Some Remarks on Haskell Curry's Treatment of Grammatical Structure

Giovanni Gobber*

Abstract: The paper aims to present Curry's viewpoint of grammatical structure as a consequent application of his mathematical formalism to natural language. Such a treatment of the grammatical structure raises the question whether formal models influence the language facts investigated.

Formal grammars are usually equipped with an artificial language based on concatenation. This is as a binary linear operation that produces strings of elements according to given rules (Quine, 1946; Rosenbloom, 1950: 189). Various non-concatenative models of grammar are also given, in which multi-dimensional schemes are taken to represent grammatical relations (see e.g. Tesnière, 1965; Perlmutter-Postal, 1983: 81-128). In other non-concatenative models, binarism is maintained and a non-linear operation – called *application* – is used to represent the dynamics of grammatical structure (Šaumjan, 1965; Shaumyan, 1987). Within the applicative framework, elements can occur either as *operators* or as *operands*. An operator acts on an operand and the result of this operation is a binary, non-linear structure. A simple rule is given to establish the compatibility between an operator and its operand. In general, an operator determines in advance the category or syntactic type of a candidate to the role of an operand. No application takes place unless an element satisfies this fundamental requirement posed by the operator – i.e. that element cannot play the role of an operand for that operator. For instance, in a noun phrase an adjective – but not an adverb or a verb – can represent an operator acting on an

* Università Cattolica del Sacro Cuore. E-mail: giovanni.gobber@unicatt.it

operand which is a noun; an intransitive verb can be applied to a nominal operand, thus giving a sentence, etc. Only operations are considered here without any reference to linear word order. The various formulations of Sebastian Shaumyan's applicative grammar rely on this binary non-linear operation.

The core of the applicative framework traces back to Haskell Curry's Combinatory Logic (Curry-Feys, 1958). Curry himself proposed an application of his mathematical models to the treatment of grammatical structure (Curry, 1961: 56-68). The present paper aims to describe the foundational aspects of Curry's ideas on the grammatical structure and to consider a possible relationship with Jespersens' notion of a *phrase*. In fact, Jespersen's *Philosophy of Grammar* is often quoted by Curry (see e.g. already in Curry, 1950a: 22), and some examples used by him to illustrate crucial aspects of his conception recall analogous cases discussed by the great Danish scholar.

1. *Curry's views on formal systems and artificial languages*

In his research on the foundations of mathematics, Curry regards mathematics as the study of formal systems. He describes himself as a «formalist», because he belongs to those «who pay more attention to the process, rather than to the subject of thought; who feel that thinking about any sort of subject matter, or about no subject matter at all, can be formal if only it is conducted in a certain way» (Curry, 1950b: 346-347). He is interested in clarifying how a formal system is organized, rather than what it has to represent.

According to Curry (1950a: 6-7), a formal system is defined by a set of conventions called its primitive frame, specifying:

a) its elements and the rules of their formation by means of specified operators;
b) a set of elementary propositions and the rules of their formation by means of specified operators; and
c) the axioms, which consist of «a set of elementary propositions stated to be true outright» (ivi: 6), and the rules specifying how theorems are to be derived from the axioms.

A first question regards what the symbols of such a system stand for. As a formalist, Curry claims that they can be treated as abstract

elements, so that they say nothing about what they represent. Such a formal system is called *abstract*. On the contrary, if it is specified what objects are represented by the elements and the operations on the elements, a represented formal system is given; in other words, a *representation* of the system is available.

As we have seen above, Curry subscribes to a formalist viewpoint, i.e. he is interested in how a formal system is built and not in what its symbols and operations on symbols stand for. In fact, his formal systems are not constructed to represent the expressions of a language, but to denote everything that can be an object of thought (Curry-Feys, 1958: 261). For this reason, the elements of his systems are called *obs* which is an abbreviation of *objects*. Every *ob* is significant:

> In mathematics we abstract […] from meanings of our symbols […] Our symbols are not intrinsically meaningless, but their meaning is unspecified (Curry, 1951: 43).

Of course, *obs* have the form of symbols of a given language, but this is the language of the theory, it is not a language about which an investigation is made by means of a formal system.

A treatment of a formal system as the representation of a language would correspond to the typical understanding of a syntactic system in logical syntax. A syntactic system corresponds to the metatheory of a language: the symbols of such a system belong to a metalanguage describing how the expressions of an object language are built. But Curry rejects what he considers to be a reduction of a formal system to a logical syntax: «in mathematics we do not talk about our symbols, we use them» (*ibid.*). He maintains that only a language exists, which is called the *U language* or «the language being used»:

> Every investigation, including the present one, has to be communicated from one person to another by means of language. It is expedient to begin our study by calling attention to this obvious fact, by giving a name to the language being used, and by being explicit about a few of its features. We shall call the language being used the *U language* (Curry, 1977: 28).

The language of a formal system is only «that part of language being used which serves to name the formal objects and to express the statements derivable within the system» (Curry, 1961: 64). The

symbols for the formal objects are introduced into the «ordinary language» (Curry, 1950a: 13).

Of course, a mathematician can become interested in linguistic matters. But in this case (s)he is not forced to deal with external aspects of language expressions, because in mathematics «[…] considerations which do not have a reference to […] meaning are ignored» (*ibid.*). It becomes clear why Curry can distinguish the structural dimension of sentence grammar and the succession in time characterizing language phenomena. In a similar way, Lucien Tesnière distinguished an *ordre structural des mots* («celui selon lequel s'établissent les connexions», Tesnière, 1965: 16) and an *ordre linéaire* («celui d'après lequel les mots viennent se ranger sur la chaîne parlée», ivi: 18). Curry's viewpoint on syntax is in line with his formalist conception: the abstract objects of a system are considered analogous to the grammatical structures, i.e. they simulate the functioning of these structures; but considerations that do not have a reference to structure are ignored. Concatenation, as an operation forming strings that represent expressions of an object language, is discarded by Curry, because he maintains that strings do not represent the structure, but only the succession in time of language phenomena.

2. *On Curry's notion of a phrase*

A natural language is called by Curry a «communicative language» and its elements are meaningful units of communication (Curry, 1950a: 13). Therefore, when the system is represented by language units, *obs* are taken to denote meaningful units and meaningful combinations of them. These units are not "expressions" consisting of combined forms without reference to meaning, but «another class of combinations which I shall call *phrases*» (*ibid.*). In this respect, Curry clearly distinguishes artificial languages from natural languages: the phrases of a natural language cannot be reduced to linear combinations of symbols identified by their position in the string, while he thinks that phrases are defined as units of meaning.

An example taken from Curry (1950a: 13) is the string *I see both red and blue dahlias*. Without reference to meaning this sequence of symbols can be segmented into expressions such as 1) *see both*

red, 2) *and blue*, 3) *th re*. The concatenation of symbols can also be explicitly indicated; for example, if '+' represents the concatenation, *th re* can be rewritten as 't' + 'h' + 'r' + 'e'. According to Curry, this description does not describe the structure of the sentence *I see both red and blue dahlias* because for this purpose it is necessary to rely on the phrases, i.e. on the meaning units.

The identification of phrases, as presented by Curry, is a sort of substitution test: if a given sequence in a sentence is a unit of meaning, then it is a phrase. In *I see both red and blue dahlias* various phrases can be identified. One of these is *both … and* which consists of two discontinuous elements; according to Curry, this allows us to conclude that «phrases are not a subclass of expressions» (*ibid.*).

3. *The echo of Jespersen's* Philosophy of Grammar

Where does a point of view so attentive to the intrinsic semiotic character of natural language expressions come from? In those years, most American linguists were interested in the analysis and classification of forms and their combination; according to the research program of logical syntax, meaning was often considered «a shortcut to a distributional differentiation» (Harris, 1960: 7, n. 4) and was tendentially reduced to its manifestations.

Curry chose to address the problem at its root: he maintained that phrases have an intrinsic semiotic character and without their semantic counterpart they cease to be phrases. The semiotic character of phrases cannot be observed, but if it is neglected, non-linguistic objects are given instead of phrases. These are like the *obs* of his theory: they are intrinsically semantical, although their meaning is left unspecified.

This viewpoint on phrases is similar to the treatment proposed by Jespersen in his *Philosophy of Grammar*. In fact, reference to this work is often made by Curry and the same analysis of a sentence with *both… and* recalls to similar English and German examples considered by Jespersen.

In the pages dedicated to the problem of the word ("What is a word"), the Danish scholar notes that «neither sound nor meaning in itself shows us what is one word and what is more than one word» (Jespersen, 1974: 93): a word form can have the same sound

as a succession of word forms (e.g. *incite* and *in sight*), and the same holds for meaning: Jespersen takes up a remark by Noreen and writes «the word *triangle* and the combination *three-sided rectilinear figure* have exactly the same meaning» (*ibid.*). On the basis of these remarks he concludes that «we must look out for grammatical (syntactic) criteria to decide the question» (*ibid.*). But he finds that these criteria do not work in a lot of instances in which they do not allow to decide whether a given expression is made up of one word form or more. According to Jespersen, a different viewpoint is needed here which relates to how word forms occur in speech:

> We should never forget that words are nearly always used in connected speech, where they are more or less closely linked with other words: these are generally helpful, and often quite indispensable, to show the particular meaning in which the given word is to be understood. Isolated words, as we find them in dictionaries and philological treatises, are abstractions, which in that form have little to do with real living speech (ivi: 95).

The investigation considers those expressions that are also «sense units» (*ibid.*). In a nutshell, he means a unit that is both syntactic and semantic, which can consist of one or more words:

> A term is wanted for a combination of words which together form a sense unit, though they need not always come in immediate juxtaposition and thus are shown to form not one word but two or more words. This may be called a *phrase*, though that term is used in a different way by other writers. The words *puts off* form a phrase, the meaning of which ('postpones') cannot be inferred from that of the words separately; the words may be separated, e.g. *he puts it off*. G. *wenn auch* forms a phrase, e.g. in *wenn er auch reich ist* (*ibid.*).

This last example helps understand what Jespersen means by «not always in immediate juxtaposition». For the identification of a phrase, the immediate juxtaposition seems to be less relevant than meaning. To him, phrases are syntactic units, but they are detected as units thanks to their meaning.

The example of the German discontinuous conjunction *wenn… auch* is enlightening: Jespersen notes that phrases can consist of discontinuous parts that are taken as a unit because they have one meaning. The question remains unclear as to how such a "sense unit" is found. Structural criteria should be considered, by which a complex discontinuous unit can be replaced by a unit made up of one or more elements «in immediate juxtaposition». But this is

possible because these different expressions are similar in meaning. And this can be taken to be equivalent to occurring in the same structural position.

Curry repeats Jespersen's argumentation and chooses an example which is discontinuous like *wenn … auch*. He states that *both… and* must be considered a phrase because it is a unit of meaning. Curry's idea that syntactic units rely on an abstract semantic level corresponds exactly to Jespersen's viewpoint.

One can wonder whether Curry had subscribed to Jespersen's conception – and then adjusted it to the requirements of his formalist viewpoint – or had found in Jespersen's pages a confirmation of his assumptions on language structure which he had already developed under the influence of his ideas about the foundations of mathematics.

4. *Concluding remarks: on the interplay between formal means and theoretical issues*

Curry's treatment of the grammatical structure is consistent with his conception of application as a binary non-linear operation. Application is fulfilled according to categorial compatibility: the operator specifies what category an element must have to be accepted as its operand. The symbolic notation reflects the order of the operation: the operator precedes its operand. The same holds for an object which results from a hierarchy of applications: for example, an object XYZ is built by applying the operator X to its operand Y; the result XY acts as an operator on its operand Z. This structure resembles a genealogical tree and has much in common with syntagmatic configurations in other formal models. According to Curry (1950a), it can be used to represent the behavior of a transitive verb in a sentence: it is first applied to its direct object and the result of this operation is applied to the subject, thus giving the structure of a sentence (Curry, 1950a: 12-13; Curry-Feys, 1958: 274-275; Curry, 1961: 65). Such an interpretation of syntactic relations seems to be required by the formal system rather than by theoretical issues concerning language structure. In this regard, the question arises on the relationship between the representational model and linguistic theory: does the method used to describe and explain facts influ-

ence the way these facts are represented? i.e. does the design of the objects used to treat the observed data "suggest" the structural design of the facts underlying these data?

The question can receive a positive answer, which can be given (at least) two different interpretations: 1) the investigation concerns more the structure of the formal language used to represent the theory than the structure of the language investigated, or 2) the language observed is given a structure that, in fact, belongs to the formal language used. From the former interpretation the following consequence can be drawn: the fact that a formal language has a structure of a certain kind is not enough to conclude that the observed language too has a structure of the similar kind. The latter interpretation allows for a different consequence: the fact that a formal language has a structure is not enough to conclude that the observed language too has a structure. A careful analysis of the data allows for the assumption that a structure of some kind manifest itself by means of the data of a given language – and this structure can be thought of in terms of a grammar. Then the latter interpretation should be dismissed. But this does not mean that the former interpretation can be abandoned…

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