

PAPERS IN PSYCHOLINGUISTICS

Proceedings of the
First International Psycholinguistics Congress

ISBN 978-85-910681-0-4



9 788591 068104

PAPERS IN PSYCHOLINGUISTICS

Proceedings of the
First International Psycholinguistics Congress

Anpoll's Psycholinguistics Work Group
March, 2010, Rio de Janeiro, Brazil

Editors
Aniela Improta França
Marcus Maia

1.2 RECURSION: WHAT IS INNATE, WHY IT NEEDS A TRIGGER, WHERE IT BELONGS IN CROSS-LINGUISTIC WORK, AND HOW IT FITS INTO THE MIND

Tom Roeper

University of Massachusetts at Amherst

Abstract

This article studies the central cognitive concept of recursion, investigating its various forms among studied languages. Different experimental explorations of recursion in language acquisition and in other areas are suggested that indicate that the core of the approach lies in the strict formal representations of linguistic theory.

Keywords

Recursion, language acquisition, Experimental Psycholinguistics

1.0 Recursion in the Public Eye

The concept of recursion as a central language ability has received an enormous amount of attention over the past five years, both in the linguistic community and the larger intellectual community, including anthropologists, computer scientists, and mathematicians. And, quite dramatically, it has received considerable public attention as well.

This ultra-focussed environment is very good for the appreciation of how the representational structures of the mind work - how special human beings are - and how, in a broad sense, language structure offers guidance and a metaphor for the study of other, less obvious, modules of mind, such as the work on morality by Marc Hauser. What structures do interfaces across modules require?

Our capacity, thinking slowly, to interconnect virtually all aspects of mind is evident in art where a collage of factors can be drawn together: a single painting can refer to the mind, body, world around us, and any kind of fantasy. Art and intellectual rumination lead to a distinction between what I have called “slow thought” and “fast thought”.

“Slow thought” (Prism (2007)) is where the deepest mystery lies: how do we slowly construct complex mental objects with many steps and revisions. We regard this as a “mystery” as opposed to a “problem” in terms that Chomsky has introduced. We do not know how to probe the deepest ruminative wells of human creativity. It is important to articulate this notion because it is deeply linked to our sense of personal identity and our capacity to respect one another’s dignity.

It is not clear that anyone is incapable of any thought if they can apply a slow-thought method to its construction. It is also unclear that language is crucial to whatever we do when we ruminate at length upon any topic. Therefore it seems wise to say that:

- 1) *No person is in a position to assert that any other human being is inherently incapable of any thought.*

Adherence to this notion is critical in our regard for children---where it is clear that children may lack the tools to articulate their thoughts. A tradition among developmental psychologists has, far too readily, been willing to interpret a failure to express thoughts as a failure to have them. This obviously applies to those whose cultures are radically different from our own as well and whose means of expression may seem alien.

In fact, similar reasoning applies to other species. We really do not know how sophisticated animals thought processes are, as Marc Hauser and various animals rights advocates have pointed out.

Because the social consequences of miscommunication can be severe, it is of paramount importance that we keep the dignity of human beings in mind, not just as a spiritual commitment, but in how we proceed step by step in investigating linguistic structure. Our experiments often reveal failures but who knows exactly where the failure lies?

The assumption about the mysterious nature of slow thought, suggested above, should be, I think carefully reiterated in every context where language is explored.

It is hard to measure the damage done by science. But whenever we ask someone a question, however careful we are about minimizing its importance, the subject may experience a sense of failure. It is my belief that the insights we obtain are valuable, ultimately very much supportive of human diversity and therefore worthwhile despite some negative consequences that arise in the process of obtaining them. Nevertheless we should acknowledge the reality of those human consequences that arise in the ups and downs of research efforts.

1.1 Fast Thought and Linguistic Recursion

The concept of recursion—to put the notion in its grandest perspective--has deep roots in the intellectual history of the 20th century. Since Russell pondered the meaning of a set that contained itself, the concept has animated

computer science, literature, and prominently, linguistics. It seems to be one concept, but like many principles in the mind it may have a number of independent biological instantiations. An analogy may be helpful. Both eyes and ears work with the notion of stereoscopy, but they are neurologically independent and if we understood them properly, the mental representation of coordinated sound will look very different from coordinated vision. Stereoscopic measurement of sound requires a register for time differences (noting the time a sound hits one ear versus the other), while visual stereoscopy operates with a spatial template, comparing angles on two different retina. Sound and sight must each have separate forms of representation, though a common principle underlies them .

Unlike the mysterious use of recursion in slow thought, there are many domains of mind that require fast-thought representations that operate in milliseconds. How does the mind operate in milliseconds? Like any machine, language must have an efficient mechanism for processing information if it occurs with such speed, hence it must involve a systematic representation. Here, we expect, recursion will be present but will be defined and constrained by the representational system in use. Nevertheless slow thought can be methodically introduced, as when recursion is utilized in the slow and laborious efforts Escher used to construct ambiguous pictures.

The distinction between slow thought and fast thought is very real, but there are points where the distinction becomes difficult to discern in language as well. When Shakespeare's King Lear says "ripeness is all" referring to the wisdom of age, one can understand it in one way at the age

of 16 and another at the age of 60. There is a level of immediate understanding, which the 16 yr old and the 60 year old share, while there are implications which appear sometimes within seconds and sometimes within years. From our perspective, implications which require several seconds may already be a form of slow thought. It is an interesting research question that is pertinent to how we comprehend and ultimately represent the semantics of sentences.

When does slow thought enter our ruminations upon hearing a sentence? If someone hears a sentence like:

2) *John really enjoys some of his books.*

This, arguably, entails the implicature that not all of his books are enjoyable. Is this part of the comprehension that occurs within a 200 milliseconds or within

15 seconds. The latter computation is 50 times slower and, possibly, does not occur at all if something else in the context does not invite it. With respect to the distinction between fast and slow thought, this implicature may belong on the slow-thought side---ultimately closer to how we understand King Lear's remark than what the automatic language comprehension system delivers. Where we draw the line between fast and slow thought is an open question. Does the child's acquisition of this implicature follow a different path from other parts of syntax because it engages quite different aspects of mind? It is possible?[1]

The challenge ultimately is to see how recursion is represented in every mental domain. Chomsky, Hauser, and Fitch (2002) claim that its linguistic representation has unique properties, but what are they? As in most biological phenomena, it is very subtle details which reveal the character of the principle.

1.2 Syntax and Externalization

How can we separate the linguistic properties of recursion from the structure of the thoughts we pour into language? Because language is used to convey thought, it is easily construed as thought itself. Obviously, however, our thoughts must also exist in other dimensions---both fast and slow--- in order to be inserted into language. Nevertheless, the logical possibility exists that the language of thought, as Jerry Fodor has described it, simply coincides in structure with the language of expression. We would modify that claim to say that there may be many languages of thought and suggest, as he does, that he is referring to "propositional" thought, where of course we have to ultimately be clear about what we mean by a proposition. In the first instance, it means thoughts that can be evaluated as true or false.

One step toward the separation is to observe where language and thought diverge. Chomsky (2010) has argued that the processes of *externalization* determine many of the structural properties of language which thoughts need not obey. For instance, he points out that while we find the following sentence ungrammatical:

3) **who do you think how __went*

we can easily have a thought that corresponds to that question. Therefore the structure of language and the structure of thought must diverge.

Chomsky argues that the linguistic constraint reflects a constraint on externalization that is stricter than the representation for the thought itself.

Arguing in a parallel manner, we can expect that constraints on recursive expression of thoughts in language may simply be different in kind, because externalization properties constrain their expression. This view follows as well from the argument above: thought engages powers that diverge from language because we can think slowly while communication occurs in milliseconds, not the hours, weeks, and months we may find ourselves ruminating on a topic.

Now let us turn to the question of how “fast thought” works. While, again, some spoken propositions can be contemplated over a lifetime, they must first have an immediate representation at the speed of speech, even if once heard, they are understood more slowly. Comprehension experiments thus involve at least a first pass representation that is an efficient mechanism and a second pass version where a child may contemplate something for many seconds and the first edge of slow thought plays a role.

If the first pass representation is not present, the process cannot begin. That is what we must seek to capture first. It arises in a sentence like:

- 4) *Mary knows Bill knows that I am dating Mary, so Mary did not expect him to ask her out.*

where the “Mary knows Bill knows that...” must be captured right away because immediate memory will erase the phonetic content very quickly. Comprehension of the second part, we may surmise, requires again the capacity to represent:

- 5) *“does not expect him to ask her out”*

efficiently. The two sections of the sentence are presumably shipped off to a representational level where the connections entailed by the word “so” can be construed.

Here, quite obviously, cultural connections are relevant and we would not expect a child, for instance, or someone unfamiliar with dating patterns, to grasp why the “so” feels like it has some logical force. At this point, then we might be seeing the first sign of slow thought. We are not in a position to state the mechanics of this interface, but it is important to be aware that the challenge of stating the interface between the structures of language and thought arises early and we do not have any real model of how it works.

Our focus in the first place must be on the initial representation: what is

involved in recursive structures before we can build a more intricate interface? (6) is an instance of language specific recursion of a propositional structure so that one proposition is inside the other:

- (6) *Mary knows => [proposition1]
proposition 1 => [Bill knows [proposition2]]*

So now we are at the point of asking how these propositions are instantly processed. Such sentences are what a full of theory of recursion and its interfaces with propositions must explain. We are far from being able to build that interface insightfully.

2.0 Simpler forms of recursion

The research task facing acquisition begins at a more elementary level. How does recursion of any kind emerge.? We will describe a variety of cases which we have explored.

Not all forms of recursion are formally identical. We will discuss an intuitive version without formal detail which in part extends into aspects of mathematics and computer science (with which I am only broadly acquainted).

Recursion in language involves different operations and outputs. The core idea lies in the operation (algorithm) that states:

- 7) *General Concept of Recursion: An operation which takes its own output as an input.*

The output of this operation, however, might be represented as a sequence of strings processed one after the other by a process of iteration---or simple copying---that reproduces the previous output. This is what we intuitively associate with a string like:

- 8) *a very, very, very tall house*

or even adjective iteration:

- 9) *a big, big, big house.*

So, the fact that a recursive rule produces a particular output does not guarantee

that it is processed that way by a hearer. This is a possibility that is very pertinent to language acquisition, where a child may apprehend a string in quite a different way from an adult.

We have undertaken research including a variety of scholars and students on five major constructions, via the study of naturalistic data and a variety of different experiments (William Snyder, Bart Hollebrandse, Jill deVilliers, Chloe Gu, Maxi Limbach, Kate Hobbs, Misato Hiraga, and Ed Matthei):

10) *Recursion Domains:*

adjectives: the second, green ball

adjuncts: according to John, according to Bill

compounds: Christmas tree cookie

verbal compounds: coffee-pourer-maker

possessives: John's friend's mother's hat

prepositional phrases: in the room in the corner on the shelf

complements: infinitives: John wanted to start to sing

tensed: John thought that Bill thought that Fred was here

In principle, one can look at the outputs and the operations which produce them as distinct (Lobsian (2010)). In fact we will argue below that children at first misanalyze these forms of recursion as conjoined. The sentences look like a sequence of conjoined word strings even though they have been generated by recursive rules. In fact, adults might convert them into such a sequence as Ed Staebler (reference) has proposed. To grasp the acquisition path we need to articulate several kinds of recursion.

2.1 Kinds of Recursion

We can distinguish four kinds of recursion:

11) *Merge*

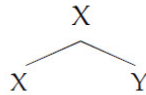
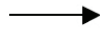
Direct

Indirect

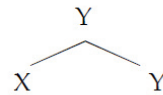
Generalized Transformations

Merge is the putative universal form of an operation that underlies any form of syntactic hierarchical structure (see Roeper (2003)).

12) *merge Y*



or



where (Hornstein (2009)) a label must be chosen reflecting the dominance of either the right or the left branch (or possibly a more complex choice—see Chomsky’s discussion of labeling algorithms and Perez and Roeper (2010) for discussion).

This operation lies at the heart of the claims made by Chomsky, Hauser, and Fitch and it can hardly be disputed. Other forms can be expressed through Phrase-structure rules with an important distinction between Direct and Indirect recursion (Snyder and Roeper (2003)). Direct recursion is where a category reproduces itself and characteristically produces a conjunctive reading:

13) *Direct Recursion:* $X \Rightarrow Y(X)$
 $NP \Rightarrow NP ((and) NP)$

This will produce potentially infinite sentences like:

John, Bill, Fred, and Susan arrived

It has a critical feature: there is no significant semantic ordering among the elements. They are parallel and interchangeable:

14) *Bill, Susan, John and Fred arrived*

By contrast, Indirect recursion may (or may not) involve an interpretive step which changes meaning, as in the way that possessives are stacked:

15) *John’s friend’s father’s student’s essay*

is quite different from:

16) *John’s student’s father’s friend’s essay*

We can capture the difference by introducing the notion of indirect recursion and an important interface constraint, known as the Strong Minimalist Constraint

(SMT) (See Chomsky (2005, 2010):

17) *Phase by Phase interpretation*

The recursion is indirect because another category is present:

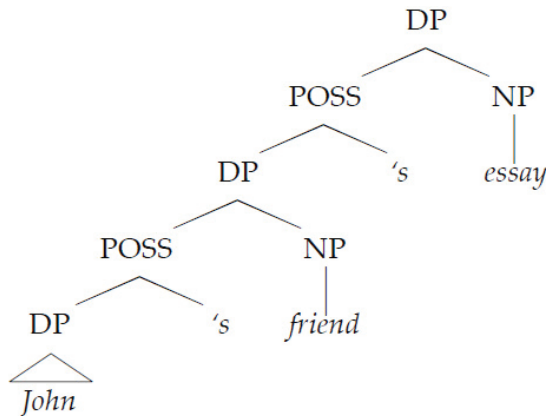
18) *Indirect Recursion:* DP => (Determiner) NP

Determiner => {ARTicle POSSessive}

POSS => DP 's

The Determiner Phrase (DP) is repeated inside the Possessive phrase, and therefore can generate another 's for John's friend's essay:

19)



The interpretation occurs at each Phase. A critical assumption then is:

20) *A DeterminerPhrase is a Phase*

which is a designated interpretive Phase, as are clauses (CP), verbphrases, and PP's. If indirect recursion occurs outside of Phases, it goes by unnoticed and without consequence, as in the fact that there is one the inside another in this sentence:

21) *the box in the corner*

Therefore it is indirect recursion linked to the interpretive requirement (SMT) on Phases, that carries the weight of recursion on interpretation.

2.2 Grammar Variation

It is important to note at this point that grammars vary in where they generate recursion. German (and most Germanic languages) allows a single pronominal genitive, limited to proper nouns:

22) *Maria's Haus* [*Maria's house*]

**Maria's Nachbar's Haus* (*Maria's neighbor's house*)

Therefore the child needs to identify where in his language recursion occurs. Snyder and Roeper (2003, 2005) have argued that children may have to experience recursion directly in order to know that it is present, even though such recursive structures are rare. A major challenge is to uncover where recursion occurs in less studied languages. Here are major known recursion contrasts:

23) a. *Compounds:*

Germanic languages => recursion

Romance languages => no (recursive)

b. *Possessives:*

English => recursive possessives (Saxon Genitive)

German => no recursive possessives

c. *Adjectives:*

English => recursive prenominal adjectives

and no recursive post-nominal adjectives

French => no recursive prenominal adjectives

recursive post-nominal adjectives

d. *Serial verbs:*

Bantu => recursion

English => no recursion

e. *PP:*

English => recursion

f. *Clausal:*

Germanic, Romance => recursion

Sign Language, Piraha => no recursion (disputed)

There is much that may yet need to be uncovered across the languages of the world.

2.3 Generalized Transformations

The generation of indirect recursion is in a sense automatic when the phrase structure rules generate these options. However there is a fourth kind of recursion which suggests that this form of recursion involves a further step of insertion. It is called Generalized Transformations (expanded in Tag grammars) where each recursive Phase is preformed and substituted later. Relative clauses, for instance, may be separately assembled and then substituted for a simple NP => NP [relative] (see Lebeaux (2000)). To put it simply, the grammar generates a sentence like: the boy plays baseball and that I like separately and then inserts one into the other. We will not go into the details of this analysis but it plays a role in our account of the acquisition path. In brief, if recursion is automatic we will have to explain why it does not appear instantly in children's grammars. The answer we argue, is that recursion does involve an additional operation of composition that is captured by a Generalized Transformation of insertion.

3.0 The Conjunction Option: Direct Recursion first

Study of the acquisition of recursion thus far leads to an important generalization:

24) *Children impose direct recursion and a conjunctive interpretation on complex sentences.*

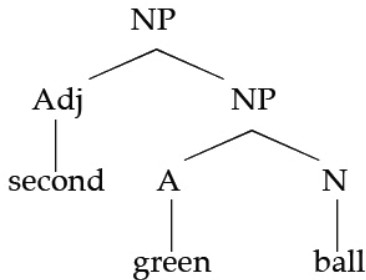
We argue that children analyze, initially, incoming sentences as an unembedded sequence, generable by Direct Recursion, with a conjunctive reading and no interpretive Phase.

We will review now a few of the results in acquisition and concentrate on how experimentation behind possessives was developed (see Roeper (2007) and especially (2009)) as well as papers on individual experiments).

3.1 The appearance of and

The first evidence of a conjunctive interpretation arises in naturalistic data where "and" is frequent and arises where one senses that adults might normally put a different conjunction. These are randomly selected from a Childe's search for "and":

29)



Thus, the default form appears to be conjunctive.

3.3 Prepositional Phrases

Naturalistic evidence gathered by Chloe Gu shows that children will treat PP's conjunctively and resist recursion (Gu (2008)).

30)

Father: Up in the shelf in the closet

Child: yeah

Father: can you say that

Child: up in the shelf in the closet

Father: very good, up in the shelf in the closet in the kitchen, can you say that?

Child: yeah, up in the # up in the # what

Father: up in the shelf in the closet in the kitchen

Child: up in the shelf in the # what

Father: closet

Child: in the closet in the kitchen

Father: in the jar up in the shelf? can you say that?

Child: I can't

Father: you can

Child: in the jar # say in the jar

Child: up in the shelf in the jar in the closet in the kitchen

Note that the PP's are now conjoined (in the shelf and in the jar), rather than recursively embedded (the shelf is not in the jar). It would be good to gather experimental evidence on this point.

3.4 Verbal Compounds

For verbal compounds Hiraga (Hiraga 2010): found that children up to roughly age 6 took a conjunctive reading in an experiment where a story allowed both a conjunctive and a recursive reading, where adults had a recursive one (see Hiraga (2010) for more extensive evidence):

31) *“which one is the tea-pourer-maker? Why?”*

Conjunctive:

6yrs: *“because he makes and pours tea”*

Recursive:

7yrs: *“because he makes the machine that pours tea”*

Why should this form of recursion be so much later? We argue elsewhere that it is a reflection of leftward movement operations and Relativized Minimality (see Friedmann et al (2009)).

3.5 Sentential Complements

The same preference for conjunctive readings was found initially for complements where initial elements are treated as independent adjuncts (I think he is here = I think and he is here) [3].

Nevertheless there is evidence that fairly young children use structures that look recursive:

32)

*adam45.cha:*CHI: “he thought those guns where coming from outside him”*

*adam45.cha:*CHI: “he thought I said something (a)bout window”*

*adam52.cha:*CHI: “he thought # bad people would get him’
“I thought you said they gonna warm”*

However it is not completely clear that these are not adjoined elements like, which themselves may be seen as recursive or conjoined:

33) *According to John, according to Bill, they are gonna be warm.*

Conjoined: according to John and according to Bill

Hacquard et al (2010) provide relevant experimentation for this question. We need more extensive investigation, in depth, of each of these constructions. At

the same time, we need to be expanding our inventory of where recursion arises and how it is acquired. Roeper (2009) reviews the evidence of recursion in serial verb languages (Adone (1994)) which also deserves more careful investigation. We turn now to a case study of how research on recursive possessives has progressed and we introduce some new evidence from Japanese.

4.0 Recursive Possessives

Naturalistic data on recursive possessives indicates that they are difficult (see Roeper (2007) for more examples):

34)

MOTHER: *What's Daddy's Daddy's name?*

SARAH: *uh.*

MOTHER: *What's Daddy's Daddy's name?*

SARAH: *uh.*

MOTHER: *What is it?*

What'd I tell you?

Arthur!

SARAH: *Arthur! Dat my cousin.*

MOTHER: *Oh no, not your cousin Arthur.*

Grampy's name is Arthur.

Daddy's Daddy's name is Arthur.

SARAH: *(very deliberately) No, dat my cousin.*

MOTHER: *oh. What's your cousin's Mumma's name?*

What's Arthur's Mumma's name?

MOTHER: *What's Pebbles-'s momma's name?*

SARAH: *Wilma.*

MOTHER: *Wilma ...yeah.*

And what's Bam+Bam's daddy's name?

SARAH: *Uh, Bam+Bam!*

MOTHER: *No, what's Bam+Bam's daddy's name?*

SARAH: *Fred!*

MOTHER: *No, Barney.*

SARAH: *Barney.*

MOTHER: *What's his mumma's name?*

SARAH: *She's right here.*

Sarah is resisting a recursive understanding although all the pragmatic support and world knowledge she needs is close at hand. A 6yr old, though, finally produces one:

35) «*where's Toto's girl's*»

4.1 Possessives Explored

In a series of explorations by various students and colleagues we began to pursue the question experimentally. The first step is to invent a context where several options are available and equally plausible. The first was invented by Sarah Gentile who gave a child three pictures based on familiar Sesame St characters, but no story was presented.

- 36) A. *Picture of Cookie Monster*
 B. *Picture of Cookie Monster and his sister*
 C. *Picture of his sister*
 Can you show me Cookie Monster's sister's picture?

The results showed that about 1/3 of the 3-4 yr olds took the conjunctive reading (Cookie Monster's and sister's picture) and chose Picture B.

In the next experiment by Maxi Limbach (2010) children and L2 German speakers whose L1 has possessives, but no recursion, were given a story. Here the story attempts to make both options equally attractive.

37) *Context story example for screen setting:*

Jane has a nice blue bike and Jane's father Gordon has a racing bike. When they do a tour together they have another bike which they can ride together. Sam has a red bike and his father Paul has a silver bike.

Which picture shows Jane's father's bike?

Subjects who were non-native often gave a conjoined reading or dropped one of the possessives.

38) Results

Age	All	Correct	Middle drop	First drop	Random	Conjunctive	Other
5	32	19 (59%)	3 (9%)	2 (6%)	0	7 (22%)	1 (3%)
4	23	16 (70%)	1 (4%)	1 (4%)	0	4 (17%)	1 (4%)
3	32	18 (56%)	6 (19%)	2 (6%)	0	3 (9%)	3 (9%)
Adult NS	109	90 (83%)	2 (2%)	11 (10%)	1 (1%)	5 (4%)	41 missing
Adult NNS	102	63 (62%)	10	12 (12%)	9 (8%)	8 (8%)	36 missing

Table 1: Overall results

It is an interesting fact that L2 speakers of English persistently claim that recursive possessives are extremely difficult. It points again to the notion that recursion is both central and difficult in language. The mere fact that we explain it to someone does not enable them to process recursion easily. The derivation for verbal compounds, involving leftward movement, creating a left-branching phenomenon may play a crucial role (See Roeper and Hollebrandse (forthcoming)).

4.2 Japanese

Finally, we look at a pilot experiment on recursive possessives in Japanese where, for the first time, four level recursion has been explored by C. Fujimuri (2010). In Japanese we have a structure similar to English but marked by *do*:

39) English: *John's brother's car.*

Japanese: *John no otouto no kuruma.*

John 's brother 's car.

A simple set-up was matched by a picture sequence that allowed the relations to be easily kept in mind.

40) *The story, told in Japanese (Figure 1). This girl is Mika and this is her dog. This boy is Mika's friend and his name is Kenta. This is Kenta's dog. This is Mika's brother and his name is Sho. And this is his dog. This is Sho's friend, Yuki, and this is her dog. And look, everyone is holding a ball.*



Figure 1: Pictures for multiple possessives in Japanese

These are single possessive questions.

1. What color is Mika's ball? - Orange
2. What color is Kenta's flower? - Yellow
3. What color is Sho's shirt? - Red

These are double possessive questions.

4. What color is Mika's dog's ball? - Black
5. What color are Mika's brother's shoes? - Yellow
6. What color is Sho's friend's ball? - White

These are triple possessive questions.

7. What color is Mika's friend's dog's ball? - purple
8. What color is Mika's brother's friend's flower? - red
9. What color is Sho's friend's dog's tail? - black

This is a quadruple possessive question.

10. What color is Mika's brother's friend's dog's ball? - yellow

	child 1	child 2	child 3	child 4	child 5	child 6	child 7
Age	2;5.26	3;2.1	4;3.18	4;4.8	5;2.13	5;7.18	6;0.13
Q1	○	○	○	○	○	○	○
Q2	○	×	×	○	○	○	○
Q3	○	○	○	○	○	○	○
Q4	×	×	○	○	○	○	○
Q5	×	×	×	×	○	×	○
Q6	×	×	×	○	×	○	○
Q7	×	×	×	○	×	○	○
Q8	×	×	×	○	×	○	○
Q9	×	×	×	×	×	○	○
Q10	×	×	×	○	×	○	○

Table 2: Two, three, and four embedded recursive possessives for Japanese children

Table 2 summarizes the responses of the seven children for the ten

questions: O = success, X = failure

What stands out in this chart is that those children who master 3 part possessives (7,8,9) have no difficulty with 4 part possessives (10). The 2 part possessives (4,5,6) are likewise grasped almost at the same time as 3 and 4 part possessives. This is strong evidence that once recursion is acquired much like the acquisition of the successor function in arithmetic (children who get 2,3,4 then grasp that 5,6,7 continue in the same manner). And it shows that there is not a significant processing demand producing a difference between 3 and 4 level possessives. These facts are perhaps the most dramatic evidence that language and recursion are a mechanism.

4.3 Cognitive Recursion again

What role do the pictures play? One might observe that they give us a visual hook with which to keep track of all the relations. They are an additional cognitive guide to the meaning. While this is correct, it is not a substitute for grammar. If we had the conjoined version:

41) show me Mika's and brother's and friend's and dog's ball

it would call for us to point to all of their balls and not just the final one, just as our first example elicited a reference to Cookie Monster's and sister's pictures.

This is precisely what transpired with the younger children who failed to grasp the recursive sentences. When there were more than one possessive, child 2's answers were more than one. For example, for the question, "What color is Sho's friend's ball?" his answer was "this and this and this" and pointed to Sho's ball, Sho's dog's ball, and his friend, Yuki's ball. Other answers among the younger children involved deleting one or more possessive.

We return thus again to our original question of how recursion relates to other aspects of mind. In effect an iterated visual scheme--allowing a child to point to "this and this and this" in a logical sequence deploys a mental capacity for a kind of cognitive recursion that is mapped on top of the intricate grammatical system that has produced recursion with the morphology of 's or do. The two are not the same, but nothing prevents us from using other mental capacities as aids to linguistic structure. One must not, however, confuse them with the mechanisms of linguistic structure that produce sentences.

The recursive possessive might engage quite a different mental scheme:

42) *Our Saab's left rear tire's hubcap's color is different from the right.*

Here we use our knowledge of how a car is organized to understand a 4 level recursive construction, but no recursive cognitive structure is involved. Note that the ellipsis requires us to reconstruct the entire recursive structure again:

43) *different from the right [rear tire's hubcap's color]*

In the former case, a kind of knowledge of visual and social relations allows us to trace the connections between brother, friend, and sister. Another case, like Monty Python's

44) *and your father's father's FATHER's father*

utilizes a recursive cognitive scheme applied to kinship. That scheme, however helpful, is quite different from the syntactic recursive structures it is linked to. Thus we have a mapping:

45) *Cognitive recursion linked to a picture sequence:*

[Name [relation [relation[relation]]]]

Name brother sister friend

Linguistic recursion: ['s] 's] 's] 's] N

= abbreviation for the whole syntactic structure

The critical point here is that the existence of a mapping does not mean that the two forms of mental representation are the same object. The recursive syntactic structure for possessives, adjectives, complements, and compounds, though each involving Phases and the SMT, are syntactically quite different.

It is worth reiteration that a person, in particular a child, might have quite intricate cognitive maps that entail an extensive form of cognitive complexity which enables many kinds of thought, indicates that he is human being with full cognitive complexity, without having acquired the particular mapping that language uses to represent the information for communicative purposes.

4.3 Acquisition Path

We have not fully discussed the pattern of how these different forms of

acquisition emerge and how properties of derivations may determine when the child can see them. In a word, if the derivational operations that are required for generating recursive structures involve transformations, they will be more challenging for the child. These important questions are addressed elsewhere (Roeper and Hollebrandse (in preparation)).

5.0 Conclusions

Our journey has covered recursion from a cultural, cognitive, and linguistic perspectives. The core of the approach lies in the strict formal representations of linguistic theory. We then discuss the various forms of recursion that are found, so far, among studied languages. Many more may still be discovered.

We have displayed acquisition methods---which we believe can apply far beyond acquisition to the study of any new language---and provided the reader with a taste of how our experimental explorations are constructed. In every instance, it is the logic of theory, the availability of pertinent acquisition data, and the experimental results appreciated as converging forms of evidence which provides the sharpest evidence.

Each domain has been described only briefly and each warrants far more extensive research.

References

- Adone, D. (1994) Acquisition of Mauritian Creole. *Language Acquisition and Language Disorders* No. 9, Amsterdam: Benjamins
- Berwick, R. and N. Chomsky 2008. *The Biolinguistic Program: The Current State of its Evolution and Development* Forthcoming in *Biolinguistic Investigations*, Di Sciullo & Aguero (eds.), MIT Press
- Chomsky, N. 2005. Three factors in the language design. *Linguistic Inquiry* 36:1–22.
- Chomsky, N. 2007. Approaching UG from below. In *Interfaces + recursion = language?* Chomsky's minimalism and the view from semantics, ed. U. Sauerland and H.-M. Gärtner, 1–30. Mouton de Gruyter
- Chomsky, N. 2008. On phases. In *Foundational issues in linguistics*, ed. C. Otero, R. Freidin, and M.-L. Zubizarreta, 133–166. Cambridge, Mass.: MIT Press.

- Chomsky, N. (2010) Lecture at Amherst on Recursion (ms)
- Diessel, H. 2004. *The Acquisition of Complex Sentences*. Cambridge: Cambridge University Press.
- Fujimuri, C. (2010) Acquisition of recursive possessives in Japanese. UMass. ms.
- Gu, C. 2008. "Structural ambiguity and AP/PP recursion in language acquisition". UMass ms.
- 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.
- Hiraga, M. (2010) Acquisition of Recursive Verbal Compound Nouns. Paper presented at DFGS Workshop on recursion, Berlin.
- Hobbs, K., Hollebrandse, R., J. deVilliers, and T. Roeper (2008) Second Order Embedding and False Belief GALA Proceedings.
- Hollebrandse, B. and T. Roeper (submitted) "Recursion and Propositional Exclusivity," *The Linguistic Review*.
- Hornstein, N. 2009. *A Theory of Syntax: Minimal Operations and Universal Grammar* Cambridge University Press.
- Lebeaux, D. 2000. *Language acquisition and the form of grammar*. Amsterdam: John Benjamins.
- Hubert, A. (2009) *The Acquisition of Ellipsis and the Structure of the Noun Phrase* MA Potsdam Diplomarbeit.
- Limbach, M. and D. Adone (2010) *Language Acquisition of Recursive Possessives in English* Proceedings of BUCLD, Cascadilla Press.
- Matthei, E. 1982. The acquisition of prenominal modifier sequences *Cognition*, 11 (3), 301-332.
- Roeper, T. and A. Perez (2010, to appear) Simplicity and complexity in child language and its explanation ms. UMass and UToronto.
- Roeper, T. 2007. *The Prism of Grammar*, M.I.T. press, Cambridge.
- Roeper, T. and Snyder, W. 2004. Recursion as an analytic device in acquisition. In *Proceedings of GALA 2003 (Generative Approaches to Language Acquisition LOT Publications*, Utrecht, The Netherlands.

Roeper, T. & Snyder, W. 2003. Language learnability and the forms of recursion. In A.M. Di Sciullo & R. Delmonte (Eds.) *UG and external systems*. Amsterdam: John Benjamins.

Roeper, T. and B. Hollebrandse (forthcoming) Language-Specific Recursion and the acquisition path.

Lobina, D. (2010) What recursion could not be ms. URV Tarragona, Spain.

Snyder, W. & Roeper, T. 2004. Learnability and recursion across categories. In A. Brugos, L. Micciulla, & C. Smith (Eds.), *Proceedings of the 28th Boston U Conference on Language Development* (pp. 543-552). Somerville, MA: Cascadilla Press.

Sowalsky, E. Hacquard, V. and T. Roeper (2009) Is PP Opacity on the Path to False Belief? *Proceedings BUCLD* Cascadilla Press.

Stabler, E. (2010) Paper on recursion and processing presented at recursion Conference Amherst, Mass.

Notes:

[1] There is an extensive literature on the appearance of implicatures; I would point particularly to the work of Gennaro Chierchia, Anna Verbuk, Francisca Foppollo, Julien Musolino and Anna Papafragou, and many references in their work.

[2] See Hubert (2009) for German preference for Direct recursion.

[3] See Diessel (2004), Hacquard (2009), Hobbs et al (2009), Roeper (2009), and all of the literature on complementation and False Belief where the initial representation of complements seems to be loosely adjoined in a way consistent with a conjoined interpretation.

1.3 THE COMPREHENSION OF *REALIS* AND *IRREALIS* MOODS BY BRAZILIAN PORTUGUESE (BP) SPEAKING CHILDREN¹

Jacqueline Rodrigues Longchamps & Letícia Maria Sicuro Corrêa

PUC-Rio / LAPAL

Abstract

This study deals with the comprehension of the morphological distinction between *realis/irrealis* moods by 5-7-year-olds acquiring BP. A YES/NO question experiment is reported, focusing on the indicative (*realis*)/subjunctive (*irrealis*) opposition and on the equivalence between subjunctive/infinitival forms in the expression of *irrealis* mood. The results show that this equivalence is recognized by 5-year-olds, though the opposition above is only mastered by the age of 7. Given the early expression of the conceptual *realis/irrealis* distinction by finite/non-finite forms, the pattern of comprehension suggests that BP verbal morphology poses difficulties to the identification of the expression of mood in the language.

Keywords

Language acquisition, functional categories, mood, *realis/irrealis* meanings, TAM complex, Brazilian Portuguese.

1. Introduction

The present study is part of a broader research in which the acquisition of verbal mood in Brazilian Portuguese (BP) was investigated (Longchamps, 2009a). Mood is a formal feature which projects the functional category MoodP, responsible for carrying information of finiteness and notions such as *realis* and *irrealis* (Rizzi, 1997; Cinque, 1999). The *realis* mood is related to factual events, which in Portuguese are expressed by means of indicative forms, while the *irrealis* mood, related to hypothetical, conditional and to-be-accomplished events, is expressed in this language by means of subjunctive and infinitival forms. Hypothetical events can also be codified by indicative forms, when combined with subjunctive ones in conditional sentences (*Se João chegasse, Maria ficaria* (conditional past tense form) */ficava* (imperfective past tense form) *feliz* [If John arrived, Mary would be happy]).

The *realis/irrealis* contrast is fundamental to human cognition. According to the Semantic Opposition Hypothesis (Hyams, 2001), it would be expected that children would find a means of expressing this conceptual distinction, even before mastering the proper morphology of the language under acquisition. It has been attested that, in Greek, Swahili and Italian, children make use of the bare

¹ This investigation was supported by a grant from Fundação Carlos Chagas de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ E-26/100.425/2008) to the first author and by a grant from Brazilian National Research Council (CNPq 304.159/2008-5) to the second author.