Chapter 2

To acquire a recursive grammar, children start with a recursive procedure (MERGE)

Iain Giblin[1], Peng Zhou[2], Cory Bill[3], Jiawei Shi[2] and Stephen Crain[1]

[1]Macquarie University / [2]Zhejiang University / [3]ZAS

Recursion is a central topic in language acquisition because it helps to inform an explanatorily adequate theory of the human language faculty. Some researchers (e.g., Roeper, 2011) have proposed that it is possible for children's early grammars to include a transitory acquisition stage that is based on conjunction rather than the truly recursive operation of MERGE which characterizes mature grammars. A truth-value judgement task with an elicitation component was designed to elicit recursive genitive structures in both Mandarin and English. Our results indicate that child participants in both Mandarin and English understood recursive genitive structures and a substantial majority could also produce the target recursive genitive structures. These

Iain Giblin, Peng Zhou, Cory Bill, Jiawei Shi and Stephen Crain

> results provide compelling evidence that recursion emerges
>
> early in child language acquisition and that there is no need to
>
> propose a transitory stage that lacks a recursive procedure.

1. Introduction

Current generative linguistics is known as the biolinguistics approach to language. This approach is an outgrowth of the Minimalist Program (Chomsky 1995). The Minimalist Program in turn is a direct descendant of the naturalistic approach to language that has been at the heart of the generative enterprise from its inception (e.g., Lenneberg, 1967). As its name suggests, The Minimalist Program seeks to simplify or dispense with many of the theoretical and technical principles and operations that were introduced in earlier theories, such as Case Theory, Subjacency, et cetera. As well as simplifying the theoretical apparatus, the Minimalist Program is restricted to levels of representation that interface with the two fundamental performance systems of sound and meaning - phonetic form (PF), the articulatory-phonetic system; and logical form (LF), the conceptual intentional system.

On the biolinguistic approach, the basic property of Universal Grammar (UG) is the combinatorial operation known as MERGE (see Hauser *et al.,* 2002; Fitch *et al.,* 2005). MERGE is a recursive procedure that explains three properties of human language: the fact that (1) sentences are assigned

structured hierarchical representations, (2) these hierarchical representations determine semantic interpretation, and (3) there is no upper bound on the depth of structure building in sentence formation. In short, MERGE enables people to construct and interpret an unbounded number of hierarchically structured sentences; i.e., it is a recursive procedure. Perhaps due, in part, to the critical role recursion plays in linguistic theory, it has figured centrally in some heated controversies in the cognitive sciences. One controversy concerns the universality of recursion in human languages (e.g., Everett, 2005; Wolfe, 2016). A second controversy concerns the existence of recursive procedures in non-human species (e.g., Fitch and Hauser, 2004; Bolhuis and Everaert, 2013) A third controversy concerns the emergence of recursion in child language. The third controversy is the main focus of the present paper.

There is a growing number of research investigations of recursion in child language. The vast majority of this research has reported negative findings. In view of these findings, several researchers have concluded that the recursive procedure MERGE is initially absent from children's grammars, or that there are significant limits to recursion in young children's grammars as compared to adult grammars. One widely discussed proposal about the limits on recursion in child language was proposed by Roeper and his colleagues (Roeper, 2011; Hollebrandse and Roeper, 2014). They claim that children's grammars initially incorporate a default recursive procedure that does not generate the same recursive structures as adult grammars. On this account, children are initially incapable of forming many of the recursive embedded

3

phrases that are exhibited by adult speakers in the linguistic community, including the genitive possessive structure that is the focus of the present study. More specifically, the proposal is that children are initially incapable of forming structures in which a constituent of one syntactic category is embedded inside a constituent of another category.[1]

Evidence is offered in support of these proposals about the limitations of recursion in child language. The evidence is based on transcripts of children's spontaneous speech, as well as the findings from recent experimental studies, which we review in Section 3. The transcripts of children's spontaneous speech contain few, if any, instances of embedded recursive syntactic structures. The findings of several recent experimental studies document young children non-adult understanding of embedded recursive structures. Children's non-adult responses to the test sentences presented to them in these studies is attributed to a 'conjoined' analysis of sentences that are analyzed

---

[1] According to Snyder and Roeper (2005), child language learners require positive evidence from adult speakers to initiate the transition to the adult grammar. The positive evidence consists of examples of the kinds of non-conjoined recursion that are acceptable in the local language but not generated by children's initial grammar. This 'conservative' language learning approach is motivated by the observation that there are language-specific constraints on recursive structures. If children are initially conservative, they will avoid 'overgeneration,' i.e., producing linguistic structures that are in other languages, but not in the local language. We consider this proposal further in the general discussion.

using embedded hierarchical structures by adult speakers of the local language.

Based on the findings from child language, Roeper and his colleagues distinguish two distinct types of MERGE. One type generates conjoined phrases. The claim is that, initially, child grammars are limited to this type of MERGE. Adult grammars also incorporate a second type of MERGE. This type generates hierarchical recursive structures that embed one syntactic category inside another. As far as we can tell, the empirical findings from the literature in child language are the only motivation for this distinction, although the account is taken to apply to several linguistic constructions (cf. Example 3 below).

This account of the stepwise development of MERGE in child language is not consistent with Continuity Assumption. According to the Continuity Assumption, child and adult languages can differ only in ways that adult languages differ from each other (e.g., Crain 1994; Crain and Pietroski 2001). Among the evidence for the Continuity Assumption is the finding that the linguistic structures that underly children's non-adult responses to sentences are structures attested in some language, albeit not in the language spoken in the linguistic community where these children are raised. As far we know, however, there are no adult languages in which speakers only generate recursive conjoined phrases. Therefore, the proposal that recursion in children's grammars is limited to conjoined phrases constitutes a violation of the Continuity Assumption.

Iain Giblin, Peng Zhou, Cory Bill, Jiawei Shi and Stephen Crain

Because the Continuity Assumption imposes a strong constraint on theories of language acquisition, it should be abandoned only if there is compelling evidence that child and adult language are not in the expected alignment. The findings of the studies we report here demonstrate that young children produce and comprehend adult-like embedded recursive structures, both in English and in Mandarin Chinese. Children acquiring both languages assign same non-conjoined interpretations to embedded recursive structures. Therefore, the findings of our studies directly undermine the conclusion that recursion in child grammars is limited to conjoined phrases. From the perspective of research methodology, it is important to reconcile the discrepancy between the findings on recursion that have emerged from our experimental design features with the negative findings in previous research. We will therefore comment on the significant design features of our studies. Once these design features are clarified, our hope is that acquisition researchers will acknowledge that the previous negative findings seriously underestimated young children's linguistic competence.

The experiments in the present study were conducted with child participants acquiring English and ones acquiring Mandarin Chinese. Before we review the previous literature and describe our experimental studies, it is worth underscoring the importance of assessing recursion in children acquiring typological distinct languages. Studies of children acquiring languages that are historically distant, as well as ones that differ in surface properties, can yield findings with more far-reaching implications than studies

of children acquiring a single language or children acquiring closely-related languages (see for example Crain *et al.* 2021) because any similarities that we detect across such languages could reflect deeper properties of the language faculty that are shared by typologically distinct languages. The claim that MERGE is a basic property of Universal Grammar predicts that all languages to exhibit recursion, regardless of differences in surface properties.

2. The minimalist program

Over fifty years ago, Chomsky (1965) introduced several criteria for assessing the adequacy of a theory of grammar. Two of these criteria were descriptive adequacy and explanatory adequacy. To achieve descriptive adequacy, according to Chomsky, a theory must successfully "describe the linguistic intuition – the tacit competence – of the native speaker" (p. 26-27). Explanatory adequacy is achieved when a theory explains how typically developing children acquire the target grammar. In this regard, Chomsky states that "… a grammar is justified to the extent that it is a *principled* descriptively adequate system, in that the theory with which it is associated selects this grammar over others, given primary linguistic data" (1965, p. 26-27).

Most approaches to language acquisition fail to achieve explanatory adequacy because they 'overgenerate,' i.e., they generate strings of words and

meanings that are not acceptable in the local language. Since the 1960s, it has been recognized that grammatical constraints are needed to limit the sentences and meanings that can be generated by candidate linguistic theories (Ross, 1967; Culicover, 1976). In the 1970s, it became abundantly clear that the primary linguistic data itself does not impose the necessary limits on grammar formation, without assistance. It soon became clear that children's linguistic knowledge included 'negative facts' such as knowledge that certain sentences are ill-formed or lack particular interpretations. However, the primary linguistic data available to child language learners lacks evidence that would enable them to 'learn' the kinds of constraints on grammar formation that account for such negative facts – i.e., explicit instruction or so-called 'negative evidence' (unacceptable strings of words labelled as such) (see Brown and Hanlon 1970; Marcus, 1993; Lasnik and Lidz, 2017). In the absence of relevant experience, language learners must come pre-equipped with internal constraints on grammar formation. These internal constraints were therefore postulated to be part of Universal Grammar (UG), which at that time was conceived of as a rich domain-specific set of linguistic principles (see Pinker and Jackendoff, 2005).

The advent of the Minimalist Program complicated matters further. To achieve its stated goals, the Minimalist Program sought to reduce the complexity and richness of UG. In order to reduce the explanatory burden on UG as far as possible, the Minimalist Program appealed to general constraints on computation (so-called third factors) rather than constraints specific to

language, The goal of eliminating core aspects of linguistic knowledge from UG led to the Strong Minimalist Thesis, which proposed that MERGE is the sole property of UG .

On its simplest formulation, MERGE is simply set formation. MERGE combines two constituents to form an unordered set. One of the elements of the set projects as a label (Chomsky, 1995). For example, the value of MERGE (X, Y) is either {X, {X, Y}} or {Y, {X, Y}} with either X or Y projecting to label the set.

MERGE (X, Y) → K {X, Y}

K {X, Y}

X   Y
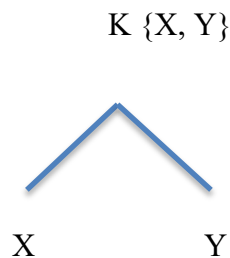
In the example above X and Y are combined using MERGE to produce the object K. K is the label of the set, i.e., one of the immediate constituents X or Y. The constituents X or Y can themselves be complex structures which were built through previous applications of MERGE. In this way MERGE can form structured syntactic objects that contain instances of themselves i.e., recursion. Chomsky (2001) proposes two types of MERGE. EXTERNAL MERGE combines separate objects X and Y. Internal MERGE combines one part of either X or

Y (say, a part of X) to the other constituent (Y). Internal MERGE yields the property of displacement/movement.

Supposing that MERGE is the sole component of Universal Grammar has led to two significant changes in the assumptions linguists made about the nature of human language. One change pertained to the origin of language. Because MERGE is such a simple operation, it is likely to have evolved in a single step (or micro-mutation) (see Hauser *et al*., 2002; Fitch *et al.,* 2005; Chomsky and Berwick, 2016). The second change pertained to the acquisition of language. Adopting the Continuity Assumption – that child and adult grammars are cut from the same cloth – the Strong Minimalist Thesis anticipates that MERGE should be manifested early in child language even in the absence of decisive evidence in the primary linguistic data (Crain, 1991; Berwick & Chomsky, 2016). The Strong Minimalist Thesis therefore anticipates early and spontaneous emergence of recursion in child language. This prediction was not readily borne out in previous research, however. Let us review some representative empirical investigations of recursion in child language.

3. Previous research

The studies we review here all focused on a unique consequence of MERGE for child language, namely recursive hierarchical structures. As Chomsky (cited

in Boeckx, 2009, p. 52) observes "the crucial thing about language is not MERGE; it is unbounded MERGE". Several previous studies have investigated the young children's ability to produce and comprehend recursive nominal (genitive) structures such as (1).[2]

(1) a. Mary's house   [DP [DP Mary]'s [NP house]]

     b. Mary's brother's house

                                  [DP [DP [DP Mary]'s [NP brother]]'s [NP house]]

In (1a) the DP immediately dominating *Mary* is itself immediately dominated by another DP. That is, one DP is embedded inside another DP. This example of self-embedding is one kind of recursive structure that languages exhibit. We will call expressions like (1a) Level 1 Genitives. Example (1b) introduces an additional level of self-embedding. At one level self-embedding the DP dominating *Mary* is embedded inside the DP dominating *brother*. In (1b), this complex syntactic structure (the DP dominating *Mary's brother*) is itself embedded inside another DP: [DP [DP [DP]]]. We will call expressions like (1b) Level 2 Genitives. As noted earlier, the Strong Minimalist Thesis predicts that recursion (MERGE) should be available early in the course of language acquisition. In assessing this

---

[2] We follow Abney (1987) who analyses the possessive -*'s* genitive marker as the head of the DP that immediately contains the possessor DP.

Iain Giblin, Peng Zhou, Cory Bill, Jiawei Shi and Stephen Crain

prediction, research on child language has investigated children's production and comprehension of both Level 1 and Level 2 Genitives. The primary focus has been on Level 2 Genitives, because these are clear examples of multiple self-embedding, and cannot be formulated by child language users based on simple symbolic representations, such as lexical templates (see Roeper 2011 and Roeper and Pérez-Leroux 2012 argue that Level 2 Genitives are a critical test case).

Several previous studies have reported that young children fail to produce or comprehend sentences that contain Level 2 Genitives. Some researchers have concluded from such findings that young children's grammars *do not* generate recursive structures. This has led to the paradoxical, yet widespread view, that recursion (MERGE) is not incorporated into young children's grammars, casting doubt on a central predication of the Strong Minimalist Thesis.

We will briefly review a representative sample of the literature assessing children's production and comprehension of Level 2 Genitives. In several papers, Roeper and his colleagues have observed that Level 2 Genitives are rarely found in transcripts of young children's spontaneous speech, and the same transcripts reveal that children experience difficulty comprehending Level 2 Genitives when they are produced by adults (Roeper and Snyder, 2005; Roeper, 2007; 2010; 2011). To illustrate children's struggle to comprehend Level 2 Genitives, Roeper (2011, citing Gu, 2008) cites the exchange in (2).

(2)   Mother: huh? what's your…. what's…. what's <u>your</u> cousin

                   <u>Arthur's Mummy's name</u>

        Sarah: I don't. …. your cousin?

In example (2), the recursive DP *your cousin Arthur's Mummy's name* is clearly the source of confusion for the child Sarah.

   Similar difficulties have been reported in experimental research. One study that reported children's unsuccessful performance was by Gentile (2003) (cited in Roeper, 2011). The study used a picture selection task. The child participants were shown two pictures, such as the ones in Figure 1, and asked to choose between them.

A: Cookie Monster's sister   B: Cookie Monster and his sister

Figure 1. Picture choice comprehension task

   On the trial that presented this pair of pictures, the child participants were asked "Can you show me Cookie Monster's sister's picture?" For adults with a recursive grammar, this request contains a Level 2 Genitive structure, so

adults point to Picture A. Some of the child participants in the Gentile (2003) study, however, pointed to Picture B. Roeper (2007, 2011) argues that the preference for Picture B by these children indicates that they did not assign a Level 2 Genitive structure to the string of words "Cookie Monster's sister's picture". According to Roeper (2007, 2011) the child participants who pointed to Picture B assigned a non-recursive conjunctive structure to the string of words, instead of a recursive structure. Hollebrandse and Roeper (2014) state that " … about one third of 3-4-year-olds took the conjunctive reading (Cookie Monster and sister's picture) …" (p. 193).

Based on this other related research finding, Roeper (2007) and Hollebrandse and Roeper (2014) conclude that child language learners initially differ from adults, in that child grammars initially lack the same adult recursive procedure as adults, unadorned MERGE. According to Roeper (2011, p. 187), children's non-adult structural analysis is based on '*direct'* recursion, whereas adults represent the same strings using '*indirect'* recursion. Direct recursion involves phrase structure rules that introduce a covert conjunction operator: X > X (and X) (see also Hollebrandse, 2018).

The lack of alignment between the grammars of children and adults is not limited to possessive structures, according to Roeper and his colleagues. Direct recursion is taken to be the source of children's initial non-adult semantic interpretation of the types of sentences listed in (3).

(3)   a.   Possessives [*Jane's father's bike* = Jane's and father's bike]

b.   Adjectives [*second green ball* = second and green ball]

c.   Verbal compounds [*tea-pourer-maker* = tea-pourer and maker]

d.   Prepositional phrases [*beside the box on the shelf* = beside the box and on the shelf]

e.   Sentential complements [*I said John likes cookies* = I spoke and John likes cookies]\

For each of the constructions in (3) adults assign recursive hierarchical structures. According to Roeper and his colleagues, children initially assign non-adult conjoined structures to these strings of words.[3]

Other research has also reported negative findings. Limbach and Adone (2010) also used a picture selection task to assess children's understanding of Level 2 Genitive structures. The Limbach and Adone study asked 3-, 4-, and 5-year-old English-speaking children to choose the picture that best matched the Level 2 Genitive structure in (4). On each trial, there were four pictures for participants to select from, as indicated in (4a-d).

(4)   Jane's father's bike

a.   A picture of Jane's bike   (Level 1 Genitive)

---

[3] Other research studies have demonstrated children's successful of sequences of adjectives such as those in (3b) in certain experimental contexts (see e.g., Hamburger and Crain, 1984; Yang et al., 2017).

b.   A picture of the father's bike   (Level 1 Genitive)

c.   A picture of Jane's father's bike   (Level 2 Genitive)

d.   A picture of a bike belonging to both Jane and her father

(Coordinate Structure)

On approximately 20% of the trials, the 4- and 5-year-old child participants chose Picture (4d), whereas adults almost never selected this picture. In summarizing the findings of the study, Hollebrandse and Roeper (2014) conclude that "[t]he 'conjunction' option is much stronger among children than adults" (p. 194). They take the findings are further evidence that a substantial population of children initially lack a recursive grammar and, instead, have a grammar that assigns a conjunctive analysis to strings that adults assign a recursive structure.

The conclusion that the grammars of child language learners initially lack recursion has also been reached by researchers who have investigated this issue using elicited production tasks. A representative study, by Pérez-Leroux *et al.* (2012) attempted to elicit Level 2 Genitives from 3- to 6-year-old English-speaking children. On a typical trial, the child participants were presented with the scenario in (5).

(5) Here is Elmo. This is his sister. And here is Bart and that's his sister. They each have a ball. Their sisters are carrying balls too. They are all going together to the basketball court. But look! Oh, oh.

Prompt: What is broken and flat?

Target: Elmo's sister's ball

Pérez-Leroux *et al.* report that only one of the forty-six 3- to 5-year-old child participants produced Level 2 Genitive structures, whereas over half of the adult controls did. The findings are summarized in Table 1 (adapted from the Pérez-Leroux *et al.* study).

Table 1. Number of embedded genitives by group

	Level 1 Genitive	Level 2 Genitive
Children (*n=46*)	28	1
Adults (*n=11*)	12	7

As this review indicates, the previous literature has failed to find compelling evidence of recursion in the grammars of young children. The negative findings have led some researchers to conclude that children's grammars initially lack the recursive procedure (MERGE) that generates Level 2 Genitives. Of course, as the saying goes: "absence of evidence is not evidence of absence." The following section describes a new experimental technique that we used to successfully elicit recursive structures (i.e., Level 2 Genitives) from children, who were in the same age range as the previous studies that were unsuccessful in eliciting recursive structures.

Iain Giblin, Peng Zhou, Cory Bill, Jiawei Shi and Stephen Crain

4. Experiments[4]

In nearly all respects, the same experimental protocols were used to elicit recursive structures from both English-speaking children and Mandarin-speaking children. Although both Mandarin and English generate sentences with recursive prenominal possessive structures, these structures differ in certain ways. Therefore, we will present the experiments individually, to clarify the subtle differences. In all events, the experimental aims and research hypotheses were exactly the same. Another similarity is worth noting. As we document in Section 5, the caregiver input to child language learners of both languages only rarely, if ever, contains sentences with recursive possessive noun phrases. Therefore, the experiments we describe here enable us to evaluate the hypothesis that children acquiring typologically distinct languages have the linguistic competence to produce and comprehend recursive structures, despite the absence of evidence for such structures in the primary linguistic data.

The experiments used a Truth Value Judgment task with an elicitation component (see Crain & Thornton, 2000). A Truth Value Judgment task typically requires two experimenters. One experimenter acts out stories with

---

[4] These experiments and results have been previously reported in Giblin et al. (2019).

toys and props in front of the child participant, and the other experimenter manipulates a puppet who watches the stories alongside the child. At the end of each story, the puppet recounts the events that took place in the story, using one of the target sentences. In the present study, the puppet's target sentences contained a Level 1 Genitive. The child's task is to indicate whether the puppet's statements are true or false descriptions of the events that took place in the story.

Whenever child participants reject a puppet's statement, they are asked to tell the puppet 'What really happened in the story?.' This is the elicitation component of the task. On each of the test trials, the puppet's false statement contained a Level 1 Genitive. These statements are a critical ingredient to successfully elicit Level 2 Genitive structures from children. This ingredient was missing in previous studies that failed to elicit Level 2 Genitives from children. The stories were designed so that a felicitous justification for rejecting the puppet's false statement could be made by embedding a second possessive phrase within the Level 1 Genitive that had been used by the puppet. Example (6) illustrates one of the false test sentences and the anticipated response by child participants.

(6)   Puppet: *I know what happened, Big Bird's blanket got dirty*

        Child: *No, Big Bird's cats' blanket got dirty*

4.1 Experiment with English-speaking children

Iain Giblin, Peng Zhou, Cory Bill, Jiawei Shi and Stephen Crain

There were 26 child participants in the English version of the study, 15 males and 11 females. The child participants ranged in age from 3;3 to 5;10, with an average age of 4;7. They were recruited from Banksia Kindergarten and Gumnut Kindergarten at Macquarie University, and the Neuronauts Program run by the ARC Centre of Excellence in Cognition and its Disorders. None of them had a history of speech or hearing disorders.

The experiment included test sentences, control sentence, and filler sentences, as indicated in (7).

(7)   a.   Target Sentences 'Big Bird's cats' blanket' – Level 2 Genitive[5]

       b.   Control Sentences   'Elephant's horse'   – Level 1 Genitive

       c.   Filler sentences   Level 1 Genitive

There was a total of 10 stories. There were 4 false trials, on which the puppet produced one of the target sentences. There also 4 True filler trials,

---

[5] The target sentences in the English version of the study had a plural DP_2. For example, the second DP, *cats,* is plural in the Level 2 Genitive *Big Bird's cats' blanket*: [$_{DP1}$ [$_{DP2}$ [$_{DP3}$ Big Bird]'s [$_{NP}$ cats]]'$\varnothing$ [$_{NP}$ blanket]]. We included a plural DP to simplify the production of the Level 2 Genitives. It is not clear whether the production difficulty arises from repeating an *'s in two consecutive words,* or whether this reflects some distinctness condition (Richards, 2010) similar to the Double-*ing* Filter (Ross, 1972) in which adjacent verbs with the *-ing* morpheme leads to ungrammaticality (for example, *it's continuing raining*).

and 2 False control trials, and 4 false test trials. The stories were arranged in pseudo-random order.

4.2 An example story

Figures 2 and 3 present an example of a test trial.

Figure 2. The story set-up

(8)	*Experimenter:*	This is Gecko and these are his koalas. This is Catboy and these are his koalas.
	Gekko:	It's dinner time and today we're having hotdogs for dinner with our pet koalas.
	Catboy:	Let's eat our hotdogs by the side of the road.
	Experimenter:	Oh no, here comes a motorbike and he's in a

hurry. He nearly knocks over Gecko's hotdog, and then he swerves and knocks over this hotdog and it falls out of the bun and is ruined!

Figure 3. The final outcome

Question to puppet: Which hotdog got knocked over?

Blindfolded puppet: I can't see but let me guess. Gecko's hotdog got knocked over!

Target response: No, Gecko's koalas' hotdog got knocked over!

As this example story illustrates, a felicitous justification for rejecting the puppet's false sentence could be formed by embedding a second possessive phrase inside the Level 1 Genitive phrase that the puppet produced. Neither

the puppet nor the experimenter produced Level 2 Genitives during the testing sessions.

4.3 Results

Table 2 gives the number of Level 2 Genitives produced by the child participants according to age. The overall finding is that children produced Level 2 Genitives on 67% of the test trials, for a total of 70 Level 2 Genitives.

Table 2. Number of Level 2 Genitives by Age

	Number of Level 2 Genitives	Percentage of Trials
3-year-olds (*n*=1)	1	25% (1/4)
4-year-olds (*n*=17)	40	59% (40/68)
5-year-olds (*n*=8)	29	90% (29/32)
All children (*n*=26)	70	67% (70/104)

As Table 2 indicates, the majority of 3-, 4-, and 5-year-old English-speaking child participants were able to produce and comprehend Level 2 Genitives. Table 3 also show that children do improve with age in their ability to produce Level 2 Genitive structures. However, significantly, 4-year-olds regularly produced Level 2 Genitives and that children as young as 3

sometimes produced recursive nominal phrases. Recall, that the Pérez-Leroux *et al* (2012) study only elicited a single Level 2 Genitive from the child participants.

4.4 Experiment with Mandarin-speaking children

For the Mandarin version of the study, we interviewed 30 4-year-old monolingual Mandarin-speaking children (18 male, 12 female). The child participants ranged in age from 4;0 to 4;11, with an average age of 4;5. They were recruited from Taolifangyuan Kindergarten, Beijing. None of them had any reported speech or hearing disorders.

In Mandarin, the genitive construction is formed using the possessive *de* marker, as illustrated in (9).

(9)   Jiawei DE laoshi

        Jiawei DE teacher

        'Jiawei's teacher'

The *de* construction marks the possessive relation with the possessor DP preceding the *de* marker.[6] Thus, phrases of the form $DP_1 + de + DP_2$ express

---

[6] The *de* marker also has other semantic functions, but these do not concern us here because these other functions are not available in the test sentences.

the possessive relation between DP_1 and DP_2, with DP_1 being the possessor and DP_2 being the entities possessed (Huang *et al.*, 2009). As in the experiment with English-speaking children, the target sentences contained Level 2 Genitives, whereas the control sentences and filler sentences contained Level 1 Genitives. Examples of the three sentence types are in (10).

(10) a. Target sentence:

haidao   DE qingwa DE   binggan

pirate   DE frog   DE   biscuit

'The pirate's frog's biscuit''

b. Control sentence:

xiaoxiongweini   DE   huasheng

Winnie the Pooh   DE   peanut

'Winnie the Pooh's Peanut'

c. Filler sentence:

tuziDE   beike

rabbit   DE shell

'The rabbit's shell'

As in the English version of the experiment, each Mandarin-speaking child participant heard 10 stories: 4 targets, 4 fillers, and 2 controls. The ten stories were arranged in pseudo-random order. On the target trials, the objective was to elicit Level 2 Genitives from the child participants. As in the

English-speaking version, the puppet's false statements contained a Level 1 Genitive. Whenever child participants (correctly) judged a puppet's statement to be false, they were asked to tell the puppet 'what really happened in the story.' The stories were designed such a felicitous statement correcting the puppet's false assertion could be formed by embedding an additional DP inside the one produced by the puppet, yielding a Level 2 Genitive. Here is an English rendering of a typical story that was presented to the child participants in Mandarin.

4.5 Example story

Figures 5 and 6 present an example of a typical story.

Figure 5. The story set-up

Experimenter: This is a story about a pirate and a witch. The pirate has a frog and the witch has a frog too. One day, they went into the woods to have a

picnic. They each had a biscuit for their lunch. They arrived early but it was not lunch time, so they gathered together to play games, leaving their biscuits behind. There was a caterpillar nearby, and he was very hungry. He saw the biscuits and wanted to steal the pirate's biscuit, but the pirate discovered the caterpillar trying to steal the biscuit. The caterpillar was still hungry, and he saw this biscuit. This time, he was very cautious and managed to steal it.
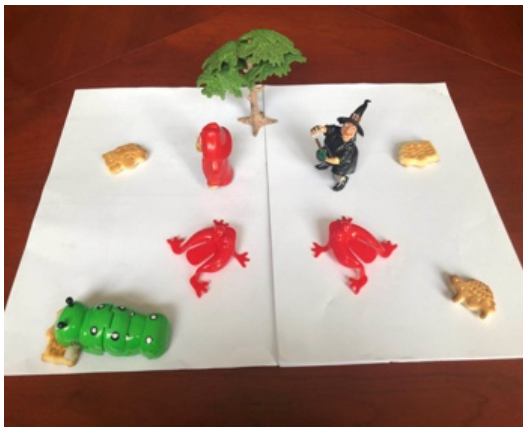
Figure 6. The final outcome

Question to Puppet: Now it is your turn, Catty.

                        Do you know which biscuit was stolen?

Blindfolded Puppet: I can't see. Let's me guess…

(Catty)   The pirate's biscuit was stolen

Target response: No! The pirate's frog's biscuit was stolen.[7]

---

[7] Note that in the Mandarin examples DP$_2$ is a singular DP whereas in English it was a plural DP.

Iain Giblin, Peng Zhou, Cory Bill, Jiawei Shi and Stephen Crain

4.6 Results

Table 3 provides the number of Level 2 Genitives produced by the Mandarin-speaking children. The children produced Level 2 Genitives on 95 occasions or 79% of the possible test trials. These results are similar to the results for English-speaking children and show that 4-and-5-year-old children can in fact produce and comprehend Level 2 Genitive structures. These results contrast with previous work (such as those studies mentioned in Section 3 above) that have found that children have considerable difficulty with Level 2 Genitives.

Table 3. Total number of Level 2 Genitives

	Level 2 Genitives	% of trials
All children (*n*=30)	95	79% (95/120)

5. Corpus studies

A previous survey of CHILDES reported that English-speaking children younger than 6 do not produce or comprehend possessive genitives (Roeper & Snyder, 2005). We conducted a broad survey of parent-child interactions transcribed in CHILDES (MacWhinney, 2000). The survey revealed 107

recursive possessive phrases by caretakers; 75 of these phrases (70%) conformed to a simple format: <proper name>'s + <common noun>'s + name (e.g., *Sue's baby's name*). We conducted a search of three Mandarin corpora (Zhou1, Zhou2, and Zhou3) and found no instances of the recursive *de* construction in adult speech to children acquiring Mandarin.

6. General discussion

The findings of the present study are relevant for current proposals in the literature on child language, and also for more the general controversies in the cognitive sciences. According to the Strong Minimalist thesis, the combinatorial operation MERGE is the basic property of the human faculty for language. MERGE is taken to be a property that is specific to a single domain of cognition (language), unique to the species, and a property that is exhibited in all human languages. As noted in the introduction, the ubiquity, domain specificity, and uniqueness of recursion to the species have all been disputed.

As for the ubiquity of recursion, Everett (2005, 2012) claims that adult speakers of one language (Pirahã, an indigenous South American language) do not produce sentences with recursion. Everett concludes that recursion is, therefore, not a basic property of the language faculty (see Sauerland 2018 and Nevins et al. 2009 for critiques of Everett's factual claims about Pirahã). This conclusion is unwarranted. Even if some language-users never produce

sentences with recursive structures, for whatever reason, this would not undermine the proposal that recursion is a basic property of the human faculty language. For example, it does not show that these language-users or their progeny are unable to acquire languages with recursion. The experiments reported in the present paper indicate that, even despite the absence of evidence for these structures in the input from their caregivers, children acquiring English and children acquiring Mandarin produce sentences with recursive structures and exhibit adult-like understand of such sentences. This finding reinforces the plausibility of the conclusion that if a young child acquiring Pirahã was relocated to a Portuguese-speaking community, the child would rapidly and effortlessly acquire Portuguese, a language with recursion.

A second challenge to the Strong Minimalist Hypothesis concerns the nature of recursion, i.e., whether it is domain-specific versus domain-general. Several researchers have argued that recursion is a general feature of cognition, and not specific to language. This proposal is made in Jackendoff (2010), Corballis (2011), and Everett (2012). In our view, the alternative positions - that recursion is innately specified in Universal Grammar versus a property of general cognition - reduces to the familiar nature/nurture debate. To adjudicate between these alternatives involves determining whether or not recursion satisfies established criteria for innate specification. The present paper has sought to evaluate two of these criteria, by seeing if recursion (i) emerges early in child language, and (ii) emerges in the absence of decisive

evidence from experience. The findings of the studies we conducted clearly weigh on the side of innate specificity.

Several specific proposals about domain-general sources of recursion can also be ruled out. In fact, all learning-theoretic account of the acquisition of recursion have difficulty explaining the findings of the present study. For example, both Tomasello (2003) and Lieven (2009) propose that recursion is simply a generalization from lexical evidence. Similarly, Perfors *et al*. (2011) claim that the distribution of frequency defined evidence is sufficient for the acquisition of recursive structures without any need for a recursive procedure to be part of the initial state. These learning-theoretic accounts of language acquisition rest on a set of specific assumptions. First, these accounts contend that linguistic knowledge is acquired piecemeal, based on the frequency of occurrence of linguistic constructions in the ambient input. A second, related assumption is that children acquire knowledge according to the frequency of linguistic constructions in the linguistic input; less frequent are acquired later in the course of language acquisition. The findings of the present study cast doubt on both of these assumptions. The corpus data we reviewed in the previous section indicate that recursive possessive phrases are highly infrequent in the input to children. Yet every English-speaking child participant and every Mandarin-speaking child participant made adult-like decisions about the truth or falsity of the target sentences. Moreover, at least three-quarters of the child participants in both languages produced Level 2 Genitives. It is reasonable to conclude that, despite a paucity of evidence, the

grammars of young children acquiring these two typologically distinct languages incorporate a recursive procedure that enables them to generate embedded recursive structures. Although it is conceivable that children could 'learn' to produce Level 1 Genitives, based on exemplars from adults, the fact that children produced Level 2 Genitives cannot be explained in learning-theoretic terms, because such sentences were not represented with sufficient frequency in the input. Children exhibit linguistic knowledge in the absence of experience. The findings, therefore, constitute a compelling poverty of the stimulus argument.

The fact that children produce recursive structures that they don't encounter in their experience also undermines a proposal by Roeper and Snyder (2005) about the development of recursion in child language (see Footnote 2). Their proposal has two parts. First, they propose a constraint on recursion in young children's grammars, called the Recursion Constraint (2005):

Recursion Constraint: The output of a given operation cannot serve as the input to the same operation.

The second part of the Snyder and Roeper account (2005, p. 160-161) concerns the language learnability. This is a proposal about how child language learners make the transition from their initial grammar to the adult grammar; i.e, the circumstances in which children abandon the Recursion

Constraint. Essentially, the constraint must be overridden by positive evidence, i.e., examples of specific recursive structures. Here are statements of this second part of the account:

[the constraint applies] "except when the child's linguistic input provides evidence to the contrary".

"children's acquisition of grammar is based on their finding clear evidence that particular grammatical operations have applied recursively".

As these quotes indicate, child language learners are taken to adopt a conservative, experience-based account of language development.

Experience-based approaches to child language development may seem attractive because they are responsive to linguistic variation that is witnessed across languages, including recursion. A conservative language learner is able to acquire the specific constructions that generate recursion in the local language, and to eschew recursive structures that are available in other languages, but not in the local language. We have already seen however, that children do not encounter the kind of linguistic input that Roeper and Snyder envision as the basis for language learning – i.e., positive exemplars of the recursive constructions that the local language permits.

More importantly, in our view, the mechanisms of language learnability should be consistent with the Continuity Assumption. The

literature on theoretical syntax has documented many syntactic differences in recursive structures across languages. In response to these differences, syntacticians have formulated principled restrictions on recursion across languages. For example, the literature includes Hoekstra's (1984) Unlike-Category Constraint, Van Riemsdijk's (1988, 1998) Unlike-Feature Condition, Richards' (2006) Distinctness Condition, and den Dikken and Dekany's (2018) Restriction on Recursion (cf. Adger 2003). Consider one example from this list, the Restriction on Recursion proposed by den Dikken and Dekany. This is a putative universal principle applying to the outputs of External Merge.[8] The constraint limits recursion to phase level categories, and imposes the further limit that recursion is only permitted when the same phase level category is separated by a phrasal head. The syntactic effects of the Restriction of Recursion are widespread, even within a single language. The syntactic effects include the use of proper names and possessive pronouns, marking for CASE and for a POSSESSION feature, number and person marking, and the position of the Definite Determiner. For example, a phrase-level projection is introduced in Hungarian when an expression that denotes a possessor is accompanied by Dative case. This explains a long list of phenomena, including the fact that recursion is acceptable in Hungarian in noun phrases such as (11), but not in noun phrases like (12).

---

[8] A symmetrical principle, with only minor differences, is responsible for the deletion of copies in expressions formed by Internal Merge, such as WH-phrases.

(11)   Janos kalapjanak   a   szele

       Janos hat.POSS.DAT the rim.POSS

       'Janos's hat's rim'

(12) *Janos kalapja   szele

       Janos hat.POSS rim.POSS

       'Janos's hat's rim'

To cite another example, recursion is licensed in Dutch prenominal genitive possessors only with relational nouns that are [+HUMAN]). Even in expressions with semantically allowable expressions, there are syntactic constraints. For example, (13) and (14) are acceptable, but (15) is not. Hoeksema (2010) advances an account according to which Spec/Head agreement of the feature [+POSS] is required between the D head (the *-s* on *moeders in examples 13-15*) and the Specifier, which must either be a proper name or a possessive pronoun, [+HUMAN] relational nouns that carry the feature [+POSS]. Without this feature, the expression is unacceptable, as (15) indicates.

(13)   *Jans/zijn moeders hoed.*

       'John's/his mother's hat.'

(14)   *Jan's/zijn vaders moeders hoed.*

      John's/his father's mother's hat.

(15)   **de moeders hoed.*

      'The mother's hat.'

Recursion with [-HUMAN] nouns is acceptable in Dutch if a speaker uses the recursive possessive structure in (16), with multiple occurrences of one of the two Dutch possessive pronoun. Perhaps it is the use of these pronouns, corresponding to English 'his and 'her,' which limits recursion to nouns that are marked [+HUMAN], broadly construed (including pets and organizations).

(16)   *Jan z'n konijn z'n eten.*

      'John his rabbit his food.'

It is worth pointing out another fact about the English possessive –'s genitive.[9] Freeze (1992) observes a parallelism between the possessive –'s genitive and the verb HAVE. In a nutshell, where the verb HAVE is acceptable, so is the possessive –'s genitive. On the other hand, where HAVE is not acceptable,

---

[9] Freeze (1992) provides further evidence that the possessive –'s structure in English, as in Dutch, is typically used with nouns marked [+HUMAN].

neither is the possessive –'s genitive. As Freeze points out, sentence acceptability can be rescued using alternative expressions such as an existential phrase (*there is* …) or by adding a locative expression (e.g., HAVE + *on it*). Examples of the relevant contrasts is provided in (17).

(17) Acceptable [+HUMAN]

The man has a book.

The man's book.

Unacceptable [-HUMAN]

*The bench has a book"

*The bench's book"

Acceptable alternatives

A book is on the bench.

The bench has a book on it.

There is a book on the bench.

The literature also makes it clear that the English possessive genitive –'*s* structure is far from unrestricted. As Hornstein et al. (1994) point out, "the truck's wheels" cannot be used to refer to some wheels that have been put in the back of a truck. Similarly, *the Saab's Ford engine* refers to the engine that

powers the Saab, and cannot refer to a Ford engine that is in the back seat of the Saab.

Earlier, we concluded that it is implausible to suppose that children must encounter exemplars of specific recursive constructions in acquiring recursive structures, at least ones that are not universal. The question arises, then, about the nature of the triggering mechanisms that enable learners to add new recursive structures to their grammars. This is where the Continuity Assumption enters the picture. First, a viable triggering mechanism must be directly related to the structural analysis underpinning the linguistic phenomena under consideration. As we just discussed, cross-linguistic research in theoretical syntax has proposed that phrase-level categories with certain syntactic features, such as [+HUMAN], [+POSS], are pre-requisites for recursion in possessive –'s genitives (cf. Adger 2003). Sentences informing children that the relevant syntactic category is part of the local language could serve as the triggering data for different types of recursion. In this case, the triggering data informs child language learners that the local language requires a phrase-level category with the relevant features. Initially, children's grammars would lack these phrasal categories, so their grammar would not generate the same set of expressions as the adult grammar. This would change once the learner encountered simple positive evidence, a detectable error, and responded by making the necessary grammatical adjustment. Such an account does not require child language learners to

encounter examples of recursive structures themselves, just evidence of the basic syntactic building blocks needed for recursion.

7. Conclusion

This paper addressed a number of recent proposals in the literature on the acquisition of recursion. Recent research has led some researchers to the conclusion that young language learners initially lack recursion or assign a different structural analysis than adults do to various recursive linguistic constructions. The findings of the present study obviate the need for any non-adult stage of language acquisition. Rather, our results suggest that children analyze Level 2 Genitives in the same way as adults do, using MERGE. Our findings undermine the motivation to postulate a simple form of recursion (e.g., direct recursion) or any other non-adult analysis, as a stage of language acquisition. Our findings are therefore consistent with the strongest form of the Continuity Assumption.

Many of the same considerations about recursion in child language acquisition extend to arguments about the evolution of human language. On one view, language evolved in stages, from proto-grammars to full-fledged grammars. This view is similar to the claim by Roeper and his colleagues that child language learners go through stages in acquiring adult-like competence

Iain Giblin, Peng Zhou, Cory Bill, Jiawei Shi and Stephen Crain

with recursion. The very idea that recursion can take on primitive forms has been challenged by Berwick and Chomsky (2016, p. 72), who assert:

> … there is no room in this picture for any precursors to language – say a language-like system with only short sentences. There is no rationale for positing such a system: to go from seven-word sentences to the discrete infinity of human language requires emergence of the same recursive procedure as to go from zero to infinity … similar observations hold for language acquisition, despite appearances.

The argument Berwick and Chomsky (2016) carries over to language acquisition. It is highly implausible to suppose that children progress through a stage of language development at which they postulate a primitive form of recursion. The findings of our study show that the same recursive procedure used in adult grammars (MERGE) is available to child language learners from the early stages of language development.

Acknowledgements

References

Abney, S. P. (1987). The English noun phrase in its sentential sspect (Unpublished PhD Thesis). Massachusetts Institute of Technology.

Adger, D. (2003). *Core syntax: A minimalist approach*. Oxford University Press.

Berwick, R. C., & Chomsky, N. (2016). *Why only us: Language and evolution*. MIT Press.

Boeckx, C. (2009). The nature of Merge: Consequences for language, mind, and biology. In M. Piattelli-Palmarini, J. Uriagereka, & P. Salaburu (Eds.), *Of minds and language: A Dialogue with Noam Chomsky in the Basque country* (pp. 44–57). Oxford University Press.

Bolhuis, J. J., & Everaert, M. (2013). *Birdsong, speech, and language: Exploring the evolution of mind and brain.* MIT Press.

Brown, R., & Hanlon, C. (1970). Derivational complexity and order of acquisition on child speech. In J. R. Hayes (Ed.), *Cognition and the development of language* (pp. 11-53). Wiley.

Chomsky, N. (1995). *The minimalist program.* MIT Press.

Chomsky, N. (2001). Beyond explanatory adequacy: *MIT Working Papers in Linguistics, 20*.

Chomsky, N. (2014). *Aspects of the theory of syntax*. MIT Press. (Original work published 1965).

Corballis, M. C. (2011). *The recursive mind: The origins of human language, thought, and civilization.* Princeton University Press.

Crain, S. (1991). Language acquisition in the absence of experience. *Behavioral and Brain Sciences*, *14*(4), 597-612.

Crain, S., & Pietroski, P. (2001). Nature, nurture and Universal Grammar. *Linguistics and Philosophy*, *24*(2), 139-186.

Crain, S., & Thornton, R. (2000). *Investigations in Universal Grammar: A guide to experiments on the acquisition of syntax and semantics*. MIT Press.

Crain, S., Giblin, I., & Thornton, R. (2021). The deep forces that shape language and the poverty of the stimulus. In N. Allott, T. Lohndal, & G. Rey (Eds.), *A Companion to Chomsky* (pp. 462-475). Wiley.

Culicover, P. (1976). *Syntax*. Academic Press.

den Dikken, M., & Dékány, É. (2018). A restriction on recursion. *Syntax*, *21*, 37-71.

Everett, D. L. (2005). Cultural constraints on grammar and cognition in Pirahã: Another look at the design features of human language. *Current Anthropology*, *46*(4), 621-646.

Everett, D. L. (2012). *Language: The cultural tool*. Pantheon Books.

Fitch, W. T., & Hauser, M. D. (2004). Computational constraints on syntactic processing in a non-human primate. *Science, 303*, 377-380.

Fitch, W. T., Hauser, M. D., & Chomsky, N. (2005). The evolution of the language faculty: Clarifications and implications. *Cognition, 97*, 179-210.

Freeze, R. (1992). Existentials and other locatives. *Language, 68*, 553-595.

Giblin, I., Zhou, P., Bill, C., Shi, J., & Crain, S. (2019). The spontaneous eMERGEence of recursion in child language. *Proceedings of BUCLD*, *43*, 270-285.

Hamburger, H., & Crain, S. (1984). Acquisition of cognitive compiling. *Cognition, 17(*2), 85-136.

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*(5598), 1569-1579.

Hoekstra, T. (1984). *Transitivity: Grammatical relations in Government-Binding theory*. Foris.

Hollebrandse, B. (2018). Indirect recursion: The importance of second-order embedding and its implications for cross-linguistic research. In L. Amaral, M. Maia, A. Nevins, & T. Roeper (eds.), *Recursion across domains*, 35-47. Cambridge University Press.

Hollebrandse, B., & Roeper, T. (2014). Empirical results and formal approaches to recursion in acquisition. In T. Roeper & M. Speas (Eds.), *Recursion: Complexity in cognition, studies in theoretical psycholinguistics* (pp. 179-219). Springer.

Iain Giblin, Peng Zhou, Cory Bill, Jiawei Shi and Stephen Crain

Hornstein, N., Rosen, S., & Uriagereka, J. (1994). Integrals. *University of Maryland Working Papers in Linguistics*, *2*, 70-90.

Huang, C.-T. J., Li, Y. Audrey, & Li, Y. (2009). *The syntax of Chinese.* Cambridge University Press.

Jackendoff, R. (2010). Your theory of language evolution depends on your theory of language. In R. K. Larson, V. Déprez, &H. Yamakido (Eds.), *The evolution of human language: Biolinguistic perspectives* (pp. 63-72). Cambridge University Press.

Lenneberg, E. H. (1967). *Biological foundations of language.* John Wiley and Sons.

Lasnik, H., & Lidz, J. (2017). The argument from the poverty of the stimulus. In Ian Roberts (ed.), *The Oxford handbook of Universal Grammar* (pp. 221-248). Oxford University Press.

Li, D., Yang, X., Roeper, T., Wilson, M., Yin, R., Kim, J., Merrit, E., Lopez, D., & Tero, A. (2020). Acquisition of recursion in Mandarin. *Proceedings of BUCLD, 44*, 294-307.

Lieven, E. (2009). Developing constructions. *Cognitive Linguistics*, *20*(1), 191-199.

Limbach, M., & Adone, D. (2010). Language acquisition of recursive possessives in English. *Proceedings of BUCLD*, *34*, 281-290.

Marcus, G. (1993). Negative evidence in language acquisition. *Cognition, 46*(1), 53-85.

MacWhinney, B. (2000). *The CHILDES Project. Tools for Analyzing Talk* (3rd edn.). Lawrence Erlbaum.

Nevins, A., Pesetsky, D., & Rodrigues, C. (2009). Evidence and argumentation: A reply to Everett (2009). *Language*, *85*(3), 671-681.

Pérez-Leroux, A. T., Castilla-Earls, A., Bejar, S., & Massam, D. (2012). Elmo's sister's ball: The problem of acquiring nominal recursion. *Language Acquisition*, *19*(4), 301-311.

Perfors, A., Tenenbaum, J. B., & Regier T. (2011). The learnability of abstract syntactic principles. *Cognition, 118*, 306-338.

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

Richards, N. (2006). A distinctness condition on linearization. Ms., Massachusetts Institute of Technology.

Richards, N. (2010). *Uttering trees*. MIT Press.

Roeper, T. (2007). *The prism of grammar: How child language illuminates humanism.* MIT Press.

Roeper, T. (2010). Recursion: What is innate, why it needs a trigger, where it belongs in cross-linguistic work, and how it fits into the mind. *Proceedings of Anpoll's 1st International Psycholinguistics Congress, Rio de Janeiro*, 42-64.

Roeper, T. (2011). The acquisition of recursion: How formalism articulates the child's path. *Biolinguistics*, *5*(1-2), 57-86.

Roeper, T., & Snyder, W. (2004). Recursion as an analytic device in acquisition. *LOT Occasional Series*, *3*, 401-408.

Roeper, T., & Snyder, W. (2005). Language learnability and the forms of recursion. In A.-M. DiScullo (Ed.), *UG and external systems: Language, brain and computation* (pp. 155-169). John Benjamins.

Ross, J. R. (1967). Constraints on variables in syntax (Unpublished PhD thesis). Massachusetts Institute of Technology.

Ross, J. R. (1972). Doubl-ing. *Linguistic Inquiry, 3*, 61-86.

Sauerland, U. (2018). False reports in Pirahã. In L. Amaral, M. Maia, A. Nevins, & T. Roeper (eds.), *Recursion across domains*, 21-34. Cambridge University Press.

Tomasello, M. (2003). *Constructing a language: A usage-based theory of language acquisition.* Harvard University Press.

van Riemsdijk, H. C. (1988).The representation of syntactic categories. In *Proceedings of the Conference on the Basque Language, Second Basque World Congress* (pp. 104-116). Central Publications Service of the Basque Government.

van Riemsdijk, H. C. (1998). Categorial feature magnetism: The endocentricity and distribution of projections. *Journal of Comparative Germanic Linguistics*, *2*, 1-48.

Wolfe, T. (2016). *The kingdom of speech*. Random House.

Yang, C., Crain, S., Berwick, R. C., Chomsky, N., & Bolhuis, J. J. (2017). The growth of language: Universal Grammar, experience, and principles of computation. *Neuroscience & Biobehavioral Reviews, 81,* 103-119.