12-2010

On the Universality of Recursion

Timothy Koschmann
Southern Illinois University Carbondale

Recommended Citation

1. RECURSION AND THE THEORY OF UNIVERSAL GRAMMAR

One of the things learned teaching introductory computer science is that the concept of recursion can't really be taught—students either get it or they don't. It is a matter both stunningly simple and frustratingly elusive. It resides at the center of a controversy now dividing the linguistics community. The controversy was stirred by the Hauser, Chomsky and Fitch (2002) article proposing that a recursive computational mechanism underlies the Faculty of Language in humans, Narrowly-defined (FLN). They hypothesized, "FLN *only* includes recursion and is the *only* uniquely human component of the faculty of language" (Hauser, et al. 2002: 1569, emphasis added).

In one of his earliest papers, Chomsky observed, "a grammar must reflect and explain the ability of a speaker to produce and understand new sentences which may be longer than any he has previously heard" (1956: 124, footnote 5). A grammar, he argued, must have the capacity to generate an unbounded set of sentences, while, at the same time, be expressed cleanly and simply. He went on,

> If a grammar has no recursive steps … it will be prohibitively complex—it will, in fact, turn out to be little better than a list of strings of morpheme class sequences in the case of natural languages. If it does have recursive devices, it will produce infinitely many sentences. (1956: 115-116).

In this way recursion was initially introduced into the study of syntax as a notational convenience. Hauser et al. proposed, however, "novel capacities such as recursion are implemented in the same type of neural tissue as the rest of the brain and are thus constrained by biophysical, developmental, and computational factors shared with other vertebrates" (2002: 1574). Recursion, therefore, has been transformed from a tool for representation to a genetically-endowed, neurophysiological structure. Discussing the factors that shaped the evolutionary development of this capacity for recursion they write, "Such constraints have historically been termed 'innate dispositions,' with those

underlying language referred to as 'universal grammar'" (Hauser, et al. 2002: 1577).

This description employs terminology introduced earlier by Chomsky: "In pursuing [the question of how knowledge of a language is acquired], we attempt to construct a theory of universal grammar, a theory of the fixed and invariant principles that constitute the human language faculty and the parameters of variation associated with them" (1988: 133).

Evans and Levinson (2009) critique the way in which the theory of universal grammar has been applied in linguistics. They stake out the position that, upon close examination, there are few if any features that are universal to all known natural languages. Describing recursion in syntax, they observe, "it is a well-developed feature of some languages, like English or Japanese, rare but allowed in others (like Bininj Gun-wok), capped at a single level of nesting in others (Kayardild), and in others like Pirahã, it is completely absent" (2009: 443). They go on,

> Consider that instead of saying, "If the dog barks, the postman may run away," we could say: "The dog might bark. The postman might run away." In the former case we have syntactic embedding. In the latter the same message is conveyed, but the "embedding" is in the discourse understanding—the semantics and the pragmatics, not the syntax. (2009: 443)

Evans and Levinson argue, though different languages employ recursion in different ways, they are all capable of expressing complex ideas as needed. As they put it, "although recursion may not be found in the syntax of languages, it is always found in the conceptual structure, that is, the semantics or pragmatics" (2009: 444).

Evans and Levinson's contention that recursion inevitably arises in "discourse understanding" regardless of whether or not it is seen in the syntax of a language might be seen to conflict with the view that discourse recursion does not exist. Roeper, for example, has argued, "Discourse may be governed by cognitive systems for putting ideas together that are inherently different from the systems that govern the word,

phrase, and clause" (2007: 110). To explore this issue at a bit greater depth, we need to review what we actually mean by recursion and look at how it has been studied in linguistics.

2. THE RECURSIVITY OF GRAMMAR

In mathematics, a recursive function is one defined in terms of itself.[i] Recursion has been defined in a variety of ways in linguistics. Everett, for example, writes, "Recursion consists in rule (or operation) sets that can apply to their own output an unbounded number of times" (2009: 407). A slightly more restrictive definition was provided by Pinker and Jackendoff, i.e., "Recursion consists of embedding a constituent in a constituent of the same type, for example a relative clause within a relative clause (*a book that was written by the novelist you met last night*), which automatically confers the ability to do so ad libitum" (2005: 211). Let us look at how these ideas have been applied.

Using English syntax as an example, Roeper (2007) demonstrates how a grammar determines where recursion can and cannot be used. As an instance of a recursively-produced noun phrase, he offers:

John's friend's brother's car's motor   (2007: 109)

Here we see how possessives can be stacked to compose new meanings. Roeper explains how similar recursively-produced structures arise at the level of words (prefixation, adjectives, compounds), phrases (possessives, prepositional phrases, conjunction) and clauses (infinitive and finite). He observes, "mechanical recursion is a machinelike property at the sentence level" (2007: 110).

When one goes beyond isolated sentences, however, to series of sentences, where might we expect to see analogous evidence of recursion? Roeper provides the following example,

> The earth is flat.
> The textbook said that.
> Mary told Bill that.
> The teacher didn't believe that. (2007: 110-111)

In the three latter sentences, the pronoun *that* references previous text. They are examples, therefore, of what Levinson described as "discourse deixis" (1983: 85-89). One might ask, what is referenced by the final *that*? If the series of sentences were interpreted recursively, it would resolve to "Mary told Bill the textbook said the earth is flat." But Roeper (2008) reports that such construals are uncommon in experiments with children and even adults. These findings lead him to speculate that, when we look at structures larger than single sentences, recursion is not employed and discourse recursion does not exist.

3. DISCOURSE RECURSION

 How does Evans and Levinson's proposal that understandings produced by recursive structures can be conveyed in non-recursive, non-syntactically determined structures relate to Roeper's prediction that discourse recursion will not be found? One way of reconciling these views would be to argue, a la Evans and Levinson, that specifically recursive linguistic structures are not needed at the super-sentential level as long as recursively-structured ideas can still be expressed. However, when we examine the structures of naturally produced discourse, we do, in fact, find evidence of recursivity. Consider this example from Sacks (1992, LC1:324):
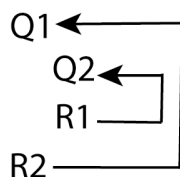
A: Did you put the garbage out?

B: Did I put out the garbage?

A: Yes.

B: Yes.

Here we have an exchange between two speakers in which B responds to A's query with a clarifying question. The second question and its response are embedded within the first Q-R pair. The exchange could be diagramed as follows:

```
Q1
   Q2
   R1
R2
```

Here is another, slightly more complicated example from a recorded phone conversation (Sacks, 1992, LC1: 55):

A: Hey did you talk Marcia into coming down here?
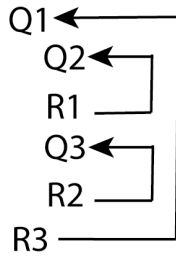
B: Was she here?

A: Yeah.

B: When did she leave.

A: About half an hour ago.

B: Yeah, I talked her into living here with me.

This example could be diagramed this way:

```
Q1 ◄─────────────┐
   Q2 ◄────────┐  │
   R1 ──────┐  │  │
   Q3 ◄──┐  │  │  │
   R2 ───┘  │  │  │
R3 ─────────┘  │  │
```

The machinery on display here could be described in the following terms: One way to
treat a prior turn as a question is to provide a response, but before doing so, it is
permissible to pose one or more clarificatory questions. This is a recursive organization
in the sense in which that term is conventionally used in linguistics, that is, we find
unbounded embedding of a constituent within a constituent of the same type.

A similar kind of recursive construction can be seen when a speaker asks a double
or stacked question as we see here (Sacks 1987: 59-60):

A: Well that's good uh how is yer arthritis. Yud still taking shots?

B: Yeah. Well it's, it <u>awright</u> I mean it's uh, it hurts once 'n a while but <u>it's</u> okay.

The structure is similar to the first example, but in this case the first and second
questions are produced by the same speaker. The listener, B, responds to the
questions on a first in/first out basis, creating again a recursively-generated, embedded
structure.

Recursion in discourse is not limited to question-answer pairs. For example, the
rule set for turn allocation presented by Sacks, Schegloff and Jefferson (1974) in their
'simplest systematics' article is explicitly recursive. The question of whether or not
recursion is seen in discourse, therefore, seems to rest on how one defines *discourse*. If
the term is restricted to concatenated sentences generated by a single speaker, it may

well be the case that it is difficult to find evidence of recursively-generated (or interpreted) structures. On the other hand, if one holds to the view of discourse as an interactional achievement,[ii] it is relatively easy to find evidence of recursion and I have provided several examples. They serve as demonstrations of how speakers and listeners construct larger interactional structures using turns at talk as building blocks.

4. ON THE UNIVERSALITY OF RECURSION

Chomsky wrote in *Aspects of the Theory of Syntax*:

Linguistic theory is concerned primarily with an ideal speaker-listener, in a completely homogeneous speech-community, who know its language perfectly and is unaffected by such grammatically irrelevant conditions as memory limitations, distractions, shifts of attention and interest, and errors (random or characteristic) in applying his knowledge of the language in actual performance. (1965: 3).

This articulates his familiar distinction between competence and performance. *Aspects* was intended to provide a blueprint for new program of study focusing on the formal properties of grammar (Newmeyer, 1986). In Hauser et al. (2002), we see the distinction extended to what constitutes a language:

In formal usage, a language is understood as a culturally specific communication system (English, Navajo, etc.). In the varieties of modern linguistics that concern us here, the "language" is used quite differently to refer to an internal component of the mind/brain (sometimes called "internal language" or "I-language"). (2002: 1570)

They elaborate, "In exploring the problem of language evolution, it is important to distinguish between questions concerning language as a communicative system and questions concerning the computations underlying this system, such as those underlying recursion" (2002: 1569). What is defensible in specifying the scope of a program of study focusing solely on language syntax, may be less so when offered as an account of the basic human capacity for communication. As we see when we begin to examine the structure of interactional discourse, there may be other competencies that underlie the

Faculty of Language and not all of them are syntax-based. Hauser et al.'s conceptualization of this faculty, therefore, may be a bit too narrowly defined.

Though recursion may indeed be difficult to understand, at least as an abstract matter, it does seem to have some sort of relationship to how we actually go about doing understanding. I take this to be quite close to Evans and Levinson's point when they observed that it is always a feature of "discourse understanding" (2009: 443). I have tried to show that recursion is not only built into the structure of languages, but is also a property of how they are placed into use in meaningful interaction. Demonstrations of discourse recursion, of course, do not rule out the possibility that we possess an innate capacity for recursive 'computation'; nor do they rule out the possibility that recursion is a uniquely human capacity. Such demonstrations, however, do argue for a re-specification of what counts as competency in human communication.

5. REFERENCES

Chomsky, N., 1956. Three models for the description of language. IEEE Transactions on Information Theory 2, 113-124.

Chomsky, N., 1965. Aspects of the Theory of Syntax. MIT Press, Cambridge, MA.

Chomsky, N., 1975. The Logical Structure of Linguistic Theory. Plenum Press, NY.

Chomsky, N., 1988. Language and Problems of Knowledge: The Managua Lectures. MIT Press, Cambridge, MA.

Evans, N., Levinson, S. C., 2009. The myth of language universals: Language diversity and its importance for cognitive science. Behavioral and Brain Sciences 32, 429-492.

Everett, D. L., 2009. Pirahã culture and grammar: A response to some criticisms. Language 85, 405-442.

Hauser, M. D., Chomsky, N., Fitch, W. T., 2002. The faculty of language: What is it, who has it, and how did it evolve? Science 298, 1569-1579.

Levinson, S. C., 1983. Pragmatics. Cambridge University Press, New York.

Newmeyer, F. J., 1986. Linguistic theory in America. Academic Press, Orlando, FL.

Pinker, S., Jackendoff, R., 2005. The faculty of language: What's special about it? Cognition 95, 201-236.

Roeper, T., 2007. The Prism of Grammar: How Child Language Illuminates Humanism. MIT Press, Cambridge, MA.

Roeper, T., 2008. The minimalist microscope: How and where interface principles guide acquisition. In: Chandlee, J., Franchini, M., Lord, S., Rheiner, G.-M. (Eds.), Proceedings of the 33rd Annual Boston University Conference on Language Development. Cascadilla Press, Somerville, MA, pp. 24-48.

Sacks, H., 1987. On the preferences for agreement and contiguity in sequences in conversation. In: Button, G., Lee, J. R. L. (Eds.), Talk and social organization. Multilingual Matters, Ltd., Clevedon, U.K., pp. 54-69.

Sacks, H., 1992. Lectures on Conversation. Blackwell, Oxford, U.K.

Sacks, H., Schegloff, E., Jefferson, G., 1974. The simplest systematics for the organization of turn-taking for conversation. Language 50, 696-735.

Schegloff, E., 1982. Discourse as an interactional achievement: Some uses of 'uh huh' and other things that come between sentences. In: Tannen, D. (Ed.), Analyzing discourse: Text and talk (Georgetown University 1981 Roundtable on Languages and Linguistics) Georgetown University Press, Washington, D.C., pp. 71-93.

Schegloff, E., 1988. Discourse as an interactional achievement II: An exercise in conversational analysis. In: Tannen, D. (Ed.), Linguistics in context: Connecting observations and understanding. Ablex, Norwood, NJ, pp. 135-158.

Schegloff, E., 1995. Discourse as an interactional achievement III: The omnirelevance of action. Research on Language and Social Interaction 28, 185-211.

Tomalin, M., 2007. Reconsidering recursion in syntactic theory. Lingua 117, 1784-1800.

[i] See Tomalin (2007) for a further elaboration of how the term was originally defined in mathematics and computer science.

[ii] For a well-developed argument for the latter view, see Schegloff (1982, 1988, 1995).