Recursion in aphasia and mental model[1]

Zoltán Bánréti

Research Institute for Linguitics of the Hungarian Academy of Sciences,   Hungary
banreti@nytud.hu

The issue
It is a debated issue whether recursivity, seen as a specific feature of human language, is a syntactic phenomenon: certain constituents can have the same types of constituents embedded in them, and this operation can be repeated again and again (Clark, 1996, Hauser et al., 2002, Fitch et al., 2005) or else the source of recursion is semantics or pragmatics: complex propositions can be expressed in some manner in human languages (Pinker-Jackendoff, 2005, Everett 2005, Evans and Levinson, 2009), or recursivity is a feature of the operations of human mind (cf. theory-of-mind type reasoning in the system of social cognition) and recursion is reflected or coded in linguistic forms . It is furthermore a crucial research issue how aphasic impairment impinges on syntactic and/or semantic recursivity.

Methods
A series of tests has been conducted with the participation of five aphasic subjects and ten control subjects. All aphasic participants had a left unilateral brain lesion. Aphasic subjects were assigned to aphasia types on the basis of performance profiles in clinical evaluations. In our tests photographs representing simple situations were presented to subjects and questions were asked about them. The types of questions:
Type 1: *What is X doing in the picture?*

Type 2: *What does X hate/like/want to do*?

Type 3: *What can be the most entertaining/unpleasant/urgent thing for X to do?*

Type 4: *What can X think /say /remind Y of /ask Y to do*?

Type 1 questions did not restrict the structure of the answer in any way. Type 2 and Type 3 questions allowed for recursive and non-recursive answers alike. In Hungarian, Type 4 questions could only be answered by using an embedded clause, introduced recursively. We used 208 photographs for each test, administered in three sessions.

Results
Answers given by the five aphasic subjects have been classified in terms of whether they were structurally linked to the questions and were or were not grammatical. The number of structurally linked and grammatical answers decreased from Type 1 questions to Types 2 and 3, respectively. Patients avoided giving recursive answers as a rule.
With respect to Type 4 questions (*What can X say /think /remind Y of /ask Y to do?*), requiring a recursively embedded clause as an answer, the performance of the subjects turned out to be better than with Type 1 questions (*What is X doing?*). This result flies in the

---

face of the expectation that building recursive structures should be more difficult than building non-recursive ones.

Wernicke's aphasics produced some descriptive clauses with subordinating conjunction (*that*-clauses) and some clauses involving the subjunctive (i.e., the mood directly indicating subordination). Broca's aphasics did not give descriptive clauses with subordinating conjunction. One of them did produce some answers involving subjunctive mood. However, all structurally linked and grammatical answers produced by Broca's aphasics, as well as the rest of the answers given by Wernicke's aphasics, were rather peculiar: they produced statements that assumed the point of view of one of the characters seen in the picture, rather than being purely descriptive. Our subjects answered the question as if they were in the "mental state" of the characters or as if they quoted their words. These answers will be referred to as "discourse statements with 'theory of mind' type embeddings" here. In them, the Verb was inflected in the first, rather than the third, person singular (or second person singular, with reference to the partner in the situation shown in the picture), their meanings differed sharply from descriptive statements, as they directly represented the thought or statement of the character they "cited". Most of them did not involve a subordinating conjunction, but represents semantic-pragmatic operations instead, with 'theory of mind' type embeddings.

Examples:
 'Theory of mind' type statements by aphasics:

On the picture**:** A girl is showing her scar to a boy.
Question: *Vajon mire gondol a fiú?*
'What may the boy be thinking of'?
Answer: *Mindjárt rosszul leszek!*
'I'm going to be sick'.
Possible recursive construction:
(Ő) arra gondol, hogy mindjárt rosszul lesz.
'He thinks (that) he is going to be sick'.

Multiple 'theory of mind' type embeddings:

On the picture: A boy is waking up a girl.
Question: *Vajon mit mond a fiú a lánynak?*
'What may the boy be saying to the girl'?
Answer: ***TE** miért vagy szomorú? Fáj a feje**m**?*
           Why are **YOU** sad? Have **I** a headache'?
Possible recursive construction:
A fiú kérdezi a lányt, hogy miért szomorú.
'The boy is asking the girl why she is sad'.

 The share of discourse statements ('theory of mind' type embeddings) jumps up in answers to Type 4 questions. These answers are supposed to involve formal structural recursion but they contain semantic-pragmatic operations instead, with 'theory of mind' type recursion.

The strategy outlined above was succesful especially for Broca's aphasics. The great majority of the grammatical answers produced by Broca's aphasics was discourse statement containing 'theory of mind' type embedding:

Table 1:
Type 4 questions: percentage of <u>all structurally linked</u> answers (outside the brackets: that of <u>grammatical</u> answers) <u>in the various grammatical categories and in aphasia types</u>:

	Wernicke's aphasics (answers :76)	Broca's aphasics (answers: 218)	10 control subjects (answers: 153)
'Theory of mind' type embedding	**(43.3) <u>43.3</u>**	**(74.0) <u>60.3</u>**	(13.1) 13.1
Sentence with subjunctive mood	(14.2) <u>14.2</u>	(11.4) <u>11.4</u>	-
Subordinating conjunction + 'Theory of mind type embedding	(12.5) <u>12.5</u>	(14.5) <u>8.7</u>	(12.4) 12.4
Subordinating conjunction + descriptive clause	**(30.0) <u>30.0</u>**	-	(74.4) <u>**74.4**</u>

Conclusion
Formal structural recursion was more impaired in Broca's aphasia and was less impaired in Wernicke's aphasia. Aphasics tend to exploit the parallel between 'theory of mind embeddings' and syntactic-structural embeddings (Sauerland, 2005) in order to avoid formal structural recursion in answering Type 4 questions.
Mental model construction is driven by a process of perspective taking. 'Theory of mind type' embeddings show aphasics utilize mental model in order to avoid syntactic structural recursion. The mental model construction as a perspective shift system may remain selectively unimpaired in Broca's aphasia.

References
Clark , D. G. (2006). Recursion and aphasic sentence comprehension. *Brain and Language*, 99, 1-2, 103-104.
Evans, N., Levinson, S. (2009.) The Myth of Language Universals. in press: *Behavioral and Brain Sciences* 32:429-448 Cambridge University Press
Everett, D. (2005). Cultural constraints on grammar and cognition in Pirahã. *Current Anthropology,* 46, 621–646.
Fitch, W. T., Hauser, M. D. & Chomsky, N. The Evolution of the language faculty: Clarifications and implications. *Cognition,* 97,179–210. 2005.
Hauser, M. D., Chomsky, N. & Fitch, W. T. (2002).The faculty of language: What is it, who has it, and how does it evolve? *Science,* 298,1569–1579.
Pinker, S., Jackendoff, R. (2006). The faculty of language: what's special about it? *Cognition,* 95, 201-236.

Sauerland, U. (2005). Recursion in Semantics? The Case of Binding. Presentation at meeting on *Interfaces+Recursion=Language. The view from Syntax and Semantics*, March 24 2005, Center for General Linguistics, Berlin, Germany.