambres sont -elles climatisées ?* (are your rooms air conditioned ? (in French the term 'climatisé' is more neutral w.r.t. the means)) with the two responses :

*Non, nos chambres sont équipées d'un ventilateur* (no, our rooms are equipped with a fan)

*Non, un ventilateur équipe nos chambres* (no, a fan 'is used' in our rooms).

The second response focuses on the means, responding more directly to the question, however it is less clear in the sense that there is a scope ambiguity (a single fan for all rooms, or a fan per room). The first response is chosen, where the use of the plural raises all scope ambiguity.

Let us now consider the more complex question-response pair *Quelles lignes de métro desservent l'aéroport d'Orly ?* (Which metro lines serve Orly airport?). A direct response can be : *L'aéroport d'Orly n'est desservi par aucune ligne de métro.* (Orly airport is not served by any metro line), with focus on the destination. With focus on the means (metro), as in the question, we have : *Aucune ligne de métro ne dessert l'aéroport d'Orly.* (No metro line serves Orly airport). If we now want to produce a cooperative response, the second part of the response, the cooperative know-how, has two different forms.

Focus on the destination allow for the production of an embedded proposition giving the alternative means of transportation :

*L'aéroport d'Orly n'est desservi par aucune ligne de métro, mais par le RER ou les bus Air France.* (Orly airport is not served by any metro line, but by the RER or the Air France busses), RER and Air France busses are underlined as hyperlinks, so that the user can get more information about any of these means depending on his/her choices. Focus on the means entails the production of a second elliptical sentence, where focus is stable :

*Aucune ligne de métro ne dessert l'aéroport d'Orly. Seulement le RER ou les bus Air France.* (No metro line serves Orly airport. Only the RER or Air France busses).

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