

# The Acquisition of Recursion: How Formalism Articulates the Child's Path

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We distinguish three kinds of recursion: Direct Recursion (which delivers a 'conjunction' reading), Indirect Recursion, and Generalized Transformations. The essential argument is that Direct Recursion captures the first stage of each recursive structure. Acquisition evidence will then be provided from both naturalistic data and experimentation that adjectives, possessives, verbal compounds, and sentence complements all point to conjunction as the first stage. Then it will be argued that Indirect Recursion captures the Strong Minimalist Thesis, which allows periodic Transfer and interpretation. Why is recursion delayed and not immediate? It is argued that an interpretation of Generalized Transformations in the spirit of Tree Adjoining Grammar offers a route to explanation. A labeling algorithm combines with Generalized Transformations to provide different labels for recursive structures projection. Recursion is then achieved by substitution of a recursive node for a simple node. One simple case is to substitute a Maximal Projection for a simple non-branching lexical node. A more complex case — essential to acquisition — is to substitute a category for a lexical string. Consequently, a computational 'psychological reality' can be attributed to explain why recursion requires an extra step for the addition of each recursive construction on the acquisition path.

*Keywords:* direct recursion; generalized transformation; indirect recursion; interfaces; phases; strong minimalist thesis

## 1. Introduction

Why would a child who can say *wagon-puller* not be able to understand *wagon-*

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*puller-maker*? Why is language-specific recursion not immediate? Our goal is to articulate the acquisition challenge, review the relevant evidence, and imagine why there is an acquisition path for recursion. The evidence leads to a rather tight grammatical edifice, which, however, is full of theoretical and empirical weak points that deserve further research. Why such a strategy? It is really the strategy of linguistic theory in general. Weak points — like question-mark data — can be strengthened by other branches in a logical and empirical, hence persuasive, edifice once general properties are identified. If we follow the acquisition path of several kinds of recursion, their faint light can become a strong beam when seen together.

In a similar vein, a number of formal alternatives<sup>1</sup> become much sharper when we attach them to empirical phenomena, even if the data might seem open to many interpretations.<sup>2</sup> The major task at hand, ultimately, is to build transparent interfaces between structure and interpretation and, as well, an interface between a theoretical account and the actual time course of acquisition. Yet, like the evolving notation of theoretical linguistics, these are proposals about how to build a notation that responds to both the facts of recursion and the acquisition path, neither of which is fully evident. Therefore we include pilot data and naturalistic data which might seem insufficient for traditional psychological experimentation, but which, in light of powerful theoretical proposals, become legitimate reference points in the interaction between theory and empirical data. This first ‘fieldwork’ stage of acquisition needs a recognized legitimacy as an important background to detailed work, much as rough awareness of language variation in unusual languages tempers broad claims about UG.

First, let us distinguish between a completely universal form of recursion, namely Merge, and language-specific forms. Merge is a binary recursive operation that is invoked as soon as more than two words are combined.<sup>3</sup> Therefore all languages with 3 word combinations are examples of recursion over

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<sup>1</sup> This is written by someone who is by no means well-trained in mathematical or formal notation. See Tomalin (2007) and Lobina (2010) for formal discussions that articulate some of the distinctions between the formal and the empirical approaches to notation. Nonetheless, the argument does build upon, in a broad way, the implicit biolinguistic philosophy that language formalism should be built straight from empirical data — much like the double-helix model in biology — rather than adhering to theorems that logic or mathematics have derived within their own systems. Thus Chomsky (2010) argues, as I understand it, that linguistic formalism should use concepts from set theory without being built from its theorems.

<sup>2</sup> In particular, one might seek to reduce the arguments to processing claims as proposed by Berwick & Weinberg (1986) and to various proposals that claim that sentences are first parsed as a series of conjunctions, then interpreted in a second pass by imposing dominance relations (see Stabler, to appear). Whatever the merit of these claims about hearer parsing, if the phenomena can be resolved into time-free structural grammatical representation, then we take this to be a superior account. Some of this structure may be a reflection of ‘externalization’ demands that are tighter than grammatical demands, but a unified account would definitely help computational efficiency at any level (see Berwick & Chomsky 2011).

<sup>3</sup> It is exactly a binary, not a ternary operation, following Chomsky (2010) who argues that theories of sideward movement and multi-dominance constitute ternary merge, a deviation from this essentially biological claim about how core grammar works, but perhaps another reflection of Direct Recursion.

two binary acts of Merge. It is possible to imagine a three-term concatenation without a binary substructure, but empirical arguments exist to demonstrate that this is not the case for humans in structure-building beyond conjunctive relations, which we will elaborate in what follows.<sup>4</sup> The presence of recursive Merge means that all languages must be recursive in a fundamental sense, just as Hauser *et al.* (2002) have claimed, which constitutes a strong biological claim.

Nevertheless, not only the empirical question, but also the formal question remains alive: Recursion may not be captured by a single formalism or be represented as a single object in the brain.<sup>5</sup> In the *Prism of Grammar* (Roeper 2007), I argued that the principles of grammar are a model for how we envision other mental operations. If true, then other analogies should be available as well. Stereoscopy, the integration of information from two sources, is one concept in science, but it applies to both eyes and ears. Nevertheless, the purposes and neurology of eyes and ears are quite different, and therefore it is obvious that they must be separately represented in the neurology of the brain and its consequent informational representations. There is no single stereoscopy center in the brain. It is possible that we need to look at recursion in the same manner. In other words, our ultimate understanding will involve coordinated representations in both grammatical and biolinguistic terms, which may be conceptually and biologically distinct from apparent forms of ‘visual’ recursion (see Jackendoff 2010, Berwick & Chomsky 2011).<sup>6</sup>

We will focus upon three representations for building recursive structure (defined below): Direct Merge, Indirect Merge, and Generalized Transformations (GTs) as realized in an adaptation of Tree-Adjoining Grammar (TAG). Direct Merge allows a category to generate itself, while indirect Merge introduces an identical category only through another non-identical one. GTs combine pre-existing structures. Related, non-recursive forms include iterativity (as in ‘*very, very big*’) and Concord (‘I don’t want *any* food at *any* time for *any* reason’). It is an interesting question, particularly from a biological perspective, whether there are deep connections among recursion, iterativity, and concord — but they lie beyond what we can approach here.

A critical ingredient in our account is the interface with interpretation,<sup>7</sup>

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<sup>4</sup> One might, in fact, argue that Direct Recursion and conjunction constitute a non-grammatical interface with phase-based grammar. This would explain why conjunctions create islands and have links to very challenging forms of across-the-board movement and gapping. In a sense, then, language acquisition begins when children re-analyze conjoined representations. Then conjunction would belong to Primary Linguistic Data representations (Chomsky 1965) whose representational characteristics deviate from what we find in Final Grammars, except in marginal constructions where they reappear. Bob Berwick (p.c.) points out that Miller & Chomsky’s (1963) explanation of center-embedding essentially claims that conjunction is the default to which the grammar returns. It is significant, then, if acquisition reveals the same default in a host of different constructions.

<sup>5</sup> Bob Berwick (p.c.) observes that this is essentially the position of David Marr on the status of representations for vision in the brain.

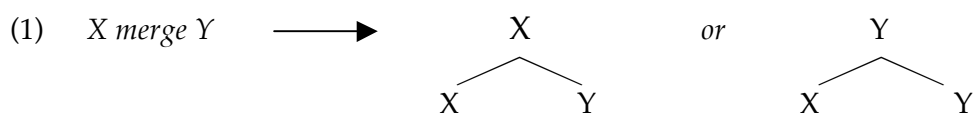
<sup>6</sup> We have no view of this matter, but Noam Chomsky (p.c.) and Bob Berwick (p.c.) argue that visual and mathematical abilities are parasitic on grammatical recursion.

<sup>7</sup> See Roeper (2009) for discussion of the distinction between an interaction and an interface. Mechanical interfaces are like cogs in a wheel, while interactions may not always have a principled basis.

which, we argue, is linked to Indirect Merge in an important, putatively innate, way. Ultimately the ideal notation for an interface should be transparent for both syntax and semantics. The critical biological claim is that there is a strict interface between points of recursion and points of interpretation. One could imagine that an organism could have both capacities, but lack the interface.<sup>8</sup>

## 2. Merge and Labeling Algorithms

Merge is the putative universal form of an operation that underlies any form of syntactic hierarchical structure, as in (1).<sup>9</sup> Although a set may be defined without a label or ordering, a signal feature of Merge lies in the fact that human languages always assign a Label to every Merge.<sup>10</sup>



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 (1995, 2008) discussion of labeling algorithms.<sup>11</sup> Hornstein (2009) has suggested that it is the combination of Merge and labeling which may define human grammar as distinct from animal constructs. We take the argument one step further in arguing that the connection between recursion and the Strong Minimalist Thesis (SMT, see below), which argues that certain nodes represent ‘phases’ which carry an interface with interpretation.

### 2.1. Direct and Indirect Recursion

An initial distinction between direct and indirect recursion can be made in terms

<sup>8</sup> Roeper (1978) argued that both hierarchy and node labels could have other origins but the innate property of language is to link them in a fixed way. Hauser (2008) argued that animals might have all abilities, but lack only the interfaces. In ongoing work, Ray Jackendoff argues that it is the connection to words that is unique to grammar. This view will reduce to the categorical feature that words carry and thus relate to the labeling claim.

Left unarticulated is how to interpret the common idea that “recursion is a general cognitive capacity” (Ray Jackendoff’s ongoing work but also Everett, to appear). The term *general* is where we must be careful. We might say that ‘motion’ is a general capacity of all muscular organisms, but the claim would have little biological force since it is obvious that the mechanisms for motion of eyelids and legs are so differently represented in different organisms, or different parts of one organism. This is analogous to our argument that there is no Stereoscopia Center in the brain, but rather the principle is independently represented in eyes and ears.

<sup>9</sup> See Roeper (2003) for discussion of the interaction between successive forms of Merge and compositionality for DP.

<sup>10</sup> A question, of course, arises about how linearization occurs and whether it belongs to a process of externalization, as Chomsky (2010) has suggested. If such a reframing occurs, the role of order and labeling in the definition of the externalization interface would leave these claims unchanged, I believe.

<sup>11</sup> See Roeper & Pérez-Leroux (2010) for discussion.

of phrase-structure rules (Snyder & Roeper 2004). Direct recursion is where a category reproduces itself and characteristically produces a conjunctive reading:

- (2) Direct Recursion:  $X \rightarrow Y(X)$   
 $NP \rightarrow NP((\text{and}) NP)$

This will produce potentially infinite sentences like:

- (3) 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:

- (4) Bill, Susan, John, and Fred arrived.

It is applicable to any category, even below the lexical level:

- (5) a. in and around and over and under the structure  
 b. pre- and post-operative care

but does not participate in other aspects of grammar; for instance, there are no movement rules that allow extraction from conjunction (see Ross 1967):

- (6) \* how did he go in and \_\_ the structure  $\rightarrow$  'around'

It is, in a sense, at the margins of grammar, but it is also a mental ability that characterizes the first stage — and the default grammar — of children with respect to every category in the grammar, as we shall illustrate.

Bob Berwick (p.c.) makes the interesting suggestion that conjunction means one simply relaxes the 'completeness' condition on dominance and precedence such that not every two phrase markers must be in a dominance (or precedence) relation. In terms of *John, Bill, Fred, and Susan arrived*, this model says that the NPs bear no syntactic relation to one another.<sup>12</sup> In sum, conjunction carries no dominance relations, and therefore a basic tenet of grammar is not honored.

Such an account matches ours, but it is worth articulating that, if the child assumes no grammar here, then inference must supply much of the meaning, including implications. Sentences like *John got drunk and Bill got angry* allow a causative inference for adults, and perhaps for children too. It can be seen as part of the acquisition process that a child exchanges broad and unreliable inferences for syntactically guided compositional meanings.

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

<sup>12</sup> Conjunctive *and* inside grammar has other subtle consequences. The default notion of Conjunction should not be seen as co-extensive with the grammar of *and*. See Munn (1999) for arguments on the special status of first conjuncts. *and*-conjunction also interacts, for instance, with binding theory. Nor should default conjunction be identified with its use in logic. It is essentially a minimal, non-syntactic association that invites all kinds of inferences, much like root compounds are open to inference: *Elephant icebox* could be an icebox for elephants, or one that looks like an elephant or has an elephant picture on it.

(7) John's friend's father's student's essay

is quite different from:

(8) John's student's father's friend's essay

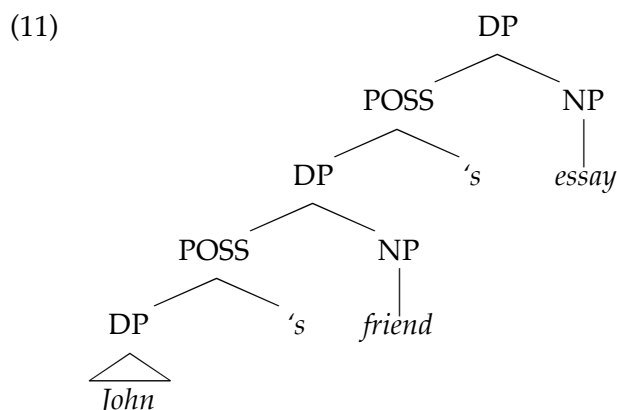
We can capture the difference by introducing the SMT (see Chomsky 2008, 2010):

(9) *Strong Minimalist Thesis (SMT)*  
Interpretation proceeds phase by phase.

Although it remains an open question just where phases occur, good arguments for CP, *v*P, PP, and DP as phases have been made (see van Hout *et al.* 2011). The recursion is indirect because another category is present:

(10) Indirect Recursion: DP → (Determiner) NP  
Determiner → {ARTicle POSSessive}  
POSS → DP 's

The DP is repeated inside the possessive phrase, and therefore can generate another 's for *John's friend's essay*:



If interpretation occurs at each phase, the phase-assumption is critical,

(12) A DP is a phase.

which is a designated interpretive domain, as are CP, *v*Ps, and PPs.<sup>13</sup> In Chomsky's phase-theoretic formulation, Transfer sends a syntactic object SO to the semantic component, which maps it to the C-I interface; this SO is identified

<sup>13</sup> If indirect recursion occurs through an intermediate phase of a very different type, like a PP, it does not impose the same recursive interpretive demand:

(i) [<sub>DP</sub> *the box* [<sub>PP</sub> *in* [<sub>DP</sub> *the corner*]]]

A PP intervenes between two DP's. Here we are basically unaware that one Determiner (*the*) is inside another. Thus the possessive interpretation inside a possessive interpretation is where recursion has the effect we are after.

as a *phase*. Thus the SMT entails that “computation of expressions must be restricted to a single cyclic/compositional process with phases”. Or in full:

As noted, iterated Merge incorporates the effects of three of the EST/Y-model compositional cycles, while eliminating d- and s-structure. Still unaccounted for are the cyclic/compositional mappings to the phonetic and semantic interfaces. These too are incorporated, and the final internal level LF is eliminated, if at various stages of computation there are Transfer operations: one hands the SO already constructed to the phonological component, which maps it to the SM [sensorimotor] interface (“Spell-Out”); the other hands SO to the semantic component, which maps it to the C-I [conceptual-intentional] interface. Call these SOs *phases*. Thus SMT entails that computation of expressions must be restricted to a single cyclic/compositional process with phases. In the best case, the phases will be the same for both Transfer operations. (Chomsky 2008: 142)

As a strong constraint, it guides and constrains acquisition as well.

## 2.2. *Alternating Phase Constraint*

Boeckx (2009) argues for what we can call the Phase Alternation Constraint (see also Richards 2011 for a somewhat different implementation):

(13) *Phase Alternation Constraint: Interpretation must occur in alternating sequence*

Transfer takes place every other time Merge applies and yields the pattern:  
phase — non-phase — phase — non-phase

In each of the constructions above we find that this sequence is followed; every other time Merge applies yields the following pattern:

(14) a. {Head4 *Transfer*2, {Head3, {Head2 *Transfer*1, {Head1}}}}  
b. = [C *phase* [T [*v phase* [V]]]]

This leads to the following kinds of familiar alternations:

(15) Sentence: John thinks that Bill thinks that Fred...  
                  VP      CP          VP      CP

PP:          John’s knowledge of Bill’s knowledge of...  
                  DP          PP          DP          PP

(16) Possessive: John ‘s friend ‘s father ‘s car  
                  NP Poss NP Poss NP Poss NP

In sum, it is indirect recursion linked to the interpretive requirement (SMT) on phases that carries the weight of recursion as a pivotal grammatical device. We will now show how languages differ in where they allow indirect recursion, and then reveal a two-step acquisition path for each form of language-specific recursion.

### 2.3. Grammar Variation

A broad overview of how grammars may vary in recursion will help see the scope of the acquisition challenge. German (and most Germanic languages) allows a single pronominal genitive, limited to proper nouns:

- (17) a. Marias Haus  
       *Maria's house*  
       b. \*Marias Nachbars Freundins Haus  
       *Maria's neighbor's friend's house*

Therefore, the child needs to identify where in his language recursion occurs. In German we argue that the POSS directly dominates the lexical item 's and therefore does not dominate DP producing recursion.<sup>14</sup> This is the child's first assumption.

Among the major known recursion contrasts, where a single element but no recursive elements occur, we find the following: (i) single possessives, as in German *Marias Haus* 'Maria's house', (ii) single double verbs, as in English *come help*, (iii) single prenominal adjectives, as in French *pauvre enfant* 'poor child', (iv) single compounds, as in French *homme-grenouille* 'man frog', (v) and single complements, as in Pirahã:

- (18) a. Compounds:           Germanic languages → recursion  
                                   Romance languages → no recursion  
       b. Possessives:       English → recursive possessives (Saxon  
                                   German → no recursive possessives  
       c. Adjectives:       English → recursive prenominal adjectives  
                                   no recursive post-nominal adjectives  
                                   French → no recursive prenominal adjectives  
                                   recursive post-nominal adjectives  
       d. Serial verbs:      Bantu → recursion  
                                   English → no recursion  
       e. PP recursion:     English → recursion  
       f. Clausal recursion: Germanic, Romance → recursion  
                                   Sign Language, Pirahã → (disputed)  
                                   Walpiri, Teiwa → no recursion

One important challenge is to uncover exactly where recursion occurs in less studied languages around the world. Each will provide an acquisition challenge.

<sup>14</sup> The contrast between lexical and phrasal possessives in English may mirror the English/German contrast. Lexical possessives (ii) cannot be phrasal unlike 's (i), as in this contrast:

- (i) the man next to me's hat  
 (ii) the man next to my hat



For instance, examples like the following Pirahã are disputed examples of complementation (from Sauerland 2010):

- g. Pirahã → hi ob-áaxái kahaí kai-sai.  
 see/know-INTNS arrow make-NOMLZR  
 'He really knows how to make arrows.'

Apparent subordination could be an effect of coordination, nominalization, and/or intonation which has led Everett (to appear) to claim it could be formed by parataxis, hence conjunction, although evidence seems to be mounting against this view.<sup>15</sup>

### 3. Data for Direct Recursion: The Appearance of *and*

Our fundamental claim about the first stage for every recursive structure is this:

(19) *Direct Recursion is the Acquisition Default*

A child first analyzes adjacent identical structures as Direct Recursion with a Conjunctive reading.

The claim is distinct from but compatible with parsing claims that conjunction is a preferred parsing strategy.<sup>16</sup>

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, although *and* is open to many inferences for adults too. There are three from Adam at age three and a half and others randomly selected from a CHILDES search (cf. MacWhinney 2000):

- (20) adam30.cha:\*CHI: when I lived in a bunkhouse # and I saw a snake coming out.  
 adam30.cha:\*CHI: and my teeth and I bite em.  
 adam29.cha:\*CHI: I goin(g) to put back # and I got something for his face.  
 57.cha:\*CHI: now they are a [/] awake and I open the door!  
 20a.cha:\*CHI: I'm gonna do it and I can turn the page.  
 16b.cha:\*CHI: I'm a bunny and I eat you.

<sup>15</sup> The claim that it is not a form of conjunction is difficult to establish. However, Sauerland (2010) provides intricate and interesting arguments that the linking morpheme *sai* may be a subordinator, particularly when intonation variation is present. Moreover, the presence of verbs like *know* suggests strongly the subordination relation. Nonetheless, it is possible that the clause could be subordinated without being recursive, as Perfors *et al.* (2011) suggest. In that case, the critical evidence would be a combination of double subordination and semantic opacity of the kind achieved in the English experiment reported here with embedded propositions whose truth the speaker does not assume. Uli Sauerland (p.c.) also has evidence of opacity in showing that Pirahã speakers can construe a subordinated clause as carrying a false belief. Thus the evidence looks strong that real subordination is present in complementation. The next step is to carry out the experiment reported here that shows recursive subordination with opacity which 6-year-olds in English can comprehend.

<sup>16</sup> Pietroski (2011) argues that a form of conjunction underlies all adult semantic interpretation as well, but the semantic notion in logic may not coincide with the argument here.



### 3.2. *Prepositional Phrases*

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

- (25) 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 PPs 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. The experiment is easy to see: Put a box on a shelf and one on the floor, and a book in each. Then ask: "Show me the book in the box on the shelf". If children treat the question as conjoined, they will point to both the book in the box on the shelf and the one on the floor. As we will see, this response is found with possessives.

### 3.3. *Recursive Possessives*

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

- (26) 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-' 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 long dialogue where a father tries to get a child to simply repeat a recursive possessive shows that the child understands the meaning, but converts the possessive into a single possessive with a compound (see Roeper 2007):

(27) FATHER: How about the Dukes of Hazard's boy's car?  
 CHILD: Yeah.  
 FATHER: What is it called?  
 CHILD: The boy's Dukes of Hazard car.  
 FATHER: No, not the boy's Dukes of Hazard.  
 It's the Dukes of Hazard's boys.  
 Can you say that? Dukes of Hazard's boy's car?  
 CHILD: The boys Dukes of Hazard car. (repeated several more times)

A 6-year-old, though, produces one with ellipsis (marked by the transcriber as possessive and not plural based on context):

(28) where's Toto's girl's \_\_\_\_

The child initially finds any way possible to resist the interpretation that recursion demands. The favored move is to convert a recursive sentence into conjunctions as data below indicate.

### 3.3.1. 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 (2003), who gave a child three pictures based on familiar Sesame Street characters, but no story was presented (adults were tested in the next study).

- (29) 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 one third of the 3- to 4-year-olds took the conjunctive reading (*Cookie Monster’s and sister’s picture*) and chose Picture B.

In the next experiment by Maxi Limbach, children and L2 German speakers whose L1 has possessives but no recursion, were given a series of stories, like this one, where both options are equally attractive:

- (30) 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.*

After a presentation of all bikes and actors (Fig. 1), the bikes were then shown in separate pictures and participants chose which fit “Jane’s father’s bike”.



Bikes: Racing tandem blue  
 father’s both Jane’s

Figure 1: Recursive and conjunctive options for recursive possessives

Subjects who were either native (NS) or non-native speakers (NNS) were involved: 25 American English-speakers and 23 German university L2 students. 26 children were divided into three age groups — nine 3-year-olds (average age: 3;7), eight 4-year-olds (average age: 4;5), and nine 5-year-olds (average age: 5;7). NNS adults gave a conjoined reading or dropped one of the possessives (38%, compared with 37% for the 5-year-olds). It is noteworthy that the 5-year-olds gave 22% conjoined readings, while the NNS adults gave only 8%, preferring 30% of the time to drop the first or second possessive. Here are overall results (see Limbach & Adone 2010 for further analysis):

	All	Correct	Middle drop	First drop	Random (unrelated)	Conjunctive	Confusion
5-y.o.	32	19 (59%)	3 (9%)	2 (6%)	0	7 (22%)	1 (3%)
4-y.o.	23	16 (70%)	1 (4%)	1 (4%)	0	4 (17%)	1 (4%)
3-y.o.	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 (10%)	12 (12%)	9 (8%)	8 (8%)	36 missing

Table 1: Results

Moreover, L2 speakers of English persistently claim that recursive possessives are difficult, and triple recursion virtually impossible.<sup>19</sup>

Why should it be hard to go beyond the single possessive? We note that possessive is a form of case assignment<sup>20</sup> in many grammars and it bears thematic roles in nominalizations that have nothing to do with possession (*the enemy's destruction of the city*). Other thematic roles cannot expand by recursion. For instance we cannot expand Agent or Theme in that manner: \**The wall was built by the company by the government* meaning via the agency of the government the agency of the company caused the wall to be built. Recursive agency cannot attach to possessive agents either: \**The government's company's building of the wall*. Such a sentence could mean the company owned by the government but not the company caused by the government to build. Once again, capturing the semantic side of the interface is a critical challenge to both the theory and the acquisition process.

### 3.3.2. Japanese

Now we look at a pilot experiment on recursive possessives in Japanese where, for the first time, four level recursion has been explored by Fujimuri (2010). In Japanese we have a structure similar to English but marked by *no*:

- (31) a. John's brother's car. *English*  
 b. John no otouto no kuruma. *Japanese*  
*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.

- (32) The story (told in Japanese):

*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.*

Alongside the story, the pictures of all actors were shown:

---

<sup>19</sup> It is interesting that even among professional linguists for whom English is not native, who have intellectual understanding (by their own testimony) does not make them able to produce them in conversation.

<sup>20</sup> Pointed out to me by Uli Sauerland (p.c.).

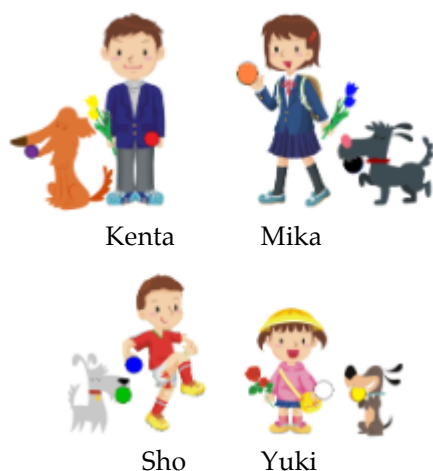


Figure 2: Pictures for multiple possessives in Japanese

(33) *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.

*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.

*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.

*quadruple possessive question:*

10. What color is Mika's brother's friend's dog's ball? — Yellow.

Table 2 summarizes the responses of the seven children for the 10 questions:

	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	×	×	×	○	×	○	○

Key: O = success, X = failure

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

Again, the youngest children correctly get a single possessive but then fail. With the exception of example 5 (about shoes, not balls) and child 5 (who manages double but not triple recursive structures), what stands out is that those children who master 3-part possessives (33.7–9) and have no difficulty with 4-part possessives (33.10). The 2-part possessives (33.4–6) are likewise grasped almost at the same time as 3- and 4-part possessives by three quarters of all children, all below 7 years of age, clearly much younger than the L2 college students.

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, as the child dialogue above, where meaning (whose car) is understood, but recursive expression of it is difficult. If we had the conjoined version,

(34) “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 (which is more work) 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 he 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.<sup>21</sup>

<sup>21</sup> In a larger experiment just completed, 26 Japanese children (seven 3-year-olds, eight 4-year-olds, seven 5-year-olds, and four 6-year-olds) were tested by Roeper *et al.* (in progress) with the same basic format. Similar results were obtained with intriguing further detail, but a full analysis must still be done.

In brief, the children were given three pictures and asked 16 questions involving 1- to 4-level recursion (three 1-POSS, five 2-POSS, four 3-POSS, and four 4-POSS). The sentences were linked to pictures where every person or animal had a hat and a balloon of a variety of colors, with questions like:

- |       |                                                              |        |
|-------|--------------------------------------------------------------|--------|
| (i)   | What is the color of Shiro’s child’s friend’s dog’s balloon? | 4-POSS |
| (ii)  | What is the color of Murasaki’s friend’s dog’s balloon?      | 3-POSS |
| (iii) | What is the color of Orenji’s dog’s balloon?                 | 2-POSS |

11 children showed mastery (80–100%) of 1- and 2-POSS and showed 50–100% correct at 3- and 4-POSS level recursion, showing that they could in general handle recursion. Interestingly, there was no difference in ability at 3- and 4-level cases. This suggests that an incremental parsing theory cannot account for the difference. Errors often involved deleting one element (which we saw with L2 speakers). This suggests that keeping track of names is an independent challenge beyond recursion, 4 children failed to get 1-level possessives right and 22 got 100% of 1-POSS correct. 4 children got 1-POSS right 100%, but only 2 out of 5 2-POSS cases. This is exactly what the hypothesis that recursion is a separate operation predicts. 7 children get 3 out of 5 2-POSS cases right, but very low success on 3- and 4-POSS. This is not exactly what the hypothesis that recursion allows 2-, 3-, and 4-POSS cases equally would predict. Informal discussion with L2 speakers who find these difficult suggests that they have some ‘strategy’ to compute a second POSS, but they are unable to handle three — indicating that real recursion is not yet in place.

Further observations include that relational nouns, like *friend’s*, might seem to be a point of confusion. We think that part–whole sequences may be where children first have success where phrasal nouns are modified: *the big house’s*, *small porch’s*, *back swing’s color*. The micro-



In sum, we have pointed out evidence that the acquisition of recursion is not immediate, but that once recursion is acquired, there is not a significant processing demand producing a difference between 3- and 4-level possessives.

### 3.4. Verbal Compounds

Snyder (1995) showed that 3- to 4-year-olds produce novel two-word compounds and Hiramatsu *et al.* (2002) showed that the ability was productive. For verbal compounds, Hiraga (2010) found that children at the age of 4 to 5 years were easily able to understand and produce a single verbal compound: When asked “What is someone who pulls a wagon?”, they provided the answer “Wagon-puller”, corroborating claims in Clark (1993). Novel compounds like “I’ll be the lunch-bringer” occur as well at 4 years. When Hiraga sought to see if recursive compounds were possible, much greater difficulty was encountered. Only by the 6- to 7-year-old range did children show clear ability to comprehend. Here is one of the stories and the picture that accompanied it:

- (35) *Kitty makes a great machine. The machine pours tea into many cups at once. Bunny bought the machine from Kitty, so Bunny only makes tea and doesn’t have to pour it. The machine pours tea into five cups at once, so Bunny’s sisters and brothers can drink it. Doggy doesn’t have the machine, so he makes and pours tea himself. One of them said “I am a tea pourer maker”.*

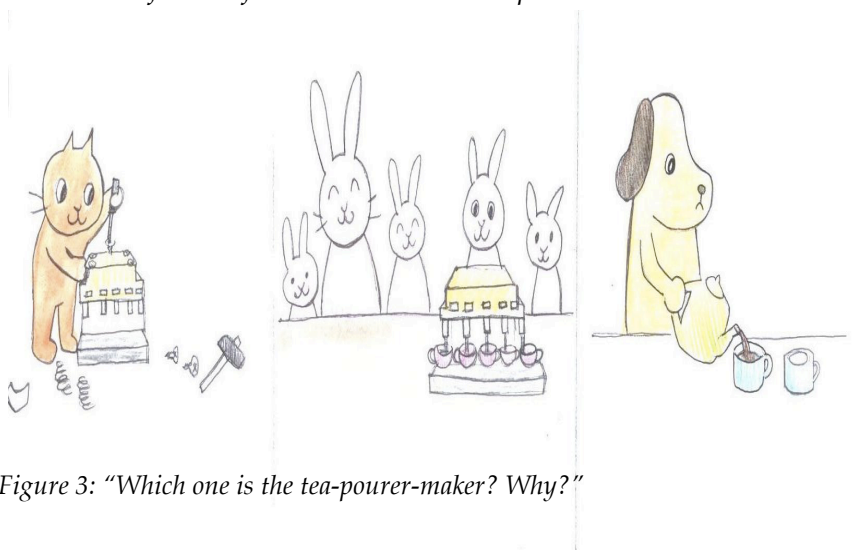


Figure 3: “Which one is the tea-pourer-maker? Why?”

The conjunctive reading is interpreted by 6-year-olds as: “Because he makes and pours tea”. Examples of recursive interpretation follow:

- (36) a. *tea pour maker* (N.I. at 6;11.2):  
 “because she pours, actually, she made the machine that pours tea”  
 b. *tea pourer maker* (N.I. at 6;11.2):  
 “because he makes the machine that pours tea”

---

conditions that provide triggering recursive environments for children are needed to see exactly what moves the child along the acquisition path.

(37) *tea pourer maker* (I.R. at 6;5.4):

“because she made the machine that can pour tea”

(38) *tea pourer maker* (P.H. at 5;11.20):

“because he made the machine that could pour it for you”

Other examples with stories included the following:

(39) *pencil sharpener spiller, picture taker liker, bottle opener breaker, tea lover taker*

These examples feel intuitively more difficult for adults as well, but 9 out of 10 adults gave 89% correct answers; only 2 out of 45 gave a conjunctive reading.<sup>22</sup>

A question arises: Why should this form of recursion be so much later than adjective recursion (*second green ball*)? Why does it feel more difficult to adults? Noun compounds [*school lunch box*] are much more frequent than recursive verbal compounds [*bread-baker watching*]. This means that, although just a few can trigger the process, their rarity could affect when they appear. This does not offer a full explanation of delay however.

We argue elsewhere that the derivational path is relevant: It is a reflection of leftward movement operations and Relativized Minimality (see Friedmann *et al.* 2009). In effect, in *tea-pourer-maker* one compound with *-er* must ‘cross over’ another *-er* [*maker of tea-pourer* → *tea-pourer-maker*]. Cross-over may explain part of why left-branch verbal compounds are especially difficult, but recursion itself seems to be the problem where no cross-over is present in rightward forms of recursion, as in adjectives and PPs and, as we now discuss, complements.

### 3.5. Sentence Complements

Finally, we add sentence complements to our overview, although they engage many more aspects of grammar than simply recursion. The first observation to make is that children appear to acquire infinitives very quickly in a recursive form, although they are arguably not phases, and certainly do not contain propositional content. A cursory search reveals recursive infinitives as early as age 2;4, but a careful study of their emergence would be very useful. Here are examples from a broad search of the database of children below 4;6 (Adam was between 3;6 and 4;6), although exact ages are not obtainable.

(40) Naomi (2;4): *to go to sleep*

Adam 27\*CHI: what you use *to carve* [?] *it to do* what?

Adam30.cha: I want *to go to sleep* and stand up

Adam 54\*CHI: here (.) we *going to have to build* one with another string on it.

Anne 34b\*CHI: you have *to get this one to go* as\_well.

stp2.cha: here am I *going to get to put* the chimney

<sup>22</sup> A kind of conjunctive reading (i.e. *or*) is possible if one takes a ‘slash’ interpretation, as in *This is a printer/copier*. When the experiment was designed, we were unaware of this option, and it is interesting that it was not taken more often by adults.

boys44.cha: when I got bigger then I'm going *to get to go*  
 cha:\*CHI: dad you're suppose *to try to get* it on me  
 e21.cha:\*CHI: Now I'm going *to try to touch* your knee  
 aran 29\*CHI: I went *to climb the house to see* them.  
 \*CHI: I want *to get to see*.  
 nic34b.cha\*CHI: you have *to go to sleep* now.  
 liz22b\*CHI: this one [\* 0is] going *to go down to drink*

How come these forms emerge at such an early point? Do they really represent a series of phases? Evidence of this kind may fit the notion that infinitives are not phases, but much more argument is needed.

Nonetheless when we turn to tensed complements, we both find some at the 4- to 5-years range (from Adam, 4;5 to 4;8) just a few earlier, though a more thorough search would be useful:

- (41) Danilo 3.2 I think Daddy says *he wears underpants*  
 adam45.cha:\*CHI: he thought *those guns were 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 be warm*

These forms might, however, be represented by a recursive adjunct that is not really sentential, much like:

- (42) to me and for you they gonna be warm

Diessel (2005) argues that the early forms of *I think* simply mean *maybe*. We must establish that each clause is really embedded inside the other, as we do next.

In fact, when we look at real comprehension, we find that children resist complementation. Even when the momentum of the story is clear, the children 'anti-pragmatically' resist embedding. Hollebrandse *et al.* (2008) with 18 children (6;3–6;11, mean: 6;9) have shown that they have no difficulty giving single complement answers for situations with sentences like: "Dad is talking to Billy about moving his tools. Dad tells Billy that Jane said that hammers are too heavy. What did Jane say?" Children easily respond "hammers are too heavy".

However, when the higher verb is needed to make sense of the question, implying recursive subordination, correct answers fall off sharply. Thus among children as old as 6, only one third provide the recursive answer, although the meaning is very misleading if you do not in the following story. Because conjunction can deliver the same inference, we sought each time to find a meaning that guarantees embedded recursive structure:

- (43) *Jane talks to mom. She is having a fight with Billy on the phone. Jane tells mom that Billy said that all sisters are stupid. What did Jane tell mom?*

Confronted with a drawing depicting the setting (Fig. 4), the two possible responses would be the ones given in (44):

- (44) Single complement: [said] “that all sisters are stupid”  
 Recursive complement: [tell Mom] “that Billy said that all sisters are stupid”.

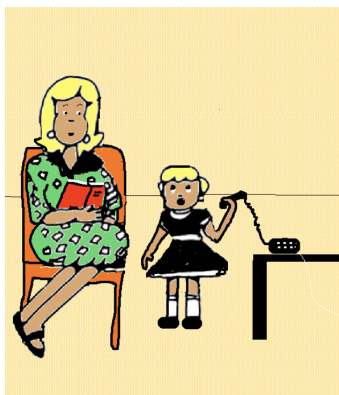


Figure 4: Two complement sentential recursion experimental illustration

The experiment is constructed anti-pragmatically because if she gives a single complement answer (“all sisters are stupid”), then she condemns herself. Here are the results:

- (45) 23% irrelevant, 34% single, 33% recursive

Thus, these children, until the age of 6, despite being invited by the momentum of the story to oppose the boy by mentioning that he is the speaker, offer a single clause or an irrelevant answer in two thirds of the answers. This leads to the clear conclusion that a single complement answer is not represented in the same manner as a recursive complement.

In sum, the children allow a single possessive, single adjective, single complement preferentially as the first step. The second step involves a direct-recursion conjoined response. Finally we obtain an indirect recursive response.

#### 4. Generalized Transformations and Tree-Adjoining Grammar

Now we need to address the question squarely of what change could occur to shift from a conjunctive representation to a recursive one. In principle, recursion is an automatic consequence in a phrase-structure rule system. If one category contains another, then what would block the generation of recursive forms? Thus if I have,

- (46) *John said S2*

and I realize S2 as NP – VP and choose *Bill said* for VP, then I automatically introduce another VP — and *it is raining* is possible, giving:

- (47) John said Bill said it is raining.

Under this formalism, we must stop this core process from occurring.

If the initial representation, however, were not an expandable S-node, then the derivation could be constrained to a single complement.<sup>23</sup> In fact, Perfors *et al.* (2011) have suggested that children might begin with a direct subcategorization of complement structure that avoids recursion.<sup>24</sup>

(48) NP *think* NP *verb* NP

This would predict that the child's progress to other forms would occur step by step, just like matrix clauses emerge step-by-step. For instance, the passive form,

(49) *John thinks* NP *was* V+*ed* *by* NP

would have to be separately acquired. Then at some point — a critical point in the biology of the organism — the list of possible structures becomes uneconomical and the child substitutes S or CP for the whole list. At that point recursion would be present and nothing could stop it: *John thinks that Bill thinks that Fred believes...* And each additional instance would not be costly. Capturing that act of substitution is a fundamental acquisition ability. It is not automatically represented in UG.

This substitution approach has independent plausibility when one considers, for instance, how V2 develops (and historical evolution has similarities, see Westergaard 2009). Children begin with locative–verb–subject (*da isst er* 'there eats he'), then other forms, like conjunctions appear (Conj–V–subj) (*nun kann ich* 'now can I'), but only at a late stage does the child acquire full V2, allowing Obj–verb–subj (*Fleisch isst er* 'meat eats he')<sup>25</sup> with XP–verb–subj, where V2 is defined entirely in categorical terms as XP followed by V. In English, V2 exists but in lexical, not categorical terms. Only verbs of speaking are involved: "Nothing"

---

<sup>23</sup> We know that in other environments recursion is blocked, as in evaluatives:

- (i) John knew Bill to be a fool.
- (ii) \* John knew Fred to know Bill to be a fool.

Evaluatives involve personal experience, as in:

- (iii) John knew Fred to be a liar.

which contrast with propositional complements which allow recursion:

- (iv) John knew that Fred was a liar.
- (v) John knew that Bill knew that Fred was a liar.

Therefore, the grammar must have a method to block recursion for evaluative complements. This happens automatically if we turn the logic around: the grammar should not allow recursion unless there is an explicit example.

<sup>24</sup> Tenenbaum and colleagues see this form of incrementalism as linked to data-processing procedures derived from general learning psychological theories. The critical moment of substitution suggests the opposite from my perspective: the move to a higher order category like Sentence, or CP, or any category that covers a superficially heterogeneous set of strings into a single higher category node label only succeeds by positing an organism with an innate bias toward specific abstract categories like CP. It would be a mistake to put all phenomena into one generalization: *think* [X]. Then: *He thinks quickly* and *He thinks he is sleeping* would lead to a generalization that had *quickly* and *He is sleeping* as one (sentence?) category.

<sup>25</sup> See Roeper (1999), Yang (2002); also Wexler (to appear), de Villiers & Roeper (to appear).

*screamed Bill*. Notably, it does not allow recursion: \*"*nothing*" *screamed Bill*" *screamed John*. Non-recursion follows if we generalize a local notion of subcategorization, allowing lexically specific or low-level categories to be locally generated. This is what allows idioms and very limited clausal subcategorization to exist in adult language:

- (50) a. you were supposed to do that  
 b. \*I supposed you to do that.

where *suppose* only allows the passivized form to take a complement. Such lexically restrictions never extend into recursive domains and no category exists that could expand into recursion.

TAG develops a notion of substitution where a non-recursive node is substituted for by a recursive node. However, this operation of substitution in acquisition is not identical to those in TAG because the criterion of Label Identity is not met: "[T]he substitution operation imposes a requirement of label identity between the root of the substituted elementary tree and the substitution site" (Frank 2006: 149).

It is, though, a fundamental aspect of microscopic steps in acquisition growth. Therefore we have to have a more powerful method for the acquisition device to establish equivalence between a string and a higher category:

(51) *Acquisition Substitution Algorithm*

Substitute a UG Category for a set of strings

This is where innate UG assumptions are needed to make acquisition efficient. We need a substantive notion of S(entence) allowing the projection of a higher category from a set of possible strings with T(ense) and VP at the core: NP T VP → S. This question is really the acquisition version of how we develop a Labeling Algorithm, which Chomsky (2008) has proposed, but which remains largely unarticulated. This challenge reaches to the heart of linguistic theory because the system must not allow a nominalization, for instance, to be analyzed as a sentence. If it did, then the child would generalize *John eats Bill's cooking* into *eat* (S) which would incorrectly allow the generation of \**John eats Bill cooks*.

TAG proposes a more general form of substitution that may be useful for other cases:

I will adopt the two operations of the Tree Adjoining Grammar (TAG) formalism: *substitution* and *adjoining* [...]. Given two independently derived pieces of structure, the substitution operation inserts one along the periphery (or frontier) of the other at a node, called the substitution site. One can think of substitution as an operation which rewrites a node along the frontier of one structure as another piece of structure (called an *elementary tree*).

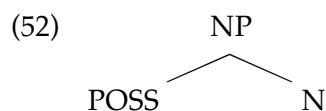
(Frank 2006: 149)

This approach obeys a principle of Label Identity:

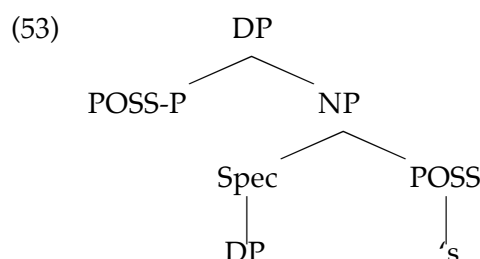
I assume the Condition on Elementary Tree Minimality (CETM), according to which the heads in an elementary tree must form part of the extended projection of a single lexical head, following the notion of extended pro-

jection of Grimshaw (2000). As a result, the lexical array underlying an elementary tree must include a lexical head and may include any number of functional heads that are associated with that lexical head. (Frank 2006: 151)

We suggest that a simple form of projecting a Maximal Projection instead of a single lexical category is a natural projection of this substitution:



and we now make POSS into an MP with a SPEC position:



And this will automatically allow in principle a recursive projection. If [Spec, POSS-P] carries a feature that allows D projection, a DP can be projected and recursion is launched. Thus a specific operation would be present to accomplish this goal.

We argue in effect that the addition of new projections both allows recursion and reflects a distinct computational act along the acquisition path. Once introduced into the grammar, however, each further instance will be automatic and therefore we do not predict that the shift from two to three to four embeddings will cause a serious online increase in difficulty. Under classic Generalized Transformations, each time a complex POSS phrase is added, a substitution must occur, which if translated into a processing account, would predict incremental difficulties. Longer sentences always produce some parsing complexity, but our evidence suggests that additional possessives do not complicate matters. Therefore, in this case, the acquisition substitution into the equivalent of rewriting rules is sufficient.

#### 4.1. *Relative Clause Substitution*

Frank's account of relative clause attachment is similar:

- (54)  $S \rightarrow DP_1 VP \Rightarrow$  John like  
 $VP \rightarrow V DP_2 \Rightarrow$  John liked the cat.

However, independent of this form we have a second rule:

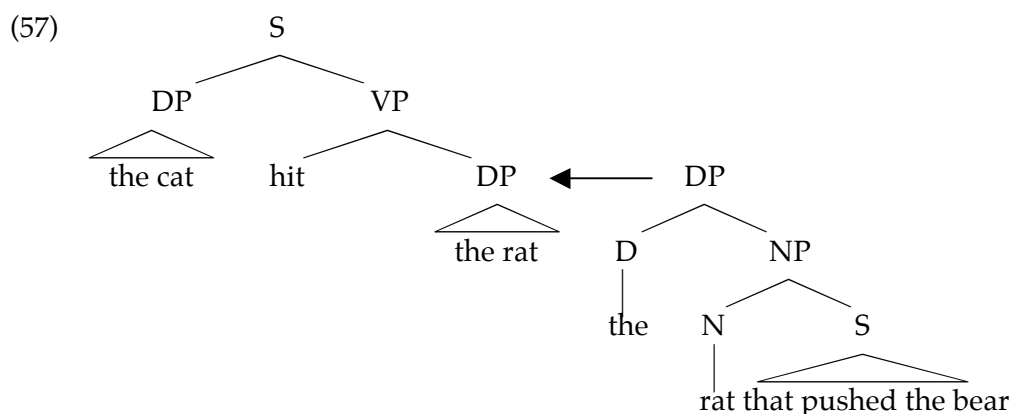
- (55)  $DP_3 \rightarrow NP S$

which carries a branching node and a meaning that allows the relative clause to

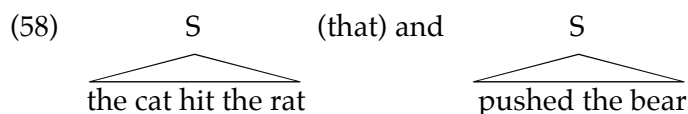
restrict the range of reference, therefore to participate in the interpretation of the DP. Thus TAG allows the generation of two forms:

- (56) Sentence: DP1 [the rat] VP [hit] DP2 [the cat]  
 DP3 [the cat] Sentence [that I like]

and the second tree is inserted by substitution of DP3 for DP2 into the first:



Without the substitution, the relative clause automatically attaches as an adjunct to the Root node and we have exactly conjunction as we found in the examples above and as Goodluck (1981) argued, who said *that* was treated as *and*:



Predictably, as the earliest results showed (Tavakolian 1981), the relative clause is typically interpreted with reference to the subject *the cat* instead of *the rat* by children in the 3- to 4-year-old range.<sup>26</sup>

#### 4.2. Labeling Algorithm

The notion of substitution of a complex form interacts with the current lively question of how labels are determined. If our proposal is carried forth, it will require that the Labeling Algorithm be one that fits this move (see Chomsky 2008). Capturing the acquisition path might in fact be an important criterion to evaluate the formulation of a labeling algorithm. In effect it would be a method whereby recursive nodes could look different from non-recursive ones which in turn would fit the claim we make that the acquisition path for recursion involves a critical step beyond recognition of the basic syntactic category. The acquisition path should reflect upon the notational choices made in linguistic theory.

<sup>26</sup> Many grammars (Keenan & Comrie 1977) allow a final relative clause, attached to the root, to be interpreted either with the subject or the object.



## 5. The Experience of Recursion

We are now in a position to answer the question raised by William Snyder and me in a series of papers examining the appearance in naturalistic data of recursive compounds, possessives, adjectives, and serial verbs. We advanced the hypothesis that children must ‘experience’ recursion in order to allow it in their language (Roeper & Snyder 2004, 2005). We had no statement about what impact the experience of recursion would cause.

This hypothesis followed from the observations above, that single instances of possessives, adjectives, and compounds in a language did not guarantee recursion.<sup>27</sup> If we now argue that recursive nodes are discernibly different from non-recursive nodes, then the argument that experience is necessary is clearly justified. A consequence, of course, is that such triggers are rare, and hence we can predict that they may arise late or in a non-uniform fashion among children. The number of times one hears *coffee-maker* in comparison to *coffee-maker-maker* is obviously small. If recursion is the primary form of productivity in grammar, the rare evidence for recursion becomes a powerful demonstration that frequency is not a primary factor in advancing productive powers in grammar. In fact, children occasionally spontaneously create recursion in new environments, but not often, suggesting that the experience requirement is correct.<sup>28</sup>

This leads to the question whether language-specific recursion is a marginal phenomenon — as much of the public controversy would suggest (Everett, to appear) — or whether recursion is the fundamental pivot, the axis which forces productivity and allows an efficient flow of thoughts into language.

It is not simply an abstract question. A close look supports the latter view. Recursive operations operate upon hierarchical structures. Those labeled hierarchical structures represent a range of abstractions that allow some productivity. Identifying a node with an NP allows any NP to occupy that node. As we have seen, subcategorization (which applies to verbs but also to other lexical items) allows the hierarchy to be overruled by lexically specific information. Thus, the verb *crane* allows only *necks* as an object; you cannot *\*crane your elbow*. Recursion, once recognized by the child, never allows this constraint: It operates only on grammatical categories. A single complement may be an idiom: *John knows what’s what*. It is not possible for *know* to project such an idiom into a recursive domain, that is, over another clause: *\*John knows Bill thought what’s what*.

The recognition of recursion is an automatic liberation from searching for idiomatic subcategorizations. And it relegates exceptional constructions to secondary grammars. Under the Multiple Grammars approach (see Roeper 1999), a signal feature of the presence of a sub-grammar is the absence of recursion. An example again is V2 in English, discussed above, which applies to quotations (“*Nothing*” said Bill) and stylistic inversion (*In the room ran John*) — but notably neither allows recursion.

This bifurcation between recursive and non-recursive rules gives the child

<sup>27</sup> The idea originated with the observation about productivity from Namiki (1994) that only those grammars with recursive compounds had productive compounds.

<sup>28</sup> For example, a 4-year-old said *Here is another another box*, where adults would say ‘yet another box’. See my *Prism of Grammar* (Roeper 2007) for a few other examples.

a means to assemble his core grammar and exclude marginal exceptions. Before specific nodes, entailing recursion are recognized, it is commonly suggested (Roeper 1992, Tomasello 2003) that there is a great deal of lexical specificity that blocks or limits easy overgeneralizations. To return to our possessive example, the child may first represent possessives in both English and German with a constraint on human or animate possession. Independently assembling examples of early possessives, from Galasso (1999), here is what we find:

- (59) a. i. I want *me* bottle. Where *me* Q-car? That *me* car. Have *me* show. *Me* turn. *Me* cat. *Me* pen. (2;6–2;8)  
 ii. No *you* train. It's *you* pen. It's *you* kite. It *you* house? (3;2)  
 iii. I want to go in *him* house. *Him* bike is broken. It's *him* house.  
 b. *Lexical*  
 i. *Mine* banana. *Mine* bottle. *Mine* car. *Mine* apple. *Mine* pasta (2;4)  
 ii. *My* car. (3x at 2;4) *My* pasta. I want *my* key. It is *my* t.v.

(60) *Single Poss*

[whose hat is that] "Mrs. Wood's" (2.7)

Jensen & Thornton (2007)

They are all human possessors (no cases like *the car's tire*) and, of course, none are recursive. Therefore at Stage 1, the English and German child may have the same grammar. When the child re-analyzes the possessive to allow recursion, as we saw above, then the grammars diverge, and lexical constraints on the nature of the NP are dropped. Thus we suggest that it is exactly recursion which enables the child to generate a grammar where English and German diverge.

## 6. Conclusion

Our focus has been various language-particular forms of recursion. We have seen a variety of evidence of a default conjunctive interpretation that can be captured by Direct Recursion: the included possessives, PPs, adjectives, and complements.

We claimed that the core analysis lies in a combination of Indirect Recursion and SMT, the Strong Minimalist Thesis. Finally, we sought to explain why recursion is not immediate via the proposal that Generalized Transformations cause the definition of recursive nodes to be distinct from non-recursive ones such that an operation of Substitution is necessary, as proposed in TAG:

Implicit in the study are several broader claims:

- A. If variation exists in where languages allow recursion, then an acquisition challenge exists.  
 B. The grammar, not simply processing, can be engaged in formally specific ways to capture this acquisition path which, moreover, provide insights into the formalisms themselves.

- C. The time-course of each form of recursion may be a function of how much exposure is involved, the nature of the derivation, the intersection with morphology, and other factors.
- D. The representation of recursion critically involves an interface with interpretation — via phases and the SMT — which we take to be an innate interface.
- E. Our mode of argumentation, given the obscurity of the process and the evidence, is to include small amounts of suggestive evidence if they point in the same direction and contribute to a deeper generalization, or acquisition hypothesis. This then invites a more thorough program of research.

In sum, we argue that the child seeks many kinds of recursion as the core of syntactic productivity.

## References

- Berwick, Robert C. & Noam Chomsky. 2011. The Biolinguistic Program: The current state of its evolution and development. In Anna Maria Di Sciullo & Cedric Boeckx (eds.), *The Biolinguistic Enterprise: New Perspectives on the Evolution and Nature of the Human Language Faculty*, 19–41. Oxford: Oxford University Press.
- Berwick, Robert C. & Amy Weinberg. 1986. *The Grammatical Basis of Linguistic Performance*, Cambridge, MA: MIT Press.
- Boeckx, Cedric. 2009. On the locus of asymmetry in UG. *Catalan Journal of Linguistics* 8, 41–53.
- Bryant, Doreen. 2006. *Koordinationsellipsen im Spracherwerb: Die Verarbeitung potentieller Gapping-Strukturen*. Berlin: Akademie-Verlag.
- Chomsky, Noam. 1965. *Aspects of a Theory of Syntax*. Cambridge, MA: MIT Press.
- Chomsky, Noam. 1995. *The Minimalist Program*. Cambridge, MA: MIT Press.
- Chomsky, Noam. 2008. On phases. In Robert Freidin, Carlos P. Otero & Maria L. Zubizarreta (eds.), *Foundational Issues in Linguistic Theory: Essays in Honor of Jean-Roger Vergnaud*, 133–166. Cambridge, MA: MIT Press.
- Chomsky, Noam. 2010. Fall lectures. Cambridge, MA: Massachusetts Institute of Technology.
- Clark, Eve V. 1993. *The Lexicon in Acquisition*. Cambridge: Cambridge University Press.
- Diessel, Holger. 2004. *The Acquisition of Complex Sentences*. Cambridge: Cambridge University Press.
- Everett, Daniel L. To appear. You drink. You drive. You go to jail. Where's recursion? In Margaret Speas & Tom Roeper (eds.), *Recursion*. New York: Oxford University Press [under review].
- Frank, Robert. 2006. Phase theory and Tree Adjoining Grammar. *Lingua* 116, 145–202.

- Friedmann, Naama, Adriana Belletti & Luigi Rizzi. 2009. Relativized relatives: Types of intervention in the acquisition of A-bar dependencies. *Lingua* 119, 67–88.
- Fujimori, C. 2010. Acquisition of recursive possessives in Japanese. Ms., University of Massachusetts, Amherst.
- Galasso, Joseph. 1999. The acquisition of functional categories: A case study. Colchester: University of Essex dissertation.
- Gentile, Sarah. 2003. On the acquisition of left-branching recursive possessives. Amherst, MA: University of Massachusetts honors thesis.
- Goodluck, Helen. 1981. Children's grammar of complement-subject interpretation. In Susan L. Tavakolian (ed.), *Language Acquisition and Linguistic Theory*, 139–166. Cambridge, MA: MIT Press.
- Grimshaw, Jane. 2000. Extended projection and locality. In Peter Coopmans, Martin Everaert & Jane Grimshaw (eds.), *Lexical Specification and Insertion*, 115–133. Amsterdam: Benjamins.
- Gu, Chenjie. 2008. Structural ambiguity and AP/PP recursion in language acquisition. Ms., University of Massachusetts, Amherst.
- Hauser, Marc D., Noam Chomsky & W. Tecumseh Fitch. 2002. The faculty of language: What is it, who has it, and how did it evolve? *Science* 298, 1569–1579.
- Hiraga, Misato. 2010. Acquisition of recursive verbal compound nouns. Paper presented at the 32<sup>nd</sup> Annual Conference of the Deutsche Gesellschaft für Sprachwissenschaft (DGfS), Humboldt University, Berlin (24 February 2010).
- Hiramatsu, Kazuko, William Snyder & Tom Roeper. 2002. Learnability in a Minimalist framework: Root compounds, merger, and the syntax–morphology interface. In Ingeborg Lasser (ed.), *The Process of Language Acquisition*, 25–37. Frankfurt: Peter Lang.
- Hollebrandse, Bart, Kathryn Hobbs, Jill G. de Villiers & Tom Roeper. 2008. Second order embedding and second order false belief. In Anna Gavarró & M. João Freitas (eds.), *Proceedings of Generative Approaches to Language Acquisition (GALA) 2007*, 270–280. Newcastle: Cambridge Scholars Publishing.
- Hornstein, Norbert. 2009. *A Theory of Syntax: Minimal Operations and Universal Grammar*. Cambridge: Cambridge University Press.
- van Hout, Angeliek, Masaaki Kamiya & Tom Roeper. 2011. Passive, reconstruction and edge phenomena: Connecting English and Japanese nominalizations. Ms., Rijksuniversiteit Groningen, University of Massachusetts, Amherst & Hamilton College, Clinton, NY.
- Jackendoff, Ray. 2010. What's in the human language faculty: Two views. Ms., Tufts University, Boston, MA.
- Jensen, Britta & Rosalind Thornton. 2007. Fragments of child grammar. Ms., Macquarie University, Sydney.
- Keenan, Edward L. & Bernard Comrie. 1977. Noun phrase accessibility and universal grammar. *Linguistic Inquiry* 8, 63–99.
- Limbach, Maxi & Dany Adone. 2010. Language acquisition of recursive possessives in English. *Boston University Conference on Child Language (BUCLD)* 34, 281–290.

- Lobina, David J. 2010. What recursion could not be. Ms., Universitat Rovira i Virgili, Tarragona.
- MacWhinney, Brian. 2000. *The CHILDES Project: Tools for Analyzing Talk* (3<sup>rd</sup> edn.). Mahwah, NJ: Lawrence Erlbaum.
- Namiki, Takayasu. 1994. Subheads of compounds. In Shuji Chiba (ed.), *Synchronic and Diachronic Approaches to Language: A Festschrift for Toshio Nakao on the Occasion of His Sixtieth Birthday*, 269–285. Tokyo: Liber Press.
- Matthei, Edward H. 1982. The acquisition of prenominal modifier sequences. *Cognition* 11, 301–332.
- Miller, George A. & Noam Chomsky. 1963. Finitary models of language users. In R. Duncan Luce, Robert R. Bush & Eugene Galanter (eds.), *Handbook of Mathematical Psychology*, 419–491. New York: Wiley.
- Munn, Alan. 1999. First conjunct agreement: Against a clausal analysis. *Linguistic Inquiry* 30, 643–668.
- Perfors, Amy, Joshua B. Tenenbaum & Terry Regier. 2011. The learnability of abstract syntactic principles. *Cognition* 118, 306–338.
- Pietroski, Paul M. 2011. Minimal semantic instructions. In Cedric Boeckx (ed.), *The Oxford Handbook of Linguistic Minimalism*, 472–498. Oxford: Oxford University Press.
- Richards, Marc D. 2011. Deriving the edge: What's in a phase? *Syntax* 14, 74–95.
- Roeper, Tom. 1978. Linguistic universals and the acquisition of gerunds. *University of Massachusetts Occasional Papers in Linguistics* 4, 1–37.
- Roeper, Tom. 1992. From the initial state to V-2: The architecture of acquisition. In Jürgen M. Meisel (ed.), *The Acquisition of Verb Placement: Functional Categories and V2 Phenomena in Language Acquisition*, 333–370. Dordrecht: Kluwer.
- Roeper, Tom. 1999. Universal bilingualism. *Bilingualism: Language and Cognition* 2, 169–186.
- Roeper, Tom. 2007. *The Prism of Grammar: How Child Language Illuminates Humanism*. Cambridge, MA: MIT Press.
- Roeper, Tom. 2009. The minimalist microscope: How and where interface principles guide acquisition. *Boston University Conference on Child Language (BUCLD)* 33, 24–48.
- Roeper, Tom & Ana T. Pérez-Leroux. 2010. Simplicity and complexity in child language and its explanation. Ms., University of Massachusetts, Amherst & University of Toronto.
- Roeper, Tom & William Snyder. 2004. Recursion as an analytic device in acquisition. In Jacqueline van Kampen & Sergio Baauw (eds.), *Proceedings of Generative Approaches to Language Acquisition (GALA) 2003*, 401–408. Utrecht: LOT.
- Roeper, Tom & William Snyder. 2005. Language learnability and the forms of recursion. In Anna Maria Di Sciullo (ed.), *UG and External Systems: Language, Brain and Computation*, 155–169. Amsterdam: John Benjamins.
- Roeper, Tom, Akiko Terunuma & Terue Nakato-Mishiyata. In progress. Acquisition of recursive possessives in Japanese. Ms. University of Massachusetts, Amherst.
- Ross, John R. 1967. Constraints on variables in syntax. Cambridge, MA: MIT

- dissertation.
- Sauerland, Uli. 2010. Experimental evidence for complex syntax in Pirahã. Ms., Zentrum für allgemeine Sprachwissenschaft, Typologie und Universalienforschung, Berlin. [<http://ling.auf.net/lingBuzz/001095>]
- Snyder, William & Tom Roeper. 2004. Learnability and recursion across categories. *Boston University Conference on Child Language (BUCLD) 28*, 543–552.
- Stabler, Edward P. To appear. Recursion in grammar and performance. In Margaret Speas & Tom Roeper (eds.), *Recursion*. New York: Oxford University Press [under review].
- Tavakolian, Susan. 1981. The conjoined-clause analysis of relative clauses. In Susan Tavakolian (ed.), *Language Acquisition and Linguistic Theory*, 167–187. Cambridge, MA: MIT Press.
- Tomalin, Marcus. 2007. Reconsidering recursion in syntactic theory. *Lingua* 117, 1784–1800.
- Tomasello, Michael. 2003. *Constructing a Language: A Usage-Based Theory of Language Acquisition*. Harvard: Harvard University Press.
- Villiers, Jill G. de and Tom Roeper. In press. Introduction. In Jill G. de Villiers & Tom Roeper (eds.), *Handbook of Generative Approaches to Language Acquisition*. New York: Springer.
- Westergaard, Marit. 2009. *The Acquisition of Word Order: Input Cues, Information Structure and Economy*. Amsterdam: John Benjamins.
- Wexler, Kenneth. In press. Grammatical computation in the optional infinitive stage. In Jill de Villiers & Tom Roeper (eds.), *Handbook of Generative Approaches to Language Acquisition*. New York: Springer.
- Yang, Charles D. 2002. *Knowledge and Learning in Natural Language*. Oxford: Oxford University Press.

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