Lingue e Contesti

Studi in onore di Alberto M. Mioni

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M. Grazia Busà e Sara Gesuato

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Some reflections on the notion of recursion[1]

Giorgio Graffi
University of Verona

Abstract. The paper examines the different ways in which the notion of 'recursion' has been conceived and defined in linguistics, from Chomsky's early works to the present day. Two meanings appear to especially stand out: recursion as an iterative operation and recursion as self-embedding of structures. Furthermore, it is argued that a particular type of self-embedding, namely the clausal one, has been the focus of attention of most linguists, independently of the theoretical frameworks they subscribe to.

1. Introduction

The notion of 'recursion' was introduced in linguistics in the early works of Chomsky (starting with *The logical structure of linguistic theory*, dating back to 1955-1956 and published twenty years later as Chomsky 1975) and since then it has remained a basic tenet of generative grammar. A decade ago, Hauser, Chomsky and Fitch (2002) assigned a key role to it in the evolution of the language faculty. In their paper, recursion was defined as "a core property of FLN" (p. 1571), where FLN means 'faculty of language in the narrow sense'. Recursion "yields discrete infinity (a property that also characterizes the natural numbers)" (p. 1571). The authors maintain that "FLN – the computational mechanism of recursion – is recently evolved and unique to our species" (p. 1573). Hauer, Chomsky and Fitch (2002)

[1] Alberto Mioni has always united attention to theoretical questions with his deep knowledge of many languages. I hope that these few remarks on a theoretical issue which has recently been revived also on the basis of "exotic" data may be of interest to him. I would also like to thank Denis Delfitto, Andrea Moro and Luigi Rizzi, who provided insightful comments on an earlier version of this paper, the responsibility of which, of course, is entirely mine.

originated a lively debate, which spread outside professional linguists, and it is not surprising that a good deal of this debate focused on the notion of 'recursion', namely on what it really means and on what role it plays in the evolution and the characterization of the language faculty. Some recent works (Tomalin 2007; Lobina 2011a, 2011b) have investigated the historical roots of the notion of 'recursion' and its different meanings. These works will be our starting point (section 2); then we will sketch the history of the notion of 'recursion' throughout the various phases of generative grammar (section 3) and the current debate about it (section 4); in the final section, we will try to draw some conclusions from this overview.

2. Some different meanings of 'recursion'

According to Tomalin (2007: 1797), 'recursion' has (at least) five possible interpretations, namely: (1) "inductive definition"; (2) "primitive recursion"; (3) "general recursion"; (4) "λ-definability"; (5) "computability". Tomalin (2007: 1798) goes on to remark that "given the brief and non-technical presentation offered by Hauser, Chomsky, and Fitch, it is simply impossible to determine with certainty which interpretation of 'recursion' the authors are actually adopting." Nevertheless, "it should be obvious that the most general of the five interpretations enumerated above is" (1): "then the HCF [i.e. Hauser, Chomsky and Fitch's] hypothesis would essentially resolve itself to the (comparatively) transparent claim that, in addition to the interface mappings, the FLN contains a component that simply enables syntactic objects to be defined inductively." Tomalin's conclusion (2007: 1799) is that "it would be better to abandon the term 'recursion' entirely in the context of linguistic theory, and replace it by a more precise phrase such as 'inductive definition'".

According to Lobina (2011b: 1564-1565; cf. Lobina 2011a: 154, 158 ff., 163), 'recursion' applies (at least) to "four distinct theoretical constructs", namely: (1) "it may be used in the specification of technical terms when these are 'defined by induction', which is in fact the original sense of recursion in mathematics"; (2) it "may appear as a general and central property of algorithms and generative systems"; (3) it "pertains to the study of computational processes"; (4) it "refers to structures rather than operations. […] The prototypical cases here are the 'trees within trees' so familiar to generative grammar". Concerning especially the last point and its relationship with the preceding ones, Lobina stresses that recursion has often been confused with hierarchy, which should not happen (cf. Lobina

2011a: 161; 2011b: 1571-1572). The feature common to all such constructs "is the self-reference property that characterizes recursion — a feature that is quite unrelated to the uses to which this notion can be applied" (Lobina 2011a: 151). Chomsky's view of recursion would essentially fit into construct (2): recursive processes are those brought about by means of the "successor function" (cf. Lobina 2011a: 154). Lobina (2011a: 156) recognizes "a common thread running through Chomsky's writings, but this is not to say that he has always been consistent". It would therefore be useful to investigate next what was meant by *recursion*, *recursive rule* and *recursive processes* in the different periods of generative grammar.

3. 'Recursion' throughout the history of generative grammar

In Chomsky's early works recursion appears to amount to the possibility of indefinitely iterating the same rule, or the same procedure (cf., e.g., Chomsky 1975: 194-195). The notion has also a more specific sense, namely a recursive rule is defined as the one that rewrites one given category as itself (cf. Chomsky 1975: 171-172). At first, recursion is assigned to the phrase-structure component of the grammar, but this position is abandoned in the subsequent chapters of the work: "it seems reasonable to place the formal requirement that no recursions appear in the kernel grammar" (Chomsky 1975: 516-517), where the "kernel" is derived "by a simple system of phrase structure" (Chomsky 1957: 61). The reasons for taking this step are essentially of a formal nature: "it follows from the nonrecursion requirement that the kernel must be finite" and "if the kernel is finite, we do have a mechanical way of determining whether a given grammar is a reduced form of some system **P** [Phrase Structure, G.G.]" (Chomsky 1975: 517-518). As a consequence, the recursive property is only assigned to the transformational component (cf. Chomsky 1975: 393).

This framework undergoes some important changes in subsequent years, namely: (a) recursion is no longer assigned to the transformational component, but to the phrase structure component of the grammar; (b) recursive rules are only those that introduce the category S (i.e. sentence) in the derivations. While the first change has been largely recognized, the second one has remained almost unnoticed. Nevertheless, it is clearly stated: "the recursive property is a feature of the base component, in particular, of the rules that introduce the initial symbol S in designated positions in strings of category symbols. There are, apparently, no other recursive rules

in the base" (Chomsky 1965: 137).[2] Recursion seems therefore to refer to the last of the "four theoretical constructs" listed by Lobina (2011a, 2011b), namely "to structures rather than operations". Such structures, moreover, are not simply of the kind [$_A$…A…], where A is any category: in other words, a structure such as *the king of England's hat* would not be recursive, in this more restricted sense. The reasons for the first change in the view of recursion are clear: they are connected to the *Standard Theory* assumption that "the transformational component is solely interpretive" (Chomsky 1965: 137). No special motivation, however, is given for the second change: this is possibly the reason why it has escaped the attention of virtually every scholar.

The notion of recursion is not significantly explored during the Extended Standard Theory and the Principles and Parameters periods of generative grammar. It is, however, central to the Minimalist Program, from its very first formulation (Chomsky 1995). It occurs in the definition of "syntactic objects" formed by the operation Merge (cf. Chomsky 1995: 243): any application of Merge would be recursive, independently of the categories involved. On the basis of this new definition, all structures which were treated as recursive in the preceding frameworks remain so in the new one, but the opposite is obviously not true.

4. A glance at the current debate

4.1 Recursion and Merge

The basic assumption of the Minimalist Program as is conceived by Chomsky, which is also adopted by Hauser, Chomsky and Fitch (2002), is therefore that recursion is identical to Merge. This assumption has been essentially rejected by some scholars, while some others have tried to qualify it.

Let's begin with some opponents of Hauser, Chomsky and Fitch (2002), namely Pinker and Jackendoff (2005). I will limit myself to quoting their definition of recursion, without discussing the more general theses of their paper: "recursion consists of embedding a constituent in a constituent of the same type, for example a relative clause inside a relative clause" (Pinker,

[2] See also Chomsky (2006: 138; the text dates back to 1968): "[i]t may be that introduction of 'propositional content' in deep structures by this means is the only recursive device in the grammar, apart from the rules involved in forming coordinate constructions".

Jackendoff 2005: 211). Hence the authors restate one of the views of recursion as presented in generative grammar before Minimalism, namely the self-embedding of structures (without restriction to self-embedding of sentences). Some pages earlier, however, they comment on Hauser, Chomsky and Fitch's (2002) assumptions, remarking that "recursion refers to a procedure that calls itself, or to a constituent that contains a constituent of the same kind" (Pinker, Jackendoff 2005: 203). The first member of this disjunction directly applies to recursion considered as equivalent to Merge, while the second member essentially amounts to the definition of recursion as self-embedding, which the authors reiterate on p. 211. Fitch, Hauser and Chomsky (2005), in their response to Pinker and Jackendoff, do not enter into the problem of exactly defining recursion. Or rather, the "simplest" view of it, namely as unlimited application of Merge, does not seem to be disputed.

Indeed, Fitch, Hauser and Chomsky (2005) themselves do not strictly identify recursion with Merge: in the Appendix to their paper (Chomsky, Hauser, Fitch 2005) they state that "the 'core computational mechanisms of recursion' include the indispensable operation *Merge* and the principles it satisfies" (p. 2). Similarly, Chomsky (2008: 144), discussing the way Merge combines the different syntactic objects, writes that such a procedure "yields a certain subcategory of recursive systems: with embedding, a pervasive feature of human language"; and Chomsky (2009: 393) defines Merge as "the simplest possible mode of recursive generation". One could therefore draw the conclusion that, according to Chomsky's present assumptions, Merge is the basic recursive operation of human language, but not every recursive operation can simply be identified with Merge. This perspective is pursued, it seems to me, by Rizzi (2010), who distinguishes between three kinds of Merge: Primary Merge, Recursive Merge and Phrasal Merge. The first kind of Merge "takes two items from the functional or substantive lexicon and forms minimal phrases"; the second one "takes an item from the functional or substantive lexicon and a phrase already formed" and is defined as "the fundamental recursive step in syntactic computations"; the third one (whose recursive status is dubbed *controversial*) "takes two complex phrases already formed by Merge".

4.2 The Pirahã issue

Within the debate about recursion as the key feature of the FLN, much discussion has focused on some data from Pirahã (an Amazonian language)

first brought to light by Everett (2005). According to Everett (2005: 628), "Pirahã lacks embedding altogether" and this alleged phenomenon leads him to the conclusion that recursion is not a universal feature of human language capacity, with the further consequence that "the case for an autonomous, biologically determined module of language is seriously weakened" (Everett 2005: 634).

The responses to Everett by Chomsky and his followers are partly divergent. Fitch, Hauser and Chomsky (2005: 203) adopt a rather dismissive attitude: the absence of embedding in languages like Pirahã "is no more relevant to the human ability to master recursion than the existence of three-vowel languages calls into doubt the human ability to master a five- or ten-vowel language". Nevins, Pesetsky and Rodrigues (2009a), on the contrary, gave a much more articulated response. Everett (2009) is a reply to such criticisms, to which Nevins, Pesetsky and Rodrigues (2009b) replied in their turn.

Nevins, Pesetsky and Rodrigues initially seem to consider Everett's arguments as essentially irrelevant, claiming that these would apply to the property of recursion as conceived in the former periods of generative grammar, namely as if it "could properly be ascribed only to a rule that takes the same category as an input and as an output […] In a model with category-neutral Merge, however, a language that lacks recursion would be considerably more exotic. No sentence in such a language could contain more than two words. Pirahã is manifestly not such a language" (Nevins, Pesetsky, Rodrigues 2009a: 366, fn. 11).[3]

Everett (2009: 438) replied to this criticism by stating that "Merge is unnecessary in Pirahã, just as recursion is" and that there are "alternative approaches to syntax" that can account for the existence in Pirahã of sentences containing more than two words. I do not enter into this question. Rather, I would like to remark that Nevins, Pesetsky and Rodrigues's arguments vary according to the different categories whose recursive nature is being debated. In the case of NP within NP (e.g. *John's father's hat*, etc.), they remark that "the distribution of possessors in German is strikingly similar to Pirahã" and therefore "whatever syntactic switch turns off prenominal possessor recursion in German is also at work in Pirahã" (Nevins, Pesetsky, Rodrigues 2009a: 368). In the case of sentence embedding their strategy is the opposite: they state that "when it comes to clausal embedding, Pirahã

[3] It might be interesting to note that Nevins, Pesetsky and Rodrigues quote as a "standard example" of a recursive rule in this sense the rule which introduces English possessors: NP → NP*'s* N. As will be recalled from section 3. above, this kind of rule would not be recursive according to Chomsky (1965), since it does not introduce an S category.

is a language like any other" (Nevins, Pesetsky, Rodrigues 2009a: 376). In sum, the bulk of both Nevins, Pesetsky and Rodrigues (2009a) and (2009b) is devoted to showing that Pirahã *does* have clausal embedding.[4]

4.3 Recursion: syntax vs pragmatics

The Pirahã problem has been recently touched upon by Levinson (2013): "in lacking evidence of indefinite recursion Pirahã is not unique at all. The Australian languages provide a wealth of better-documented cases" (Levinson 2013: 151). Levinson's goal is, however, more general and ambitious: namely, to show that recursion does not just characterize syntax, but also, and even to a larger degree, language use. Support for this conclusion would be given by the analysis of some corpora of written language on the one hand, and of dialogues on the other. Recursion within a dialogue is illustrated by means of examples like the following one (cf. Levinson 2013: 154, quoted from Merritt 1976: 333):

A:	⌈ May I have a bottle of Mich?	
B:	⌈ Are you twenty one?	← degree 1 center-embedding
A:	⌊ No	← response at degree 1
B:	⌊ No	

The "smaller" sequence B-A is embedded within the "larger" one A-B: speaker B must keep in mind the first utterance of speaker A in order to give an appropriate answer to it. Levinson (2013: 154) states that "no examples of degree 3 embedding were found in corpora" of written texts; on the contrary, corpora of conversational interaction would present cases where embedding can reach degree 6, or even more. Levinson's (2013: 157) conclusion is therefore that "'recursion' understood propositionally (as relations between propositions) is not so much a universal property of grammar as a property of human psychology, most evident in language use. […] Once again, pragmatics outplays syntax".

[4] Rizzi (2013: 9) offers a possible solution to the "Pirahã issue", based on his hypothesis that "Merge is fully available in the language as a general computational device, but its applications are modulated by the specific properties of the lexical items it acts upon." Pirahã could therefore be a language lacking complementizers, and, since clausal embedding needs complementizers, this could account for its lack in that language.

In their criticism of Levinson's paper, Legate, Pesetsky and Yang (2013: 7) remark that corpus statistics "must always be evaluated against a baseline, before concluding that the relative rarity of a given phenomenon requires special explanation" and that neither Levinson nor his source (Karlsson 2007) "provides such an evaluation". Moreover, they maintain, on the basis of several arguments, that embedding probably cannot exceed degree 2 even in conversational interaction. Apart from such remarks, however, one could object that corpora in themselves are not especially relevant to the problem at issue, namely the nature of recursion as a feature of human language syntax: this property evidently lies at the level of competence, not at that of performance. In other words, the fact that clausal embedding is shown to extend only to a limited degree in written (as well as in oral) texts in whatever language does not imply anything about the *possibility* of realizing such a structure.

5. Some tentative conclusions

From this very brief and partial overview, it is possible to draw (at least) the following conclusions: (a) as Lobina (2011a: 158) writes, "Chomsky's leitmotif is based on recursion *qua* general property of the computational system underlying language, be this a production system or a set-operator like Merge". (b) On the other hand, several linguists, starting with Chomsky himself, have also viewed recursion as a particular type of hierarchical structure, namely as self-embedding of a given category; furthermore, while sometimes any self-embedding category was defined as potentially recursive, in some other cases the recursive property was assigned only to S. This point was not explicitly recognized by many linguists, but it is the case that the most lively debates have centered around the possibility of clausal embedding (see sections 4.2. and 4.3. above).

What suggestions could be offered to future research by such conclusions? In my view, the first one would be to clearly distinguish recursion as referring to operations from recursion as referring to structures (cf. Lobina 2011b: 1564-1565). As far as the typology of such structures is concerned, the special status of clausal self-embedding cannot be ignored: although in different and often contrasting ways, this fact has been stressed by several scholars, from Chomsky (1965) to Levinson (2013). In other words, the problem of the existence of languages without sentential self-embedding cannot be dismissed as irrelevant to the characterization of Universal Grammar.

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