# Recursion across Domains

Edited by Luiz Amaral, Marcus Maia, Andrew Nevins and Tom Roeper


Amaral, Maia, Nevins and Roeper

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"In the light of recent claims according to which syntactic recursion is *the* defining property of natural language, this volume offers an excellent collection of contributions dealing with the issue of how to detect and define recursion across syntactic domains and different languages. Since many chapters provide a comparison between languages that have been in the focus of recent debates on recursion and indigenous languages of Brazil, the book is a 'must-read' for linguists interested in the issue of recursion from a typological perspective."
**Andreas Trotzke**, *Universität Konstanz*

Recursion and self-embedding are at the heart of our ability to formulate our thoughts, articulate our imagination and share with other human beings. Nonetheless, controversy exists over the extent to which recursion is shared across all domains of syntax. A collection of eighteen studies is presented here on the central linguistic property of recursion, examining a range of constructions in over a dozen languages representing great areal, typological and genetic diversity and spanning wide latitudes. The volume expands the topic to include prepositional phrases, possessives, adjectives and relative clauses – our many vehicles for expressing creative thought – to provide a critical perspective on claims about how recursion connects to broader aspects of the mind. Parallel explorations across language families, literate and non-literate societies, children and adults are investigated and constitute a new step in the generative tradition by simultaneously focusing on formal theory, acquisition and experimentation, and ecologically sensitive fieldwork, and initiate a new community in which these diverse experts collaborate.



CAMBRIDGE
UNIVERSITY PRESS
www.cambridge.org

ISBN 978-1-108-41806-5
9 781108 418065

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University Printing House, Cambridge CB2 8BS, United Kingdom

One Liberty Plaza, 20th Floor, New York, NY 10006, USA

477 Williamstown Road, Port Melbourne, VIC 3207, Australia

314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi – 110025, India

79 Anson Road, #06-04/06, Singapore 079906

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of education, learning, and research at the highest international levels of excellence.

www.cambridge.org

Information on this title: www.cambridge.org/9781108418065

DOI: 10.1017/9781108290708



First published 2018

Printed in the United Kingdom by Clays, St Ives plc

*A catalogue record for this publication is available from the British Library.*

*Library of Congress Cataloging-in-Publication Data*

ISBN 978-1-108-41806-5 Hardback

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# Foreword

The chapters in this volume represent a very important set of contributions to the recent debates regarding the nature of recursion in natural language and the typological issues surrounding its (non-)manifestation in the syntax of various languages. In many of the chapters, important new data from the indigenous languages of Brazil are also presented.[1]

Although the issues at stake here are long-standing ones in linguistic theory, the immediate stimulus to the conference comes from two papers published in the early 2000s: Hauser, Chomsky and Fitch (2002) and Everett (2005).

Hauser, Chomsky and Fitch (2002) made an important conceptual distinction between the Faculty of Language in the broad sense (FLB) and the Faculty of Language in the narrow sense (FLN). The former includes both the narrow-syntactic component that generates structural descriptions of sentences along with the two principal interfaces (Articulatory-Perceptual, governing the transduction of syntactic representations ultimately into a perceptual modality, speech or sign, and Conceptual-Intentional, converting syntactic representations into objects of thought, belief or judgement). It was suggested that aspects of FLB might not be specific to humans. FLN, on the other hand, was argued to consist purely of the computational system of the syntax, whose central property is discrete infinity: the ability to generate an infinite set of structural descriptions from the iterated application of the single structure-building operation Merge. Merge, as a property of finite human minds, must itself be finitely specifiable. Formulating Merge as a recursive function, able to apply to its own output in iterative fashion with no limit in principle, makes possible the generation of infinite sets from finite means. In slightly more formal terms, Merge can be seen as the intensional definition of a set of structural descriptions, whose extension is infinite (see Watumull et al. 2014 for more detailed discussion of

[1] The papers were presented at a conference held at the Federal University of Rio de Janeiro in August 2013. The project that led to the conference is a result of a partnership between the Graduate Program in Linguistics of the Federal University of Rio de Janeiro (PPGL-UFRJ) and the Language Acquisition Research Center at the University of Massachusetts Amherst (LARC-UMass).

this aspect of Merge). Hauser, Chomsky and Fitch thus argued that the central property of FLN was a recursive operation. They further suggested that FLN, and hence Merge, is a uniquely human trait, and one which is likely to have evolved very recently in human phylogeny, perhaps through exaptation from some other aspect of cognitive or motor function.

The obvious inference to make from Hauser, Chomsky and Fitch's conclusions is that recursion is a property of all, and only, humans. Therefore, evidence of recursive structures of one kind or another should be available in all human languages; in fact, recursion, as part of FLN, forms part of the definition of a possible human language. This view was directly challenged by Everett (2005), who argued that Pirahã, an indigenous language isolate spoken in Amazonas, Brazil, lacks evidence for what is often seen as the clearest form of syntactic recursion, namely sentential embedding. If this conclusion is correct, then the view of FLN espoused by Hauser, Chomsky and Fitch may be challenged (although there are reasons to question this conclusion, as we will see below). More generally, since Hauser, Chomsky and Fitch were articulating a particular version of the general programme of generative grammar as formulated originally by Chomsky (1955/1975, 1957), Everett's conclusions may be seen as a challenge to the entire enterprise of generative grammar as it has been conceived since the 1950s; this is certainly how Everett himself sees them.[2]

Unsurprisingly, Everett's conclusions have been controversial; for extensive discussion of the nature of the syntactic evidence for and against recursion, and how this may or should be interpreted, see Nevins, Pesetsky and Rodrigues (2009a, 2009b), Everett (2009) and Sauerland (2010b). Everett's views have also received considerable media attention, in the form of two popular books by Everett himself (Everett 2008, 2012), one film, articles in *The New Yorker* and elsewhere, and regular appearances by Everett in the media.[3]

The central question which the chapters collected here address is then: what is the evidence from the indigenous languages of Brazil and elsewhere for and

[2] In fact, Everett (2005) goes further than this, in that he suggests that in order to fully understand the grammar of Pirahã it is necessary to take into account certain cultural beliefs he claims to be held by the speakers of that language. As Everett points out, this alleged inseparability of grammar and culture challenges more deeply held views in mainstream linguistics, views which were inherited by generative grammar from the earlier American and European structuralist traditions.

[3] For the *New Yorker* article, see www.newyorker.com/reporting/2007/04/16/070416fa_fact_colapinto. For a presentation of Everett's views on American National Public Radio, see www.npr.org/templates/story/story.php?storyId=9458681. The film is *The Grammar of Happiness*, produced by Essential Media (www.essential-media.com/node/119). See also www.bbc.co.uk/radio4/science/thematerialworld_20060622.shtml, an occasion on which Everett and the present author attempted to debate the issues within the confines of a live radio programme, arguably not the optimal environment for this kind of discussion.

against recursive structures in natural language? On the simplest interpretation of what is at stake here, one could think that if such evidence is not directly forthcoming, then it is right to conclude, as Everett and others (notably for example, Evans and Levinson 2009) have, that the Chomskyan programme for linguistic theory is so fundamentally flawed that it must be abandoned. If, on the other hand, irrefutable evidence for such structures is available, then Everett's challenge can be deemed to have failed, and Chomsky's programme is thereby supported. The chapters in this volume certainly tend to favour the latter conclusion. Moreover, such a conclusion would in any case be naive. One could argue, as Chomsky himself has done (Chomsky 2012:30), that the absence of recursion in Pirahã proves nothing about the overall nature of the human language faculty, any more than the discovery of a group of humans who do not walk upright would disprove our innate capacity for bipedalism. Alternatively, one could argue that any linguistic structure containing more than two elements must feature binary Merge and is hence recursive, and so Everett's observations regarding Pirahã syntax are beside the point.

What is at stake in these debates is more than either the question of the correct analysis of various syntactic structures in a range of languages (from Brazil or otherwise, Indo-European or otherwise, "exotic" or otherwise), or the correctness of an influential theory of language. These debates go deeper: they directly address the question of what it is to be human. The capacity for the acquisition of complex language under naturalistic conditions without explicit instruction is universal to, and unique to, human children. The human capacity for language underpins human culture, civilisation and technology. Therefore, our view of the essential nature of language profoundly informs our view of human nature, the human mind and human culture.

For Chomsky, as we saw from the brief summary of Hauser, Chomsky and Fitch (2002) above, the central property of language is the fact that sound and meaning (the two interfaces implicated in the FLB) can be related over an unbounded domain; Berwick and Chomsky (2015:1) refer to this as the Basic Property of human language. This is possible because the two interfaces are mediated by the syntactic component whose central formal property is Merge. Recursion lies at the very heart of the definition of the language faculty (broad or narrow). It is the cognitive capacity to manipulate symbols in a recursive fashion that is central to human nature. To the extent that this ability is not shared with other species, it must be somehow instantiated in the human genome, such that the genetic blueprint for building a human brain contains an "instruction" to create the neural substrate for such representations (in our current state of ignorance, we have no more idea as to how these representations are neutrally instantiated than we do of how any "higher" cognitive functions are). The ability to manipulate such structures emerges spontaneously in human development, as long as (and perhaps as soon as) a child is exposed to language. Somehow, at some stage since the human lineage diverged from that of the most closely related primates, this cognitive capacity must have evolved (see Berwick and Chomsky 2015 for a recent discussion of language evolution in the light of the Basic Property).

But there is more, at least arguably. The cognitive capacity to manipulate symbols using a recursive schema such as Merge may underlie other human abilities: our ability to manipulate numbers (Merge is formally very close to the successor function, the recursive function $S$ such that $S(n) = n+1$ for every natural number $n$), our musical capacities (Lehrdahl and Jackendoff 1983), our moral sense (Hauser 2006) and our capacity to recognise and ascribe content to other minds (i.e. Theory of Mind, deVilliers 2007). Thus much of what many would agree makes us human may be traceable to a simple formal property of human mental computation. There is, moreover, a still deeper point at stake here, one with its origins in Cartesian philosophy: the recursive nature of syntax is a necessary component of what Chomsky has called the "creative aspect of language use", i.e. the fact that humans are able to produce and understand utterances that have never been produced before. This formal property quite literally allows us to give expression to our freedom of will. So the postulation of the ability to produce recursive cognitive representations elegantly captures profound aspects of human uniqueness.

Everett's view, on the other hand, takes culture as the central concept in understanding human language and human nature. Culture, rather than computation, is the key to the understanding of human nature (although Everett does not deny that humans are capable of recursive cognition; he merely asserts that it is not central to natural-language syntax). In order to understand the nature of human cognition, we must understand human culture and cultural evolution. Language is, as the title of his 2012 book implies, a cultural tool: something that, like other tools, humans have invented; something that may vary greatly from culture to culture, and that has developed through cultural, rather than biological, evolution. The fundamental nature of language is determined by society, rather than by any property of the individual. Hence, since Pirahã culture differs profoundly from "Western" culture, it is no surprise that the Pirahã language should also differ profoundly from (Indo)-European languages, structurally and in many other ways too (see in particular Everett 2005 for details on several strikingly "exotic" aspects of Pirahã).

These two views arguably reflect two rather different historical currents in linguistics (they are obviously also connected in a very general way with rationalist as opposed to empiricist views of epistemology). We can, in a rather superficial but nonetheless useful way, discern two distinct traditions in the linguistics of the past centuries. On the one hand, there is the "comparative/historical" approach, and on the other the "formal/universalist" approach.

The comparative/historical approach dominated nineteenth-century linguistics, leading to the establishment of many of the major language families of the world through painstaking empirical work and the development of the informal methodology of comparative reconstruction. It has its roots in the orientalism of Sir William Jones, Friedrich Schlegel (see Schlegel 1808), as well as in medievalism (see the work by the Grimm brothers on aspects of medieval German language and folklore: Grimm and Grimm 1812–1815), and, more generally, in German Romanticism. This approach to language is particularist, in that details of individual languages are focussed on without regard to issues concerning language universals. The emphasis is empirical and historical, and questions such as the nature of the relation between language and logic play little or no role. Instead, the emphasis is by and large on cultural and historical explanation. Language is, if anything, the mirror of society and history, rather than the mirror of the mind. In addition to Jones, Schlegel and Jakob Grimm, this approach to linguistics is epitomised by Bopp (1816), and was in many respects inherited by Saussure (1916) and Bloomfield (1933) (although both of the latter authors made interesting comments on universals; see Roberts (2007); moreover, starting with Osthoff and Brugmann (1878), a more formal approach to comparative reconstruction based on the regularity of sound change emerged). It is also to a large extent the approach to linguistics that characterises modern language typology from Greenberg (1963) onwards (especially more recent typological work which has moved away from the postulation of implicational universals of the Greenbergian kind in favour of diachronic and areal accounts for similarities across languages; see for example Bickel 2007).

On the other hand, the "formalist/universalist" tradition has its modern origins in seventeenth-century rationalist philosophy (its ancient origins lie in Stoic and Platonic philosophy), in particular in the work of the Cartesian Port-Royal grammarians (see Arnauld and Lancelot 1660). It is primarily concerned with the search for universal features of language. There is a related concern for the relation of grammar to logic, and, more generally, for the connection between the laws of language and the laws of thought. There is a concomitant emphasis on formalisation for precision and clarity. The first attempts in the modern era to formalise thought and language originate with Dalgarno (see Cram and Maat 2001), John Wilkins (Wilkins 1668) and, most intriguingly, Leibniz (see Leibniz 1666; Watumull and Roberts 2014). In the mid-nineteenth century, Boole attempted to formalise thought (Boole 1854), with the great breakthroughs in modern logic coming half a century later (Frege 1892; Russell 1905). Through a well-known historical path (see Tomalin 2003 for details), Russell and Whitehead's (1910–1912) attempt to formalise arithmetic on logicist principles eventually led to the development of recursive-function theory in the

1930s, and this led directly to Chomsky's formalisation of natural-language syntax (Chomsky 1955/1975).

It would seem obvious, even on the basis of this superficial presentation, that Chomsky epitomises the "formalist/universalist" approach, while Everett may represent (perhaps a rather extreme version of) the "comparative/historical" approach. But this is not really my point here, and again I leave the readers to their own conclusions on this (and, indeed, on the validity of the distinction I have tried to make). What I would like to suggest, instead, is that the chapters in this volume, with their great attention to the empirical detail of certain constructions in the indigenous languages of Brazil, their concentration on psycholinguistic experimentation, and/or the emphasis on the detailed study of aspects of child language, in fact represent a consilience of these two strands in linguistics. What we see in the chapters that follow is a set of highly empirical studies of linguistic phenomena in the service of attempting to resolve a profound question about the nature of human language and thought. The two historical strands converge. Most strikingly in the discussions of the indigenous languages of Brazil, we see very clearly how close attention to fine empirical detail and a clear, precise, formal sense of the overarching theoretical questions fundamentally inform one another. This book is testimony to what, when the right questions are posed and the answers are carefully and intelligently sought, modern linguistic theory can achieve. At its best, as here, modern linguistic theory is the true heir to both traditions.

Ian Roberts

# Acknowledgments

This is the most complex editorial project we have engaged in, and it would not have been possible without the participation of all of the linguistic consultants that contributed to each chapter. We would like to thank Evan DeFrancesco for his detailed attention to the individual chapters, and to the reviewers at each stage for their continued feedback on this thoroughly multifaceted volume.

# Interlinear Gloss Abbreviations

| | |
|---|---|
| 1 | First person |
| 2 | Second person |
| 3 | Third person |
| & | Coordinating conjunction |
| A1 | First person agreement, Class A |
| ABS | Absolutive |
| ABS.AGR | Absolutive copular agreement |
| ACC | Accusative |
| ADMON | Admonitive |
| ADVZ | Adverbializer |
| AFFEC | Affected |
| ALT | Alternate |
| AN | Anaphoric |
| APPL | Applicative |
| ARG | Argument |
| ASSERT | Assertive |
| ATEL | Atelic |
| AUX | Auxiliary |
| B1 | First person agreement, Class B |
| CAUS | Causative |
| CCERT | Complete certainty |
| CLS | Classifier |
| COLL | Collective |
| COMP | Complementizer |
| CONTR | Contrastive subject |
| COP | Copular |
| CORR | Co-referential prefix |
| DECL | Declarative |
| DEIC | Deictic |
| DEP | Dependent |
| DES | Desirative |
| DIFF | Diffuse |

| | |
|---|---|
| DIM | Diminutive |
| DISLOC | Dislocation |
| DIST | Distal |
| DPAST | Distant past |
| DS | Different subject |
| DUB | Dubitative |
| EMB | Embedded verb form |
| EMP | Emphatic |
| EP | Epenthetic vowel |
| ERG | Ergative |
| EVID | Evidential |
| EXCL | Exclusive |
| EXRT | Exhortative |
| FACT | Factual |
| FOC | Focus |
| FRUS | Frustrative |
| FUT | Future |
| GEN | Genitive |
| HSAY | Hearsay |
| IMP | Imperative |
| IMPF | Imperfect |
| IMPRS | Impersonal |
| INCL | Inclusive |
| INF | Infinitive |
| INFER | Inference |
| INS | Instrumental |
| INTNSF | Intensifier |
| IPAST | Immediate past |
| ITER | Iterative |
| LNK | Linking consonant |
| LOC | Locative |
| LOG | Logophoric |
| MASC | Masculine |
| MIR | Mirative |
| MOT | Motion |
| NEG | Negation |
| NFUT | Non-future tense |
| NMLZ | Nominalizer |
| NOM | Nominative |
| NONPRES | Non-present tense |
| NONVIS | Nonvisual |
| OBJ | Object |

| | |
|---|---|
| OBL | Oblique |
| OFC | Object focus construction |
| PAST | Past tense |
| PERF | Perfective |
| PL | Plural |
| PNCT | Punctual aspect |
| POSP | Postposition |
| POSS | Possessive |
| PROG | Progressive |
| PROX | Proximal |
| PURP | Purposive |
| Q | Interrogative |
| QUOT | Quotative |
| RCERT | Relative certainty |
| REF | Referential |
| REFL | Reflexive |
| REL | Relational |
| REM | Remote |
| S | Subject |
| SG | Singular |
| SS | Same subject |
| SUPP | Suppositional |
| TEL | Telic |
| TOP | Topic |
| UDPAST | Unattested distant past |
| V | Verb |
| VIS | Visual |

# Introduction: A Map of the Theoretical and Empirical Issues

*Luiz Amaral, Marcus Maia, Andrew Nevins, and Tom Roeper*

## 1 Recursion: Easy to Describe, Not Always as Easy to Find

Recursion is defined in a number of ways, from what Pinker and Jackendoff (2005:203) call "a procedure that calls itself, or … a constituent that contains a constituent of the same kind," or in the words of Rodgers and Black (2004), "a data structure that is partially composed of smaller or simpler instances of the same data structure."[1] Classic examples of recursion in syntactic theory arise with rewrite rules of the form developed in Post (1943) and subsequently familiar throughout all syntactic theory that include, among many other rules of course, the following key interacting rules:

(1) a. S → NP VP
b. NP → that S
c. VP → V NP
d. NP → the N

The combination of these rules yields indirect recursion, as expansion of (1a) into the VP rewrite rule in (1b) yields an infinite set of sentences of the form *The dog thought that the cat saw the rat* or *The dog thought that the bird said that the cat saw the rat*. With only the four rules in (1), an infinitude of sentences can be derived, and as Bar-Hillel (1953:164) pointed out, in the recursive analysis of such sentences with expansions like (1b), "we had to move from 'sentence' to 'nominal', then back to 'sentence', and finally once more to 'nominal' ."

Similar properties arise once conditionals are added, as in (2), which draws on examples formulated in Chomsky (1957):

(2) S → if S then S

[1] The editors thank John Goldsmith, Andrea Moro, Ian Roberts, Pieter Seuren, and Charles Yang for very helpful comments and suggestions, many of which have made their way into this introduction.

Thus we derive *If the cat saw the rat then the dog told the bird* and even self-embedded conditionals like *If if the cat saw the rat…* Indeed, one can apply such a formalism to NPs themselves:

(3) a. NP → the N'
b. N' → N PP
c. N' → N
d. PP → P NP

This set of rewrite rules will yield *The book on the table near the mat* and so forth.

Taking what these have in common, we may say that an algorithmic generative rule system is recursive if the output of a given rule R2 (like 1b or 3d) contains a symbol or sequence of symbols Z that is also part of the input of a rule R1 (like 1a or 3a), such that R1 immediately or remotely generates Z. Note that R1 and R2 may be identical, as in (2).

This is an incredibly powerful property for languages to have. Husserl's (1913) *Logical Investigations* wrote of a way of obtaining "a boundless multitude of further forms" (as translated in Goldsmith and Laks 2016) by the recursive combination of propositions in this way, a characteristic of human language whose nature has been studied in virtually all subsequent work on the topic. Notably, however, the discussion of recursion in phrase structure in the first few decades of research on the topic focused almost exclusively on recursion involving sentential embedding (see Graffi 2015 for discussion). However, recursion, whether of the center-recursion kind in (2), or the edge-recursion kind in (3), can be found across domains beyond sentential embedding alone, and once PP and NP recursion are included, it is potentially found in some form or another in all languages. This depends, of course, on the formalism used to express it grammatically, as a language that allows, say, up to four adjectives (*the shiny bright expensive green bottle*) has a more parsimonious grammatical description than one that needs to add a new phrase structure rule for every adjective that is added (as in (5)):

(4) a. NP → the N'
b. N' → Adj N'
c. N' → N

(5) a. NP → the N
b. NP → the Adj N
c. NP → the Adj Adj N
d. NP → the Adj Adj Adj N
e. NP → the Adj Adj Adj Adj N

Nonrecursive formalisms (such as (5)) *could* be written if, say, a corpus of a language never found more than four adjectives in a row, and a linguist who decided to model a grammar based on this insisted such a corpus was truly representative of the language. Conversely, one might question whether, indeed, the limit to four adjectives was found specifically because this was a finite corpus, based on limited genres like monologue narratives with no real-time conversational interactions, instead of being from a wide range of dyads, facing goal-oriented demands, or contextually varied situations of wooing, scolding, or planning. If elicitation tasks reveal that narrative-based corpora present only a limited sample of the language (see Davis, Gillon, and Matthewson 2014), then formalisms such as (5) will be inferior to the coverage and compactness of those in (4).

How to tie the widespreadness (or lack thereof) of a given recursive pattern in actual usage to its formalism? It is well established (see Chomsky and Miller 1963; Gibson and Thomas 1999) that center-embedding becomes very difficult to process, to the point of rendering grammaticality judgments difficult after three embeddings. Clearly, therefore, recursion in this domain involves more processing costs. Focusing on this kind of recursion would make one doubt its existence. By contrast, focusing on possessor recursion might make one quite confident that recursion is alive, kicking, and easy to process; Lima and Kayabi (this volume) find, for example, that Kawaiwete-speaking children correctly answer questions like "What is Pedro's friend's brother's basket's color?" Comparison of recursion *across domains* is therefore crucial, and particularly across a range of languages and with a range of methods, especially when grappling with the question of whether recursion is at the center of every language (as many interpret Hauser, Chomsky, and Fitch 2002).

It becomes immediately clear that no matter how easy it may be to write down a recursive set of rules such as (1)–(3), the full-blown use of recursion does not occur as widely as we might expect, as reflected in typological skewedness, language-specific limitations, real-time processing costs as measured behaviorally, with eye-tracking or brain-imaging, and finally in its acquisition profile. Children's acquisition of clausal embedding of the type generated in (1), studied by Bloom et al. (1989), for example, has been argued to be somewhat limited in its usage at an early age. Diessel (2004), in a thorough study of the uses of clausal embedding introduced by "I think that…" in child language, argues that in such cases, the "apparent matrix clauses are nonassertive: rather than denoting a mental state or an act of perception, they function as epistemic markers, attention getters, or markers of illocutionary force" (p.3). In fact, children sometimes omit the complementizer 'that' in even German and French, languages in which the complementizer is obligatory for adults, and frequently use "I think" as a sentence-final parenthetical. In such a characterization, the relationship between expressions such as "I think" and the proposition they introduce does not follow the hallmarks of true embedding, where embedded propositions are syntactically and semantically integrated in the matrix clause and marked as dependent structures that are formally incomplete without the matrix clause. Instead, one might treat these utterances with a rewrite rule:

(6) S → NP think that NP VP

A rule such as (6) is nonrecursive in the sense that it explicitly rules out double-embedding. Diessel's argument is that younger children start out with rule systems such as (6), only gradually later giving way to a revision of the type that yields (1).

Along somewhat similar lines, not all *languages* employ direct clausal embedding of the type that (1) would derive. Levinson (2013), for example, claims that recursion in Kayardild is limited to one level deep, precisely as (6) would restrict it, although for reasons of case morphology related to being polysynthetic. Indeed, it is sometimes claimed that the type of grammatical reanalysis that is responsible for children's transitions from paratactic embedding structures as in (6) to fully fledged embedding structures that would be generated by (1) finds parallels at longer timescales, in the kind of grammaticalization that diachronically yields clausal embedding from formerly paratactic structures. Givón (2009) shows how this kind of reanalysis takes place with examples from Bambara, Hittite, Germanic, and Uto-Aztecan, arguing that one of the parallel components in this reanalysis is when the previously adjoined material now "falls under a single merged intonation contour with the main clause" (p.202). Similarly, Hale (1976:78) argued that:

> [in] a large number of Australian languages, the principal responsibility for productive recursion in syntax is shouldered by [an] adjoined relative clause. It is typically marked as subordinate in some way, but its surface position with respect to the main clause is marginal rather than embedded.

Similarly, Nordlinger (2006) argues that structures such as *they drink grog, they'll fight* in the Australian language Wambaya are fully ambiguous between coordinated and subordinated (if-then) relations (although she contends that the subordinate construal may be forced by prosody). Nordlinger's discussion, alongside a detailed overview of Australian language data by Legate, Pesetsky, and Yang (2014), makes clear that it is far from correct to say that subordination is lacking in these languages, but nonetheless that this kind of recursion is not as freely used as it is in English, or in comparison to adjectival recursion in the same languages. If anything, then, while it is definitely too radical and simplistic to say that any language 'lacks' recursion, its distribution parallels that of, say, interdental fricatives like /θ, ð/ in English: positionally limited (found only before *r* in clusters), not often found with more than one instance (*thither*), and notoriously difficult in L1 and L2 acquisition.

What leads to these markedness-like restrictions on 'a constituent that contains a constituent of the same kind,' and how do they line up with different kinds of recursion? Why is it that some languages are more restrictive with CP recursion of the type exhibited in (1) than they are with PP recursion exhibited in (3)? Why do some languages allow recursive noun-noun compounding (e.g., *comic book club*) while others do not (Roeper and Snyder 2004)? Recursion looks like a candidate for the application of Jakobson's (1941) criteria of markedness as compellingly linked in his book *Kindersprache, Aphasie, und Allgemeine Lautgesetze*, in which he argued that marked phonological structures are rarer cross-linguistically as well as later to develop in child language. Again, these questions must be asked with respect to a much richer range of structures than center-embedding relative-clauses or sentential embedding of speech reports. What is the typological, acquisitional, and processing profile of DP recursion? Of PP recursion? Of causatives, evidentials, imperatives, and other underexplored XPs potentially allowing being pushed inside 'a constituent of the same kind'? Coming back to (3), with the case of PPs for example, interpretational issues arise. How do we know whether the interpretation of *the book on the table next to the mat* is really one of *next to the mat* modifying *the book*, rather than *the table*? How do we know that, for example, real-time instances of these are implemented in comprehension by recursion, rather than iteration? How does cross-linguistic transfer of recursive structures take place in L2 acquisition (see Nelson 2016 for PP recursion across Spanish-English L2)?

Moreover, certain kinds of XPs also naturally lend themselves to embedding more easily than others. For example, imperatives like *Go fetch the water* are crosslinguistically less likely to be embeddable. On the other hand, the kind of recursion found with possessors, as in *My sister's husband's boss got us the tickets*, are extremely natural in adult English. (And as mentioned, in Lima and Kayabi's chapter in this volume, up to four levels of possessor recursion are easily processed by Kawaiwete-speaking children.) In other languages, however, restrictions are imposed on such structures. As argued in Nevins, Pesetsky, and Rodrigues (2009b), such restrictions may be in some instances morphosyntactic: languages with certain kinds of morphological systems for case or finiteness may disallow one instance of finite morphology to be c-commanded by another. Rizzi (2013) contends that while the formal operations yielding recursion are fully available as part of general computation, its applications are modulated by the specific properties of the lexical items it acts upon. Just such an investigation of which properties, and how they modulate the possibilities of recursion, is precisely at stake in this current volume.

How does the possibility of recursive operations within particular domains come to change over various timescales – the timescale of a child that integrates language use with other cognitive systems, for example? Consider sentences such as (7):

(7) What did the girl say she bought?

De Villiers (1999) showed that when children under four years are asked to answer questions like this one, they tend to answer with what the girl actually bought rather than what she *said* she bought, which of course might be different. According to de Villiers, these children have not yet analyzed (4) in terms of an embedding syntax and semantics; indeed, she argues that cognitive development and language acquisition are mutually dependent, and that the development of faculties such as Theory of Mind and false belief go hand in hand with the analysis of (7) as fully fledged embedding. The dramatic connections between lack of subordination and false belief – the question of when children realize the "opacity" of complement sentences – parallels the evolution of subordination types along the acquisition path. These, in turn, mirror the variation across languages discussed above. A subpath of stages, with stepwise semantic changes as well (see Roeper and de Villiers 2011; de Villiers et al. 2012), precedes the full form of recursive complementation that syntactically and semantically represents false belief. These types of subordination are stepping stones to the full subcategorization of clauses that enables recursive structure for multiple points of view. In their contribution to this volume, Roeper and Oseki argue that there is an acquisition path from coordination to indirect recursion.

While recursion across the domains of sentential embedding, prepositional phrases, causative structures, possessors, and relative clauses can all be described formally with the same means (e.g., the rewrite rules in (1)–(3)), their distribution across and within the world's languages is clearly not equal. With a focus on cross-linguistic diversity, this volume includes experiments on PP recursion, possessive recursion, relative clause recursion, adjective recursion, sentential recursion of both tensed and non-finite clauses, and discourse recursion. This will allow us to begin to consider new kinds of questions: are there clusters of recursive structures that are reflected in typology, dialects, or language change? Are they acquired in a systematic way with one kind triggering another (as discussed in Roeper and Oseki's chapter)? Finally, what interfaces do they have with morphology, parametric variation, and lexical representation?

Our goal in this volume is to bring new data and emerging research methodologies from a gamut of less familiar languages to this study. This book aims to address a host of topics about recursion woven together across different dimensions of linguistic research: formal analysis, theoretical exploration, experimental fieldwork, and several methodologies (intuition, comprehension experiments, event-related potentials, and reaction time studies). Recursion is held up against its interaction with reference, evidentiality, second-order beliefs, and prosody across domains and latitudes, and it is compared to non-recursive structures (e.g., the 'coordination default') across fifteen languages, thereby informing the question of its distribution, processing, and restrictions across grammatical domains and across grammars.

## 2 Recursion across Latitudes

This book presents analyses of recursive constructions in a broad array of languages representing a great areal, typological, and genetic diversity, spanning wide latitudes. Fifteen languages are examined in the eighteen chapters of this book. Dutch, English, Portuguese, and Japanese are studied, alongside eleven Amerindian languages of South America, coming from six distinct language families or genetic affiliations.

The region of the world that is currently most prominent in contemporary discussions of recursion is lowlands South America (east of the Andes), in particular the regions surrounding the Brazilian Amazon, in large part due to the claims that arose in Everett (2005) that Pirahã, an indigenous language of Brazil, has 'no embedding,' and the subsequent debates that arose about (a) what, in fact, are the right kind of empirical tests to be conducted to make such claims (see Sauerland and Sandalo et al. in this volume for new kinds of experimental inquiry for this language) and (b) whether, if indeed, Pirahã were to be missing recursion in one particular domain (e.g., CP), what consequences this might have for developing a theory of markedness of recursive structures. Given particularly the linguistic diversity of Brazil, the unfamiliarity of many of these languages to mainstream debates on recursion, and the vibrant presence of a range of interdisciplinary methods applied by researchers working on them, their contribution to the questions laid out above is extremely valuable.

We turn, therefore, from a mapping out of linguistic domains to a necessary introduction to the distribution of recursion across latitudes as reflected in the research reported on languages within Brazil.

Brazil has, at present count, around 150–160 indigenous languages (Moore 2011). The present volume considers phenomena from ten living Brazilian indigenous languages (depicted in Figure 0.1), as well as Tupinambá, an extinct language spoken on the coast of Brazil when the first colonizers arrived. These comprise thirteen chapters in the book. Alongside these are English, Portuguese, Japanese, and Dutch, which are examined in the other five chapters, constituting the total eighteen chapters of the book. In addition to their wide areal distribution, ranging from Kotiria and Wapichana in the north-west and north regions of the country, Pirahã in the south Amazon area and Karitiana in the western state of Rondonia, to Guarani in the south and south-east, with a concentration of languages in Central Brazil (Karajá, Kawaiwete, Kĩsêdjê, Kuikuro), the languages studied in the book are also representative of


Figure 0.1 Living languages with approximate locations

some of the main linguistic stocks and families in Brazil: Tupian, Macro-Jê, Carib, Arawak, and Tukano (alongside an isolate, Pirahã).

The Tupian stock, the largest South American genetic group, is represented by languages from both its western branch (Karitiana, the last surviving language of the Arikem family) and eastern branch (Kawaiwete, Tenetehára, Mbyá Guarani), all belonging to the Tupi-Guarani family, the largest family in the stock. Damaso Vieira analyzes recursive constructions in Tupinambá, an extinct language of the Tupi-Guarani family, drawing on data registered in the sixteenth and seventeenth centuries.

Languages of the second largest genetic group in Brazil, the Macro-Jê stock, are also well represented in the book: Kĩsêdjê, a member of the Jê family, the largest family in the stock, and Karajá (Karajá family). The Carib family, which contains the second largest number of languages in a single family, is represented by Kuikuro, a language classified in the Xinguan southern branch of Carib. The Arawak family is represented in the book by Wapichana, the North Arawakan language with the largest number of speakers. Kotiria represents the Eastern Tukano family, spoken in the northwestern Amazon basin. Finally, Pirahã, which is examined in three of the chapters in the book, is the last surviving language of the small Mura family, spoken in the south Amazon area.

Even though the Brazilian indigenous languages investigated in the book present different levels of vitality according to UNESCO criteria, there is a clear consensus among linguists working on indigenous languages in Brazil that all of these languages are classified at least as "vulnerable" by UNESCO's endangerment criteria. Spoken by a mostly monolingual population, Pirahã has a high level of intergenerational transmission, but the sheer low number of speakers (less than 400) makes it vulnerable. With a population of around 7,000 speakers in Brazil, Wapichana, on the other hand, is considered "definitely endangered" by UNESCO, based on the fact that less than half of the population can speak the language (see Moore 2011) and that at least 80 percent of the population is bilingual in Portuguese. While most of the languages discussed are largely understudied, the research presented in this book, with the exception of the study on extinct Tupinambá, are based on first-hand data, collected by the authors of the chapters themselves.

All of the studies presented in the book were developed based on a cross-comparative methodology, in which theoretical questions guide data collection. Some of the studies engage in the precision offered by experimental methods, a new endeavor which is being called "experimental fieldwork," facing the challenge of bringing together crucial dimensions of linguistics such as theory of grammar, psycholinguistic methods, and fieldwork procedures in order to attempt to uncover grammatical processes that could never be discovered solely on the basis of corpus building. Thus, while our focus in this section has been on the typological diversity of the languages covered here, of equal importance in our organization of this volume is to convey the range of similar methodologies that can and should be applied across them. There are thus direct connections between the issues raised and Theory of Mind, PP recursion, and coordination and subordination in parallel investigations with English, Portuguese, Japanese, and Dutch found throughout this book (see especially the contributions by Terunuma and Nakato, Hollebrandse, and Pérez-Leroux et al.). At the same time, the Brazilian languages represented herein involve empirically foci that are largely absent from well-studied European languages, e.g., evidential marking, switch-reference marking, and embedded imperatives.

## 3 Recursion and Embedding across Domains

This volume is organized into four grammatical domains in which recursion is examined. Clearly, at some points there may be intersections or transversal connections possible across individual chapters within distinct sections.

### *3.1 Speech Reports, Theory of Mind, and Evidentials*

The formal property of sentential embedding is invariably linked to the semantic and illocutionary types of elements they link up. Most canonically, these are speech reports, which involve reporting the beliefs or speech acts of others, and thus intersect with questions of Theory of Mind, second-order beliefs, the cognitive development of Theory of Mind in children, and evidential reporting more generally.

Sauerland's chapter examines speech reports such as *Toi said that he has been to the moon*, which can be used to distinguish between subordination and coordination structures for speech reports. Specifically, if the relationship between the embedded proposition and the higher attitude verb is one of subordination, then the sentence as a whole can be judged as true. However, if Pirahã really lacked embedding, then sentences of this sort would actually be coordination structures, akin to *Toi spoke, and he has been to the moon*. The chapter discusses the result of an experiment conducted with sixteen Pirahã speakers, who as a whole end up distinguishing subordination (*Toi said that he has been to the moon*) from coordination (*Toi spoke, and he has been to the moon*), where the former as a whole can be judged as true at the same time that the latter is judged as false. The results therefore provide a new empirical base for the conclusion that Pirahã grammar contains at least one level of embedding, and moreover outline a technique for the study of speech reports that can be straightforwardly employed and replicated in experimental fieldwork situations with relatively understudied languages.

A further challenge, only recently beginning to be studied experimentally, is the extent to which one can trace the distribution and development of second-order belief ascription, as broached in the chapter by Hollebrandse, focusing on sentences like *The judge knows that the jury thinks that Malcolm is guilty*. These structures are particularly interesting for the subordination versus coordination dichotomy because, as Hollebrandse argues, there is virtually no way to anaphorically or paratactically express the second-order belief: only the recursive embedding serves to do so. They are also highly relevant, within the acquisition context, for understanding the relationship between linguistic encoding and the psychological faculty of Theory of Mind. The chapter presents two methods that can be used to elicit second-order belief ascription in language acquisition tasks, which, as we have discussed, are highly valuable as they are broadly adaptable to fieldwork situations in which one cannot always be certain what purely introspective acceptability judgments would be probing.

Focusing on Brazilian Portuguese, Corrêa, Augusto, Marcilese, and Villarinho present two sets of psycholinguistic experiments designed to investigate indirect recursion in children's comprehension of specific reference in complex DPs with an internal modifier and in complement clauses subcategorized by non-factive mental state verbs. Relying on the assessment that recursion increases computational cost, the authors explore the extent to which children rely on indirect recursion in the analysis of complex structures. They call into question the proposal of a developmental path in which direct recursion would be the default analysis, previous to the acquisition of indirect recursion. The authors claim that 6 year olds are able to engage in second-order false belief reasoning, regardless of the type of structure in which false beliefs are expressed, and that the true difficulty lies in coping with a sentence composed of propositions having different truth values.

The relation between embedding and evidentiality comes to the fore again in Stenzel's contribution. Stenzel reviews evidential categories in Kotiria in order to assess whether evidentials can be viewed as recursive constituents in the language, focusing on how to express the syntactic structure underlying the development of systems with multiple evidentials. After analyzing the structural means employed in the expression of four firsthand categories of evidentials, the author proposes that embedding can indeed be used to express detailed semantic concepts. However, there are boundaries to the number of derivable notions, since only one hierarchical level of embedding is possible, and there are few such morphological markers.

Thomas' chapter turns to a different type of embedded speech act: imperatives, which can be embedded under certain verbs of saying in languages such as Mbyá Guarani. Thomas formalizes the phenomenon of embedded imperatives as recursive instances of the functional head ForceP, embedding a semantic type known as Speech Act Potentials. Thomas demonstrates that embedded imperatives in Mbyá Guarani are not some kind of paratactic quotation, but rather true instances of embedding occurring under verbs meaning 'to say' and 'to ask to,' and even under the reportative evidential particle *je*, so that an embedded speech act can involve a structure like *Give me the maté!* ('I heard that order'). By developing a formal theory of speech act potentials, the chapter directly enables understanding these structures as an instance of recursion.

### *3.2 Recursion along the Clausal Spine*

The chapters in this part of the book examine the phenomenon of embedding in categories along the clausal spine, from VP complementation in control configurations to IP coordination in switch-reference, TP-level embedding, and recursive causative constructions, across a number of indigenous Brazilian languages. They trace new empirical routes for investigating specific morpho-syntactic phenomena, many of which can serve as future applicable diagnostics for recursive embedding, alongside developing specific analyses of how these constructions are grammatically assembled.

The chapter by Rodrigues, Salles, and Sandalo focuses on obligatory control in Pirahã. Using elicitation experiments, the authors analyze the syntax of desiderative constructions such as *I want to eat fish*. Using diagnostics based on the scope of temporal and locative adverbs as well as negation, the authors argue that in Pirahã, the complement VP *to eat fish* is distinct from the matrix verb, is subordinate to it (and not coordinated with it), and that the word-order alternation in which such nonfinite complements can appear either after or interestingly *before* the matrix verb indicate that this type of complementation indeed constitutes an instance of embedding a VP inside another VP. The data contribute towards the ongoing question of the extent to which various types of self-embedding can be unambiguously identified, and provide a set of diagnostics that can be replicated and extended to parallel questions in a number of other languages.

Nonato's contribution examines the phenomenon of 'switch reference,' in which a morphosyntactic marker indicates whether the subjects of two coordinated TP clauses are coreferent or not. As the author reports, this was initially a useful diagnostic for what is known as symmetric versus asymmetric coordination (the latter being two clauses that have a causal relation or a temporally sequential relation and thus are not commutatively reordered), and potentially would enable modeling the two structures in terms of direct recursion and indirect recursion, in a transparent way that relates to the 'coordination default.' However, despite the initial appeal from earlier fieldwork that this morphosyntactic marker was a flag of different kinds of recursion, the author provides an update on more recent and rigorous elicitation conducted on Kĩsêdjê showing that even in *symmetric* coordination, switch-reference marking is obligatory. He presents the suggestion that further research both in Kĩsêdjê and across languages might find evidence for asymmetric coordination in the phenomenon of subset and superset switch-reference.

Duarte examines the derivation of embedded clauses in Tenetehára, in which clausal complements of perception verbs, such as *Sergio saw Pedro waiting for the tapir*, involve an unexpected complementizer-final word order in the embedded clause. He provides a detailed syntactic analysis in terms of phrasal roll-up movement of the embedded VP to the specifier of the embedded TP and then CP, with this step of predicate raising therefore resulting in the complementizer-final order with the VP preceding everything else, including a set of particles that he identifies as the tense position. The study is germane to the question of how strategies of embedding may be syntactically achieved within a formal model of the clausal cartography of tense projections.

Damaso Vieira examines recursive constructions at both the syntactic and the morphological levels, demonstrating that one of the most well-studied languages in Brazil, Tupinambá, the object of grammatical analysis since the sixteenth century, exhibits indirect recursion across different domains, such as complement clauses and verb incorporation, and causative, reflexive, and possessive constructions. She provides a comparison with the modern-day Tupi-Guarani language Mbyá, where at the syntactic level, recursion applies to complement clauses and possessives, and at the morphological level, recursion is observed in the contexts of verb incorporation and causatives, concluding that the parallel existence of recursion in these two subcomponents of the grammar has consequences for understanding word-formation in terms of a partially syntactic component. This contribution represents the application of questions of recursion to affixes in morphologically complex languages, a pursuit which has as of yet been all too little undertaken (though cf. Lander and Letuchiy 2010).

### *3.3 Recursive Possession and Relative Clauses*

The chapters in this part of the book deal with two very important types of linguistic constructions that have been at the center of research on recursion in recent years. Recursive possessives have been a recently lively area of study by acquisitionists looking into how children interpret and acquire multiple embedded constructions.

The first such chapter is by Terunuma and Nakato. In their chapter, the authors describe multiple embedded genitive constructions in Japanese, comparing them to their English counterparts. They present two experiments inspired by an original test proposed by Tom Roeper and previously used by other scholars (e.g., Limbach and Adone 2010; Leandro and Amaral 2014; Lima and Kayabi, this volume). Terunuma and Nakato's findings lead them to propose a specific sequence of acquisition of recursive possessives in Japanese with three stages. Their analysis supports current hypotheses about the acquisition of recursion based on developmental paths.

Lima and Kayabi offer another study into how children interpret recursive possessives. In the same chapter, they also show the results of an elicitation task with multiple embedded locatives introduced by PPs. Lima and Kayabi studied both constructions in a Tupi-Guarani language spoken in central Brazil called Kawaiwete. In this language, possessive relations with full NPs are expressed by juxtaposition with the possibility of multiple embedding. They piloted a similar experiment to the one designed by Terunuma and Nakato. In contrast to Japanese, Kawaiwete has no additional possessive particles or morphemes. For their second experiment with embedded locatives headed by postpositions, Lima and Kayabi conducted an elicitation task that showed that adult speakers use a strategy that avoids center-embedding, creating a word order where PPs are right-adjoined, thereby triggering successive extraposition of PPs.

Relative clauses constitute another important example of how different natural languages license recursive constructions. In this volume, there are two chapters that look into relative clauses in two distinct native Brazilian languages. Amaral and Leandro describe different types of multiple embedded relative clauses in Wapichana, their potential ambiguity, and their patterns of interpretation by speakers of different ages. In Wapichana, relative clauses can be verbal or nominal in nature, and there are no restrictions for multiple embedding, as long as the head of the previous sentence subcategorizes for a noun that can be further modified by another relative clause. Amaral and Leandro find that there is a clear difference in the interpretation of lower clauses in terms of high or low attachment, depending on the part of speech of the head of the main clause. Their research is a pioneering example of how to conduct psycholinguistic experiments with multiple embedded relative constructions in an understudied indigenous language.

In many of the less studied languages, we are in need of careful descriptions to prudently advance our knowledge of how recursive structures should be represented, and indeed judgments of ungrammaticality can be informative in this respect. That is exactly what Storto, Vivanco, and Rocha propose in their chapter, where they provide a detailed analysis of relative clauses in Karitiana, along with elicitation tasks to show preferred and/or accepted grammatical patterns for relative clauses in that language. They discuss the results of an elicitation task in which subjects overwhelmingly prefer the SOV order instead of OSV for Karitiana relative clauses. They then present a thorough analysis of relative clauses that function as oblique objects of main verbs, alongside examples of multiple embedded relative constructions. The chapter provides an excellent example of how fieldwork elicitation can be improved by using techniques from experimental linguistics.

### *3.4 Recursion in the PP Domain*

The part of the book focusing on PP constructions presents five chapters that use different methodological approaches to examine these structures in Portuguese, English, Japanese, and in two Brazilian indigenous languages, Karajá and Kuikuro. Though very diverse in their theoretical scopes and in their methods of data collection and analysis, the five chapters present a noteworthy convergence in their specific conclusions. Taken together, they enable a strong takeaway message that embedded PPs are more complex to represent, acquire, and process than corresponding structures with conjoined PPs.

Roeper and Oseki set the stage with the proposal that recursion is represented by three primary types of recursion: Direct Unstructured Recursion, Direct Structured Recursion, and Indirect Recursion. The authors elaborate careful arguments about the relevance of Bare Phrase Structure for both linguistic theory and language acquisition, and add a new dimension to the typology of recursion, with the theoretical space carved out by Feature Sharing. The novel typology proposed by the authors allows them to state clear predictions about the child language acquisition path: since complexity of recursion increases from Direct Unstructured Recursion through Direct Structured Recursion to Indirect Recursion, the acquisition path should proceed in the same direction.

In their chapter, Sandalo, Rodrigues, Roeper, Amaral, Maia, and da Silva present two pilot tests investigating PPs in Pirahã. In a picture description test, three sets of pictures were presented to two Pirahã subjects, who were asked to indicate which of the pictures would better fit a description expressed in previously elicited Pirahã sentences. In the elicitation phase of the test, the Pirahã speakers systematically introduced the coordinative particle *piai* to describe the pictures, indicating coordination. However, in the interpretation phase, the participants correctly pointed at pictures, unequivocally demonstrating the capacity to discriminate between conjoining and embedding. The second test was an act-out game, in which participants had no problem in either formulating or following imperative commands involving two or three levels of PP conjoining or embedding, even though their more spontaneous preferences seemed to favor PP coordination.

Pérez-Leroux, Castilla-Earls, Béjar, Massam, and Peterson employed a referential elicitation task in order to test whether children differentiate between PP recursive and nonrecursive double modification in English. Results indicated that children (and adult controls) produced target descriptions twice as often to non-recursive than recursively PP modified NPs. According to the authors, the recursive and non-recursive conditions differ with respect to the distribution of phase boundaries, and unlike nonrecursive constructions, the recursive ones would require speakers to attend to a referent that would be no longer accessible in the active derivational workspace. They argue that this resistance to recursion is not caused by the syntax of the construction in itself, but has its roots in referential demands at the interface.

Franchetto's chapter describes and analyzes the operations available in Kuikuro for the construction of DP and PP recursive structures. The author reviews general characteristics of Kuikuro phrasal prosody in order to propose that prosodic integration is the key for the identification of these constructions. After showing that DP recursive structure is distinct from DP coordination through evidence from intonation patterning in possessives, the study focuses on PPs and documents a mismatch between prosody and syntax, while at the same time suggesting a match between prosody and cognitive integration. This chapter demonstrates that pitch tracks, extremely straightforward to generate with contemporary software, provides evidence for distinct treatment of DP and PP recursion.

Finally, Maia, França, Gesualdi-Manhães, Lage, Oliveira, Soto, and Gomes present results of psycholinguistic picture matching tests and electrophysiological experiments run with Karajá and Brazilian Portuguese (BP) subjects. Results indicated that recursive PP constructions were more difficult to process than coordinated PP constructions across all languages tested. However, the online electrophysiological test suggested that once participants were engaged in the recursive algorithm, subsequent embeddings seemed to be facilitated. In PP embedding, a more salient ERP component was found 400ms after the first PP, probably connected in the recursion condition with integration efforts. In contrast, the N400 in coordination was less salient. Crucially, in comparison with the first embedded PP, the next embedded PP shows shorter latencies in all the relevant regions of interest, demonstrating that the processing of the PPs seems to be facilitated after one enters the recursive mode. Based on these results, the authors conclude that recursion can be viewed as the result of an algorithm that is costly to launch, but once established, does not pose increasing effort for the system. This study, together with the others in this part of the book, therefore establishes the existence of a 'coordination default' encountered across production, processing, and acquisition in the case of multiple PPs, but one that can nonetheless be overridden.

## 4 Avenues Opened Up By This Volume

The highly variable forms of embedding and self-embedding that recursion enables have a long history in linguistics and computer science. Phenomena like recursive clausal embedding, PP-embedding, possessive embedding, coordination, and compounding each have special properties, and they can be remarkably different across languages. Many forms of recursion (like possessor recursion and nominal compounding) are completely absent in whole language families. Each language can be expected to have its own acquisition path across a variety of types, both left- and right-branching. Every language studied in the world, as far as we know – including Pirahã – has some such examples, as this volume incontrovertibly reveals. The late Ken Hale, the father of theoretical fieldwork, once remarked that he "always looked for the most complex parts of a language first, because they displayed the central regularities of a language most clearly" (personal communication). Such a perspective justifies the notion that we need to identify where self-embedding recursive structures are for every language and for every child acquiring a new language. This book pursues that goal, alongside its own social goal: creating a community of scholars that can share ideas, methods, and particular experimental devices, as the collection of chapters on PP-recursion convincingly illustrates.

Recursion, as a formal mechanism, has been argued to permeate many cognitive spheres, from planning to discourse (Corballis 2007; Lobina and García-Albea 2009; Levinson 2013). In a way, it is a microscope that can be used across domains as a point of comparison because of its centrality to phrase-structure descriptions of languages, alongside at the same time its elusiveness in showing full-blown unrestrictedness. In a way, the fact that it is so easy to formally represent yet so difficult to encounter vindicates the hunch that its limitations come from many syntax-external systems. Tracking reference, second-order beliefs, speech act potentials, and morphological and prosodic integration across multiple dependent issues of the same kind of constituent presents challenges for a number of cognitive systems, the nature of which are much more complex than the format of rules like (1) themselves.

As such, it is an extremely useful guiding heuristic that leads us to the core of some of the contemporary questions in the language sciences: what is the relative weight of syntactically specific mechanisms as opposed to language-external systems in terms of an overall explanation of a given phenomenon? Although many studies have addressed this question with respect to the highly familiar territory of center-embedding in English, the experimental fieldwork and transversal comparisons conducted here represent relatively recent modes of exploration of recursion and its processing in unexpected corners of the grammar, and in less well-trodden corners of the world. The burgeoning literature on the computational and genetic underpinnings of recursion (e.g., Friederici et al. 2011) must be in dialogue with an understanding of the ubiquity and limits of its distribution. The investigation of recursion in unfamiliar and often isolated societies, whose grammars have emerged under little contact with the much-studied languages of developed societies, bear clear consequences for discussions of whether the regularities and nature of its patterning have biological, and not culture-dependent, origins.

There are many aspects in the study of recursion that we have not even touched upon here. Recent work in the semantics of attitude verbs by Kratzer (2013) has begun to question whether the semantic relation between an embedding verb and its propositional complement in sentences like *John yelled that it was hailing* are indeed direct function application, or whether they semantically look more like adjunction structures that are combined by predicate modification. At the same time, syntactic research by Aboh (2004), Arsenijević (2009), and Krapova (2009) indicates that sentential complementation is achieved by the same syntactic means as relativization, mediated by a nominal complement. Both of these strands of research suggest that CP-recursion of the type in

(1) may not always be the appropriate representation for sentential embedding. It is only through further crosstalk with ongoing work in semantics, and with comparative work with the morphosyntactic evidence for complementation-as-relativization, that work on the markedness of recursion may move forward in tandem. Similar work on 'alternative' strategies to compensate for PP and DP recursion reveal themselves in the evidence brought forth by processing and prosody studies presented herein.

In closing, beyond recursion and embedding themselves, it is our hope that the overall organization of a team of interacting researchers that put theory and data collection in dialogue within the reach of a single core computational topic with a complex set of interfaces can yield an overarching research strategy to be applied to the exploration of other recurrent, defining characteristics of grammar in experimental fieldwork across languages and their interfaces with processing and cognition (such as, say, the representation of nominal number, or logical connectives such as disjunction). We contend that the study of syntactic markedness as understood in formal, computational, and experimental approaches to grammar becomes more robust through the kind of emphasis adumbrated here, one that productively sums the contributions of each constituent of diverse comparative fieldwork across grammatical domains. And now, on to the chapters!

*Part I*

# Speech Reports, Theory of Mind, and Evidentials

# 1 False Speech Reports in Pirahã: A Comprehension Experiment

*Uli Sauerland*

A lively debate has ensued about syntactic recursion in the Pirahã language, starting with a paper by Everett (2005) (see also Roberts, this volume).[1] Everett claims that Pirahã does not allow syntactic recursion. Furthermore he claims that a constraint that is part of Pirahã culture militates against the use of recursion by the Pirahã. Nevins et al. (2009b) argue that there are several problems with Everett's argumentation. Specifically, they show that several of the arguments presented by Everett do not support his conclusions, and that in other cases there are factual contradictions between Everett's earlier work on Pirahã and the 2005 paper. In response, Everett (2009) partially revised his analysis of some Pirahã data and made other changes to his argument, which are discussed further by Nevins et al. (2009a).

The debate has ensued for the most part without new data. In fact, most of the debate has rested on data that seem to be about thirty years old (though see Stapert 2007; Sauerland 2010a; Rodrigues et al., this volume; Sandalo et al., this volume). Everett's (2005) arguments are based on the reevaluation of his own field data from the 1980s and on data gathered even earlier by Steven Sheldon. Nevins et al. (2009b) rely exclusively on data from the published literature. This chapter presents new data from an experiment designed to test for the comprehension of speech reports by Pirahã speakers.

Throughout I understand *recursion* along the lines of the formal concept *self-embedding* defined in Chomsky (1959) – a property of a language that provably

[1] I thank Cilene Campetela, Mathias Schenner, Miguel Oliveira, and Verão Augusto Diar-roi for technical assistance during the fieldwork, and two anonymous reviewers for their helpful comments. The fieldwork reported on here was carried out in 2009 during a thirteen-day stay in Humaitá and the Piraha territory. Ethical permission for the project was granted by the University of Manchester (ref: TPCS/ethics/05148), and access permission by the Brazilian Ministry of Justice, President of the National Indian Foundation (FUNAI No. 163/CGEP/08), and the Humaitá office of the FUNAI (Oficio o. 003/NAL/FUNAI/HTÁ/2009). I also thank the local FUNAI office in Humaitá for organizational help. The data reported in this chapter were gathered with financial support from the European Union (FP6 project CHLaSC), and this work was also supported in part by the German Federal Ministry for Research (BMBF) (Grant Nr. 01UG1411).

requires an analysis that is not finite state.[2] Recall that a finite-state language is defined as one that can be parsed by an automaton that has only finitely many memory states, i.e. a finite-state automaton. A simple self-embedding grammar is the mirror grammar generating strings like *aa*, *abba, abccba*, *abcddcba*, and so on. Because a parser for this grammar needs to remember all prior symbols up to the middle of the string, finite memory would be insufficient. Sauerland and Trotzke (2011) suggest that this understanding of *recursion* as beyond-finite-state is relevant to the previous discussions of Hauser et al. (2002). The beyond-finite-state understanding is different from one based on current syntactic analyses, where any sentence containing three elements or more must involve recursion at the level of the generalized transformation *Merge* (Chomsky 1995). However, current syntactic analyses assume a phrase structure analysis as necessary, while it is part of the debate concerning Pirahã whether a phrase structure analysis is necessary. Therefore, the abstract, mathematical notion of Chomsky (1959), which motivates the phrase structure analysis of English, is the right starting point for the following discussion. I adopt one modification of Chomsky's approach, though, that I argue for in Sauerland (2015): Chomsky's notion of grammar only concerned the generation of the grammatical strings. Because of this perspective, Chomsky could show that only center-embedded structures require a analysis that is not finite state. I, however, adopt the modern view that a grammar generates form-meaning pairs (Chomsky 1995 and many others). This has consequences for what a finite-state analysis can accomplish. Specifically, I have argued that a finite-state analysis is insufficient for left or right-embedded structures if the semantic analysis requires a memory load that grows with each level of embedding (Sauerland 2015): I conclude therefore that even non-center-embedded structures can be recursive in the sense of requiring a non-finite-state analysis if they require unbounded memory for the semantic interpretation.

In this chapter, I address one specific aspect of recursion in Pirahã: embedded clauses, and more specifically complement clauses. I focus on this domain rather than other cases of recusion for two reasons: Firstly, the semantics of embedded sentences clearly requires a memory load that grows with each level of embedding (Cresswell 1990), such that even right (or left) recursive embedding of sentences is beyond a finite-state analysis (Sauerland 2015). Secondly, the meanings of some other recursive constructions in European languages can alternately be expressed without the use of a recursive structure, while complement clauses are sometimes essential to describe the propositional attitudes of others. For instance, single possessor recursion in (1a), double possessor

[2] Chomsky (1959) actually uses the notion of *regular grammar*, but Chomsky and Miller (1958) showed the equivalence of the notions of regular and finite-state languages. The term *finite-state language* is more commonly used, so this chapter adopts this terminology.

recursion in (2b), and single prepositional phrase recursion in (3a) can all be expressed without recursion of this type as in (1b), (2b), (2c), and (3b).

(1) a. John's mother smiled.
 b. John has a mother and she smiled.

(2) a. John's mother's car broke.
 b. John has a mother and she has a car and it broke.

(3) a. The house in the village is pretty.
 b. In the village is a house and it is pretty.

Some complement clauses though cannot be expressed recursion-free. This is illustrated by the failed attempt to paraphrase (4a) recursion-free as in (4b).

(4) a. John believes that he didn't do anything wrong.
 b. John didn't do anything wrong and he believes/knows it.

Sentence (4a) can be uttered by an honest speaker who is certain that John in fact did something wrong. But, (4b) couldn't be uttered by an honest speaker who believes that John did something wrong. This limitation of (4b) follows directly from standard theories of speech acts such as Stalnaker (1978), where a declarative sentence must reflect the speaker's beliefs (see also Meyer 2013). A speaker who is convinced that John did something wrong couldn't utter (4b). This holds even if *perhaps* or a possibility modal is added to the first conjunct. Therefore, embedding in complement clause structures is necessary to report other people's propositional attitudes without committing the speaker to the same attitude.

English grammar allows sequences of two apparent root clauses like (5) with roughly the same meaning as (4a) (Davidson 1968). These initially appear to not involve embedding because a colon joins the two clauses in writing. However, I believe that the English rules of punctuation are a poor guide to syntactic structure and that a sequence like (5) is actually an instance of a complex syntactic structure, and therefore a case of syntactic complementation.

(5) John believes this: He didn't do anything wrong.

Four arguments for an analysis of (5) as one single sentence come from intonation and word order facts. Firstly, (5) has a specific intonation contour with a rise on *this* and a subsequent fall. Secondly, if we switch around the order of the two sentence parts of (5) as in (6), the meaning is different. Namely, (6), just like (4b), is incompatible with a speaker who believes that John did something wrong.

(6) He didn't do anything wrong. John believes this.

The third argument comes from the observation that no non-embedded clause can occur between *this* and the second clause in (5). For example, the middle clause in (7) is hard to construe with an embedded interpretation, and correspondingly the final clause can also not be construed as embedded, but must reflect the speaker's opinion.

(7) John believes this. He is of course wrong. He didn't do anything wrong.

Finally, a Condition C effect can be observed in such sequences: In (8), the pronoun *he* is difficult to understand as coreferent with *John*.

(8) *He$_i$ believes this: John$_i$ didn't do anything wrong.

This reasoning shows that complement clauses are crucial for false belief expression. Findings in language acquisition of complement clauses corroborate this point. Namely, work in language acquisition has shown that the mastery of complement clause syntax by children has significant effects on their social cognition (de Villiers and Pyers 2002; Schick et al. 2007; Pyers and Senghas 2009). Specifically, this work shows that one aspect of social cognition, namely Theory of Mind, is on some tests absent before the acquisition of complement clauses, and delayed when the acquisition of complement clauses is delayed (see also Corrêa et al., this volume; Hollebrandse, this volume). While other works report that different tests for Theory of Mind indicate an earlier presence of Theory of Mind (e.g., Clements and Perner 1994; Southgate et al. 2007), this likely shows that there are two related abilities, one of which is supported by complement clause understanding. Therefore, a language without embedded clauses would be expected to either be strictly less expressive than well-studied languages or to have a semantic mechanism that differs from those available in well-studied languages. Either would be a surprising finding.[3]

## 1 Method and Participants

In this chapter, I report a study that considered the interpretation of sentences that in earlier writings of Everett (specifically, Everett 1986) were described as speech reports. One important characteristic of attitude reports is that the speaker need not share the reported attitude expressed in the embedded clause – in fact, the speaker can disagree with the content of the embedded clause. Consider for example, what I as a speaker commit to by uttering (9):

[3] Note that this reasoning predicts that embedded clauses should occur across langauges independently of European influence, as e.g., Vieira (this volume) shows for Tupinambá, an extinct Tupi language of the first contact between Europeans and the Brazilian indigenous population. The observation that embedding is marked in ways unfamiliar from European languages further corroborates this point (Storto et al.; Duarte; Stenzel; Thomas; Nonato, this volume).

I do not need to myself be committed to the truth of what Joe said, i.e., I can utter (9) even when I myself am not of the opinion that I misbehaved.

(9) Joe said that I misbehaved.

The kind of commitment a speaker takes on with an assertion is shown by what is called *Moore's problem* in the philosophical literature (see e.g., Sorensen 2013) and is illustrated in (10a). The contrast between (10a) and (10b) shows that the speaker takes on no commitment to the truth of the embedded clause, as already mentioned above.

(10) a. #I went to the pictures last Tuesday, but I don't believe that I did. (Moore 1942)
b. Joe said I went to pictures last Tuesday, but I don't believe that I did.

For the following, I operationalize the distinction between matrix and embedded sentences using true reports of a false statement. Consider the scenario indicated in (11), where speaker A utters a statement that is evidently false. A subsequent speech report with the same content in the complement clause is nevertheless true: in (11a), speaker B accurately reports what speaker A said. But a non-embedding conjunction as in (11b) is judged differently: because in this case, speaker B takes on a commitment to the truth of the content of the second conjunct, (11b) is false. Utterance (11c) with two independent sentences is interpreted like a coordination of the two, as for example the discourse model of Stalnaker (1978) makes explicit.

(11) Speaker A: My skin is green.

a. Speaker B: Speaker A said that his skin was green.
b. Speaker B: Speaker A was talking and his skin is green.
c. Speaker B: Speaker A was talking. His skin is green.

The distinction in (11) can be used to determine whether a Pirahã structure is understood as subordination or as two independent sentences or a coordination.[4] For this purpose, I constructed ten short dialogues in Pirahã like the following and recorded them with Toe as speaker A and a second Pirahã as speaker B. For the recordings, the sentences were written out with the help of the translator and a Pirahã consultant. Then the translator read out the sentences one at a time and the Pirahã speakers repeated the sentence they just heard. These utterances of the two native Pirahã speakers were recorded and then used to create the experiment.

[4] Two other, frequently used, terms for the distinction between subordination and coordination are hypotaxis and parataxis. In the following, I continue to use only the Latinate terms sub-/coordination for consistency.

(12) A: ce kahápe ogéhiai igeuo
I have-been stars there
*I have been to the stars.*
B: Toi hi gái-sai ce kahápe ogéhiai igeuo
Toe 3s say 1s have-been stars there
subordination: *Toe says "I have been to the stars*."
coordination: *Toe talked and I have been to the stars*.

As in (11), the first sentence in (12a) and the other nine dialogs consisted of a single, obviously false statement. The second statement was spoken by a different speaker, and was the critical utterance. It contained a form of the verb *gái* followed by the report of Toe's utterance. If Pirahã speakers could construe this utterance as subordination, the interpretation of (12b) should be like that of subordination in English. But if the only construal available to Pirahã speakers was coordination, then only a different interpretation ought to be available to the Pirahã speakers. In the scenario, the two interpretations are predicted to differ in truth: the subordinated interpretation is predicted to be true because speaker B is accurately reporting the false statement that speaker A made. The coordination structure, however, would be predicted to be false because the second conjunct is false.

Sentence (12b) contains the indexical pronoun *ce/ti* ('I') as the subject of the potentially embedded clause. Therefore (12b) only is true if the interpretation of the indexical is shifted to denote Toe, the subject of *gái-sai*. A similar indexical shift is possible in English only with direct speech, which is a quotation subject to a verbatim requirement. However, recent comparative work has found that some languages allow indexical shift in complement clauses that are not direct speech, and at least in the language Matses indexical shift is obligatory in complement clauses (Munro et al. 2012). For Pirahã, Everett (1986) reports that both direct and indirect speech are possible, but I found that most speakers used sentences with indexical shift as in (12b) in attitude reports. Hence, I used sentences like (12b) in this experiment.

The results of the comprehension task might have been affected by a number of factors other than the syntactic structure assigned to speaker B's utterance. The experiment was conducted with recorded utterances replayed from a laptop computer over loudspeakers and the participants' answers were recorded with a small digital recorder. Pirahã speakers were neither used to participating in such experiments nor familiar with computer technology.[5] This may have led to the Pirahã participants not attending fully to the recordings at least at times

[5] In Forquilha Grande, there was no grid electricity in 2009. While I was in the village, most Pirahã were watching Brazilian music DVDs after dark on a TV screen operated by staff of the FUNAI, the Brazilian government organization in charge of the native Americans.

during the experiment, and therefore leads us to expect a greater amount of noise in the data than with other participant groups. An additional concern was the Pirahãs' ability to accurately hear the recordings and not be distracted by environmental noises during the experiment. Nevertheless, I chose to present the items without the use of headphones and in different places within the two settlements to be able to recruit a large number of participants. Finally, the two native speakers that recorded the utterances with me were both respected, older men, and some of the experiment participants might have found it hard to classify any of their utterances as false.

To eliminate the effect of the extraneous factors just mentioned on the results, I included nine control items in the experiment. The control items were similar to the experimental items, but the second speaker didn't accurately report the statement of the first speaker. (13) shows an example of such a control item. Since speaker B's statement is in this case not an accurate report of what speaker A said, the expected response in the experiment is rejection of speaker B's utterance. I worked with the same two Pirahã speakers to record the control items as for the experimental items.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (13) | A: | ce | kahápe | kahe'ai | igeuo | | | |
| | | I | have-been | moon | there | | | |
| | | *I have been to the moon.* | | | | | | |
| | B: | Toi | hi | gái-sai | ce | kahápehai | heesé | igeuo |
| | | Toe | 2s | say | 1s | have-been | sun | there |
| | | *Toe said "I have been to the sun."* | | | | | | |

The experimental items were generated and recorded in Forquilha Grande. For the recording, I recruited two native Pirahã speakers. They are both men. Speaker A is from Forquilha Grande and speaker B from Ce'ege (in Portuguese 'Pereira'). The name of speaker A, *Toe*, occurs in almost every recording. First, speaker A recorded the thirty unembedded sentences given in Appendix A. These recordings were played back to speaker B, who was instructed to produce a speech report for each of the thirty items, starting with *Toe higaisai*.[6] Finally, I arranged the recorded sentences on the computer into the order used for the experiment as follows: For the experimental items, I concatenated the statement by speaker A with the corresponding speech report. For the control items, I concatenated a statement by speaker A with a speech report corresponding to a different statement. Specifically, the basic statements in Appendix A are arranged in ten blocks of three. In each case, I used the c-statement with the matching speech report, while I used the a-statement with

[6] In one case (namely the report of item (i9c) in Appendix A), speaker B's utterance starts with *Ti higaisai* with a first person pronoun, rather than the name *Toe*. However, since the prefix *hi–* is third person, we assume that listeners ignored this speech error by speaker B in the experiment. The item is included in the following analysis.

the speech report corresponding to the b-statement. For example, the true report (12) was generated from (i1c) and its report, which in the following is coded as item 1cc. The false report (13) was generated from (i1a) and the report of (i1b), and is coded as item 1ab in the following. In this way, each statement or its report or both were only used in a single experimental item.

The order of presentation was pseudo-randomized manually, but fixed for all subjects. I used two items as practice items during the instruction of the participants, namely 5cc and 5ab. Then the other items were presented in the following order: 10ab, 8ab, 2cc, 1ab, 9cc, 3cc, 6ab, 4cc, 9ab, 7ab, 4ab, 6cc, 3ab, 7cc, 10cc, 2ab, 1cc, and 8cc.

The instruction of participants itself was partially scripted, but allowed some individual variation. In English, the instruction was to answer the question 'Did speaker B hear well?' or 'Did speaker B say the truth?' and to answer with *ma'a* ('yes') or *maabi* ('no'). The instructions were translated into Portuguese and Pirahã and then the first practice item 5cc was played, and participants were asked to respond. Whether they gave a response or not, participants were then told that *ma'a* ('yes') would've been the correct response. In case a subject gave initially no response at all, had questions, or seemed unsure, the practice item was repeated even multiple times. Then item 5ab was played. Again, participants were asked to respond, but then were also told about the correct response, in this case *maabi* ('no'). Again, the practice may have been played repeatedly in case the task seemed to still be unclear. After this, the experimental items were presented and subjects received no further feedback from the experimenters.

I gathered data during a seven-day period in two Pirahã settlements, Forquilha Grande and Ce'ege. The participants were sixteen Pirahã native speakers. Nine of the sixteen participants were female and seven male. Precise ages weren't available to me for the participants, but the age of the participants varied greatly from the late teens to the oldest people living in the two villages. All participants could readily recognize both speaker A and speaker B. In fact, most of the participants were closely related to speaker A and B, e.g., the three wives of speaker B and the father of speaker A were among the participants. Participants received a small amount of consumer items in return for their participation.

## 2 Results

The participants' responses were recorded and subsequently transcribed from the recordings. There were no missing responses. Figure 1.1 displays the raw data graphically.

The results show that the Pirahã speakers distinguish between the correct and incorrect reports. Of the 288 responses overall, 153 (53.1 percent) were

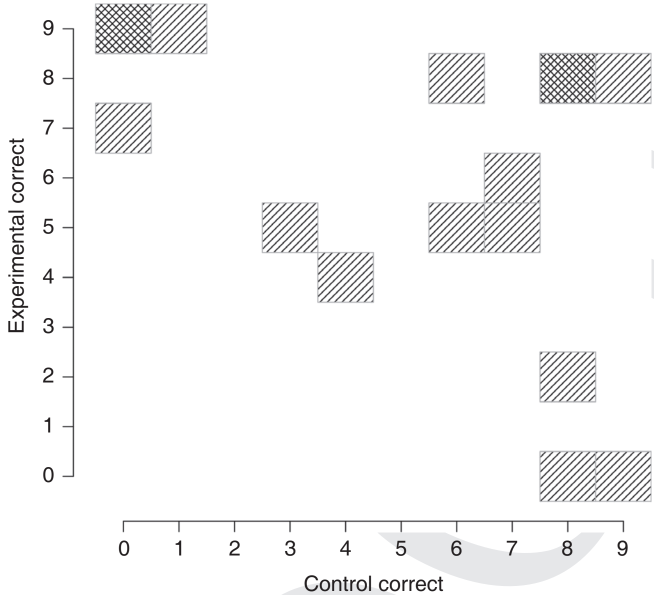



Figure 1.1 Raw response data from sixteen participants. Single-striped boxes correspond to one participant; cross-hatched boxes correspond to two participants. The location of each box indicates the number of expected responses for the control condition (x-axis) and the experimental condition (y-axis). For example, the cross-hatched box at the top left indicates that two participants answered zero control conditions and nine experimental conditions as expected.

*ma'a* ('yes') and 135 (46.9 percent) were *maabi* ('no').[7] I applied the two-sided exact binomial test to this distribution, and found that overall the numbers of responses did not differ from chance level ($p$ = 0.3165). This result was expected because the predicted responses were exactly a 50:50 split of *ma'a* and *maabi*. Then I looked at the control and experimental conditions separately, and a different distribution obtains: Out of 144 control conditions total, 84 were answered by *maabi* ('no'), i.e., I observed 58.3 percent expected responses. To test whether the number of expected responses was significantly different from chance, I computed a two-sided exact binomial test, and found the difference from chance to be marginally significant with a p-value of 0.0549. I then performed the same analysis for the 144 experimental conditions. Ninety-three (64.6 percent) were answered with the expected response *ma'a* ('yes'). The

[7] In the course of the experiment, I found that *maabi* could also express the meaning close to the English verb *lie*. But this doesn't affect the interpretation of the results.

exact binomial test shows that this distribution is significantly greater than chance ($p = 0.0005851$). The overall result therefore indicates that Pirahã speakers were sensitive to the difference between true and false reports.

The percentage of understanding overall seems low with only about 177 of 342 (61.5 percent) correct responses. The overall result furthermore hides significant variation among participants that can be seen in Figure 1.1. While this doesn't affect the significance of the overall result, understanding the sources of this variation may lead to improvements in future studies.

The subjects reported in the top left quadrant responded with *ma'a* most of the time, not discriminating between control and experimental items. Such subjects may have misunderstood the directions, and might be judging grammaticality or comprehensability. The subjects reported in the bottom right quadrant responded with *maabi* most of the time, again not discriminating between control and experimental items. Such subjects also may have misunderstood the directions, and may be responding based on pragmatic felicity of the recorded dialogues. Subjects entered in the top right quadrant exhibit close to the expected pattern. The presence of these subjects drives the overall result. Equally important is that hardly any participants fell into the bottom left quadrant. Subjects entered near the center of the graph displayed an overall chance response, and may have not understood the directions or may have been unable to hear the recordings properly.

I performed a second statistical analysis restricted to subjects whose responses didn't show a bias for either *ma'a* or *maabi*. For each subject, I recorded eighteen responses. According to the strict binomial test, a frequency of fourteen or higher of one of the two possible responses (and correspondingly a frequency of four or lower of the other response) is a significant bias for one response. Specifically, the p-value is 0.031 if fourteen out eighteen responses are the same. Therefore in the second analysis, I excluded the responses from the seven participants with a response-bias by this criterion. After exclusion of the response-biased subjects, I observed the expected response fifty-seven out of eighty-one times for the control condition and fifty-nine out of eighty-one times for the experimental condition, corresponding to 70.4 percent and 72.8 percent correct responses, respectively. The exact binomial test shows that both frequencies diverge significantly from chance at the $p < 0.0005$ level. This suggests that the main result I reported above would have been even stronger if participants had been instructed to not be biased towards one of the two possible responses.

## 3 Conclusion

In this chapter, I presented an experimental study evaluating the comprehension of embedded sentences in the Pirahã community. The study addressed the question of how a sequence of a verb of speech and a second clause as in (14) would be understood.

(14) Toe hi gaisai ce a'ai kohuaipaha
Toe 3 say 1 stone eat

As I argued, if Pirahã lacked true embedding, (14) would need to be understood as the coordination (15a) or, equivalently, as two separate sentences. However, the interpretation of the coordination in (15a) can be distinguished from that of subordination in (15b) on the basis of truth value judgments.

(15) a. Toe was talking and he has many noses.
b. Toe said that he has many noses.

Namely, (15a) is judged false since Toe can never have many noses. (15b), however, is predicted to be judged true in case Toe actually claimed to have many noses previously. The test applied in this chapter operationalized this predicted difference in truth judgment. The field conditions, the need to go through translators, the unfamiliarity of the Pirahã with technology, and possibly other factors likely caused substantial variation in judgments. But overall, I found that the data from sixteen Pirahã speakers unequivocally supported the subordination analysis. The data show that Pirahã allows at least one level of subordination and falsify the proposal of Everett (2005).

# Appendix A: Items

The following ten basic items were used in the comprehension experiment in the way described above. The following transcriptions are rough and the audio recordings should be consulted (available by request from the author).

(i1) a. ce kahápe kahe'ai igeuo
*I have been to the moon.*
b. ce kahápe heesé igeuo
*I have been to the sun.*
c. ce kahápe ogéhiai igeuo
*I have been to the stars*.

(i2) a. ce aoiagaha ka huaáí
*I have a car*.
b. ce aoiagaha oaahabi 'iai
*I have a bike*.
c. ce ao naheau agaha
*I have an airplane*.

(i3) a. ce au kai agaha Humaita o
*I live in Humaita*.
b. ce au kai agaha ceege'egeo
*I live in Pereira*.
c. ce au kai agaha pitiao
*I live in Pekeno*.

(i4) a. ce hoa ahiai ipaha ahoikasi
*I planted rice.*
b. ce hoa ahiai ipaha cehua
*I planted corn*.
c. ce hoa hai kape'e soai hiaipaha
*I planted coffee*.

(i5) a. ce soa tobagahai iga aopapáhá
*I brought a computer*.
b. ce soa igaabopapáhá pihoagesai
*I brought a generator*.
c. ce soa igaabopapáhá peage'esai
*I brought a fridge*.

(i6) a. ce epe'e kuabahaipaha maihipai
*I kill a jaguar now.*
b. ce epe'e kuabahaipaha ka'aihi
*I kill a paca now*.
c. ce epe'e kuabahaipaha ko'oé
*I kill a monkey now.*

(i7) a. ce bego kohuaipaha
*I eat soil.*
b. ce tabo kohuaipaha
*I eat board.*
c. ce a'ai kohuaipaha
*I eat stone.*

(i8) a. ce apai aiba koe
*I have many heads*.
b. ce itaoe aiba koe
*I have many noses*.
c. ce kaoé aiba koe
*I have many mouths*.

(i9) a. ce apaitau biagaha
*I have white hair*.
b. ce apisoe kobi'agaha
*I have white skin*.
c. ce epee kobi'agaha
*I have a white tongue*.

(i10) a. ce aitahoagaha moitohoiko
*I sleep in a boat*.
b. ce aitahoagaha ce'apo
*I sleep in a tree*.
c. ce aitahoaaha taihoa'aiko
*I sleep in a pot*.

# Appendix B: Raw Responses

The following table shows the raw responses of all sixteen participants. 0 corresponds to the negative response *maabi* ('no'), 1 to the positive *ma'a* ('yes'). The order of rows represents the order of presentation. The first column shows the sequence order starting with item 3 since items 1 and 2 were practice items. The second column shows the item number in the coding scheme introduced in the text. The third column shows the expected response.

Participant

Table 1A.1 Raw responses

| # | item | E | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 10ab | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 4 | 8ab | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| 5 | 2cc | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| 6 | 1ab | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| 7 | 9cc | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| 8 | 3cc | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| 9 | 6ab | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| 10 | 4cc | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| 11 | 9ab | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 12 | 7ab | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 13 | 4ab | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| 14 | 6cc | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 15 | 3ab | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| 16 | 7cc | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| 17 | 10cc | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 18 | 2ab | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 |
| 19 | 1cc | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| 20 | 8cc | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 |

# 2 Indirect Recursion: The Importance of Second-Order Embedding and Its Implications for Cross-Linguistic Research

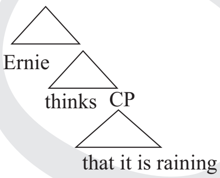
*Bart Hollebrandse*

## 1 The Relation between Subordinate Clauses and Belief Reports

The best way to report a belief is with a sentence with a subordinate clause embedded under a mental state verb such as *think*, *know*, or *believe*.[1] For example, the sentence in (1) is a perfect linguistic report of the thought balloon in (2a):

(1) Ernie thinks that it is raining.

(2) a. b.




The structures in (2) share an interesting feature: both the cognitive structure (2a) and the linguistic structure (2b) involve a form of embedding. This similarity might be the reason why embedded structures, i.e., complement clauses, are the "best" way of expressing a belief. De Villiers (2005) even argues for an even closer relation between the two structures. She proposed the language-first hypothesis, i.e., it is the development of linguistic structure that triggers the development of cognitive belief structure.

However, the evidence for the tight relation between linguistic and cognitive structures comes exclusively from Indo-European languages (de Villiers and

[1] The author thanks Petra Hendriks, Angeliek van Hout, Marcus Maia, Andrew Nevins, Tom Roeper, Uli Sauerland, Jill de Villiers, and the audiences of the UMass Conference on Recursion, the Recursion in Human Languages conference in Normal, Illinois, and the TARK XIII workshop, Reasoning About Other Minds. This work was supported by the Netherlands Organisation for Scientific Research (NWO) under Grant number 277-70-005 and a EU 6th Framework Programme under Grant number 028395.

Pyers 2002; de Villiers 2005; Hollebrandse 2000). It is quite conceivable that languages from other language families express beliefs in different structures. Other languages might use constructions other than the complement clause. In this chapter, I will show how tight the relation between the two structures is, by presenting both empirical and experimental data. I will also suggest that the tight relation should hold for all languages in the world. It is also conceivable that other languages have very different complement constructions. This question is also addressed in several chapter in this volume (see Sauerland, this volume; Rodrigues et al., this volume).

## 2 From First to Second

The subordinate clause might be an excellent way to report on belief ascriptions, but there are other alternative ways to express beliefs. For instance, beliefs can be reported across sentences (3a). Other alternative ways to express beliefs are direct speech (3b), *according-to*-phrases (3c), and sentences with dislocated clauses (3d).[2]

(3) a. It is raining. Ernie thinks that.
  b. Ernie thinks: "It is raining."
  c. According to Ernie, it is raining.
  d. Ernie thinks it, that it is raining.

All the examples in (3) are appropriate belief reports. In fact, Everett (2005) states that expressing belief reports in main clauses is the common way in Pirahã. This assertion raises a number of interesting questions. For instance, is it the only way this language can express beliefs? And more importantly, how does Pirahã express beliefs about beliefs? This chapter focuses on the question why then is it that sentences with complement clauses are so commonly used for belief reports, at least in European languages? The answer to this question lies in the nature of recursion. The answer might suggest that recursion in language is universal.

Recursion is the process that enables human beings to create infinitely long sentences with a finite set of rules. Recursion is the processes of repetition in a self-similar way. In more mathematical terms, recursion is a function that calls itself ($X \rightarrow Y\ X$) (Lobina and García-Albea 2009).

When we apply clausal embedding recursively, we can express beliefs about beliefs, i.e., second-order beliefs in the sense of Dennett (1996). The sentence in (4) is a report of the thought balloon in (5).

[2] As was pointed out by a reviewer, (3a) differs from the other examples in (3). For the first sentence in (3a), the truth is asserted. This is not the case in the other examples. Nevertheless, all the examples are suitable ways of reporting beliefs.

(4) Ernie thinks that Cookie Monster thinks that it is raining.

(5)

We can construct infinitely long recursive structures with subordinate clauses, but it is almost impossible to express a belief about a belief with only main clauses (Roeper 2007). For example, the three-sentence discourse in (6) is not a report of a belief about a belief, whereas the sentence with the double-embedded clauses in (4) is.

(6) It is raining. Ernie thinks that. Cookie Monster thinks that.

Note that constructing a belief about a belief on the basis of only main clauses, as in (6), is not entirely impossible. With support from specific pragmatic contexts, a belief about a belief might be created for these sentences. Peter Svenonius (personal communication) provided the example in (7a), which could be understood as a belief about a belief as in (7b), given that the hearer is familiar with the appropriate pragmatic context.[3]

(7) a. Malcolm is guilty. The jury thinks that. The judge knows that.
b. The judge knows that the jury thinks that Malcolm is guilty.

However, without such a context, constructing a belief about a belief for a three-sentence ascription is very difficult. Hollebrandse, Hobbs, de Villiers and Roeper (2008) tested cases as in (6). They tested eighteen American-English children in the ages between 6;3 and 6;11 (mean age: 6;9) on prerecorded stories: (8) is one of these stories. Thirteen adults were tested as well.

(8) Jimmy and his sister live next to a bridge.
The bridge is broken.
Jimmy knows that.
His sister doesn't think that.

After this short discourse, participants were asked to answer either one of the two questions in (9). Participants were also asked to justify their answer.

(9) a. Will his sister warn Jimmy?
b. Will his sister cross the bridge?

[3] As was pointed out by a reviewer, the order *know* and *think* might make a difference. How it makes a difference is unclear and I will leave it to further research.

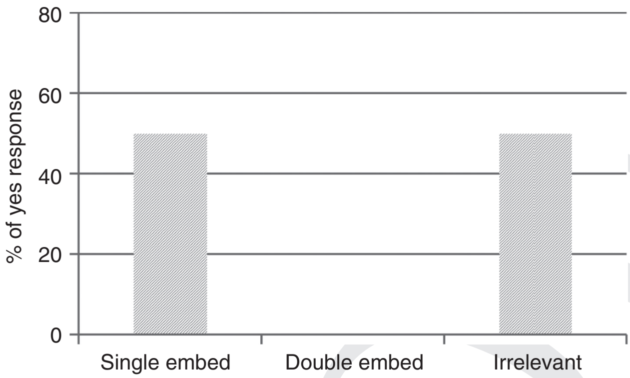



Figure 2.1 Results for anaphoric relations in discourse (adult participants, N=13)

Participants responded correctly when the target was an instance of single embedding. In this case all participants gave an answer based on a single-embedded construal, *His sister doesn't think that the bridge is broken*. Participants answered *yes* for (9a), because she did not think the bridge was broken and *no* for (9b), because there was no reason not to cross the bridge. The double-embedded constructions – *no* to (9a) and *yes* to (9b) – however, cannot be supported by clarifications. Participants consistently avoided explanations on the basis of double-embedding, and instead gave irrelevant answers such as *No, she is afraid of bridges* for (9a) or *Yes, she likes her brother* for (9b). The results for the adult participants are given in Figure 2.1.

The observation that it is almost impossible to express a belief about a belief with a discourse of independent main clauses also holds for the other examples in (3). These examples cannot easily be extended to expressions of second-order beliefs, i.e., beliefs about beliefs, as in (10) (the #-sign indicates the lack of the double-embedded belief) (Hollebrandse 2010; Hollebrandse and Roeper 2007).

(10) a. #Ernie thinks: "Cookie Monster thinks: 'It is raining.' "
b. #According to Ernie according to Cookie Monster it is raining.
c. #Cookie Monster thinks it, that Ernie thinks it, that it is raining.

One might argue that the construction in (10a) does not involve complementation. However, Collins and Branigan (1997) argue that the quote in direct speech has the same complement structure as that-clauses in indirect speech.

Collins and Branigan (1997) argue for a complement status on the basis of quotative inversion (11). They explain the fact that the inflected verb and the subject are inverted as a case of V-second. The immediate consequence of that analysis is that the quote itself should be in a complement position.

(11) "The man," said Mickey, "was going home."

Hollebrandse (2000, 2007) finds that young children take the quote as a complement and they can even extract out of it. Children gave long-distance answers to the question in (12).

(12) How did Deanne ask: "Can I ride a bike?"

We can conclude that the linguistic freedom to express beliefs at a first-order level disappears at second order, at least for European languages. In European languages, the "designated" form[4] to express beliefs about beliefs is the recursive clausal embedding, i.e., it is the *that*-clause which allows syntactic recursion and therefore can express embedded propositions or beliefs.

## 3 Questions

In the previous section, we have observed that there is a designated construction in European languages for expressing beliefs about beliefs, namely the complement clause under a mental state verb. This raises three questions. First, we can ask why the sentence with double-embedded clauses is the designated construction. Second, we can wonder how universal the observation is that the complement clause is the designated construction for expressing recursive propositions. It is conceivable that languages other than European languages have picked out other constructions to express beliefs about beliefs. In other words, some languages might opt for the complement clause, whereas other languages might choose to do this with, for instance, the *according to*-constructions or independent main clauses. Third, we can raise the question of how to experimentally test multiple belief ascriptions.

This chapter will focus on the first question. Although the second question is interesting, we leave it mostly unanswered in this chapter. New analyses of empirical data of Teiwa, a Papuan language, and Pirahã, however, indicate that in these languages, the complement construction is used to report beliefs (for Teiwa, see Sauerland, Kratochvil and Hollebrandse (in prep) and for Pirahã, see Sauerland (this volume)). The third question will be addressed in Section 5 by presenting experimental designs previously used in child language.

## 4 Direct and Indirect Recursion

To address the first question, we need to have a closer look at recursive rules. There are two forms of recursion: direct and indirect recursion. Direct recursion

[4] One can wonder, as one of the reviewers did, whether languages have designated constructions to express meaning. What is meant here is that languages have highly frequent forms to do so.

is a rule that calls itself: like something of the form X → X Y, which has a single loop to form a string. Indirect recursion is a set of rules in which the looping occurs over two or more rules. One of the earliest linguistic recursive set of rules involved the construction of embedded clauses (Chomsky 1965), as in (13).

(13) S → NP VP
VP → V S

Examples of direct recursion are cases of coordination and some cases of PP-recursion. Indirect recursion creates embedding and as such the possibility of reporting on second-order beliefs (Dennett 1996). Indirect recursion is more interesting because it creates layers in the structure that can contain semantic information that "blocks" recursion, i.e., it blocks the flow of information from clauses embedded lower in the structure. Evaluative predicates are examples of such cases.

### *4.1 Evaluative Predicates*

The essence of belief reports is that the speaker can disassociate himself or herself from the propositional content of the belief. In this respect, belief reports channel thoughts through embedded structure. A speaker wants to express a certain belief or thought to another person, without committing himself or herself to the content of that belief or thought. Semantically, embedding is a way of linking propositions. Clauses express propositions. The meaning of those clauses in embedded structures is passed on through the embedding verb of the higher clause and the complementizer. Hollebrandse and Roeper (2007) observe that it is only the propositional content of meaning that is relevant in recursive embedding, i.e., sentences with multiple embedded clauses link meaning in its barest form. The idea is that only the propositional content of the meaning is linked and not, for instance, presuppositional attributions or pragmatic contributions to the meaning.

For instance, the verb *consider* can embed a clause (14), but only once (15). Sentence (15) is strange, because it recursively embeds more than just the propositional content of the meaning. In other words, its meaning includes more than just the proposition: it also includes an evaluation by the main clause subject.

(14) John considers the food to be tasty.

(15) #Bill considers John to consider the food to be tasty.

One might argue that the reason for the inability to embed more than once under verbs like *to consider* is that they embed uninflected verbs. However, the Dutch evaluative verb *vinden* ('to find'), which means discover by testing or experience, embeds inflected complement clauses (16a). These Dutch cases cannot be extended to a second-order level (16b).

(16) a. Jan vindt dat FC Groningen uitstekend speelt.
"J. finds that FC Groningen plays excellently."
b. #Jan vindt dat Piet vindt dat FC Groningen uitstekend speelt.
"J. finds that P. finds that FC Groningen plays excellently."

Another argument that it is the evaluative nature of the verbs *to consider* and *to find* can be seen when we take out the evaluation. The example in (17) differs from (16) in that it contains a modal verb. The modal verb makes multiple embedding possible by taking the embedded evaluation out. The sentence in (17) is fine, because the sentence only involves one evaluation: the evaluation by the highest subject (*Jan*) and not by the subject (*Piet*) of the first embedded clause.

(17) Jan vindt dat Piet zou moeten vinden dat FC Groningen uitstekend speelt.
"J. finds that P. should find that FC Groningen plays excellently."

A third argument is provided by the example in (18). When we change the subject to a subject that is pragmatically unlikely to do an evaluation, such as a life-long teetotaler, the sentence becomes odd.

(18) #The life-long teetotaler considers the 1999 Bordeaux excellent.

What the examples above show is that only bare propositions can enter a recursive structure. The bareness of the proposition is at the heart of expressing recursive second-order beliefs. Hollebrandse and Roeper (2007) state that restriction in the *Principle of Propositional Exclusivity* (19). The exact nature of this principle is still a matter of further research.

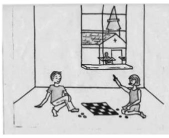
(19) The Principle of Propositional Exclusivity
Constrained recursive structures express only pure (bare) non-modified propositions.

## 5 How to Test These Cases

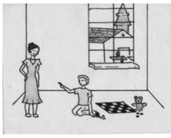
This section discusses how to test second-order linguistic embedding and belief ascription. The essence of these tests is primarily to test a false belief, i.e., in all cases, protagonists act upon a belief that the participant knows to be false. The set-up includes a second-order belief: one protagonist has a belief about another protagonist's belief. Both tests involved justification questions, which elicited second-order linguistic embedding.

For the verbal false belief task, participants listened to an elaborate story accompanied by four pictures. Each story included two first-order false belief questions and one second-order false belief question. The participants were also asked to justify their answers. Participants did not hear a double-embedded sentence in the stories. They had to construct the second-order belief and produce a second-order sentence in their justifications. Eight different stories were told to the participants. An excerpt of such a story is given in (20).

(20)

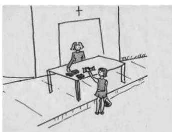


Sam and Maria are playing together. They look outside and see that the church is having a bake sale. Maria tells Sam: "I am going to buy chocolate chip cookies for us there," and she walks away.



Mom comes home and she tells Sam that she just drove past the bake sale. "Are they selling chocolate chip cookies?" Sam asks. "No," mom says, "they are only selling pumpkin pie." "Maria will now probably get pumpkin pie at the bake sale," Sam says.

*Probe Question 1: Does Maria know they are selling pumpkin pie at the bake sale?*



Maria has arrived at the bake sale. "I would like to buy chocolate chip cookies," she says. "All we have left are brownies," says the lady behind the stall. Since Maria also likes brownies, she decides to get some brownies.

*Probe Question 2: Does Sam know that Maria bought some brownies?*

*First-Order Question: What does Sam think they are selling at the bake sale?*

*Justification Question: Why does he think that?*

On her way back, Maria meets the mailman. She tells the mailman, "I have just bought some brownies. I am going to share them with my brother, Sam. It is a surprise." "That is nice of you," says the mailman. Then he asks Maria, "Does Sam know what you bought him?"

*Ignorance Question: What does Maria tell the mailman?*

Then the mailman asks: "What does Sam think they are selling at the bake sale?"

*Second-Order Question: What does Maria tell the mailman?*

*Justification Question: Why does she say that?*

*First-Order Question: What does Sam think they are selling at the bake sale?*

*Justification Question: Why does he think that?*

Hollebrandse et al. (2008)
Hollebrandse et al. (2014)

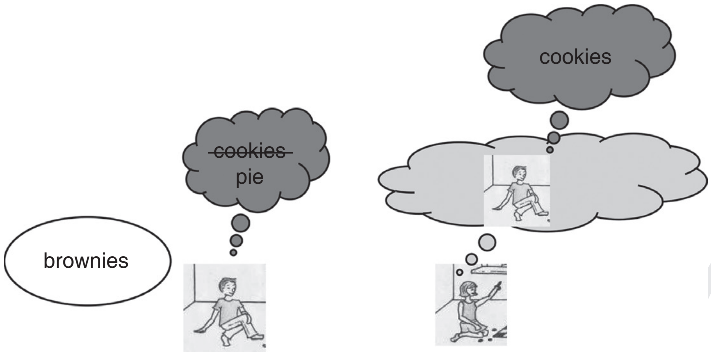



Figure 2.2 Beliefs held by protagonists in the second-order verbal order test

The story starts out with both protagonists thinking that cookies are sold at the bake sale. The mother then changes the boy's belief to pie, whereas the girl finds out that there are only brownies left and thinks that her brother still thinks they are selling cookies (the second-order belief). Again, no embedded sentences are used in the stories (for more detail, see Hollebrandse et al. 2014). Figure 2.2 gives the different belief construals.

Twenty-one Dutch 6 and 7 year olds were tested (mean age = 6;9, range = 6;2–7;3) and twenty-two Dutch 8 and 9 year olds (mean age = 8;10, range = 8;2–9;11). Seventeen Dutch adults were tested as a control group.

The results for the second-order question are given in Figure 2.3. The children performed well on the first-order question. It is immediately clear from Figure 2.3 that the children often chose a first-order reading in second-order cases in the verbal false belief cases, i.e., *pie* rather than *cookies*. Reality answers were very rare. Adults performed at ceiling. The results for the English children are comparable (see Hollebrandse et al. 2008).

Many children showed that they could construct a second-order belief and justified their answer with a double-embedded sentence (21). But more importantly, children that were not yet able to construe a belief about a belief never gave double-embedded justifications. They only gave single-embedded sentences (22).

(21) omdat zij nog denkt dat hij nog denkt dat ze koekjes verkopen
"because she still thinks that he still thinks that they sell cookies" — Child 311, age: 8;10

(22) omdat ze dat dacht
"because she thought that" — Child 317, age: 8;11

The same children who were tested on the bake sale stories were also tested on a low verbal second-order false belief task. This test is called low verbal

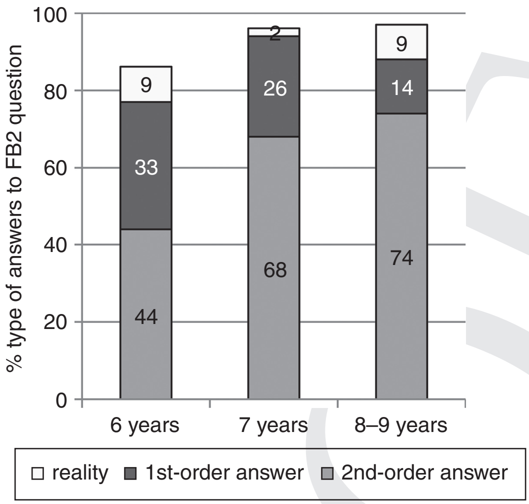



Figure 2.3 Percentage of answers to the second-order false belief question

because some language was used in the task, but not language involving mental states, such as propositional attitude verbs (*think*, *say*, *believe*), and complement clauses. It is extremely difficult, if not impossible, to convey a second-order belief without the use of any language (Hollebrandse et al. 2014). This test was also used to elicit embedded clauses in Teiwa (Sauerland et al., in prep).

Participants had to watch eight short movies. Four movies targeted first-order false belief and four movies targeted second-order false belief. The movies showed a set of windows which were opened and closed. The first-order movies showed only one protagonist, while the second-order ones showed two protagonists in the windows. The protagonists could see the scene in front of the windows, depending on whether the windows were closed or opened. Two stills of the movies are displayed in (23).

(23)

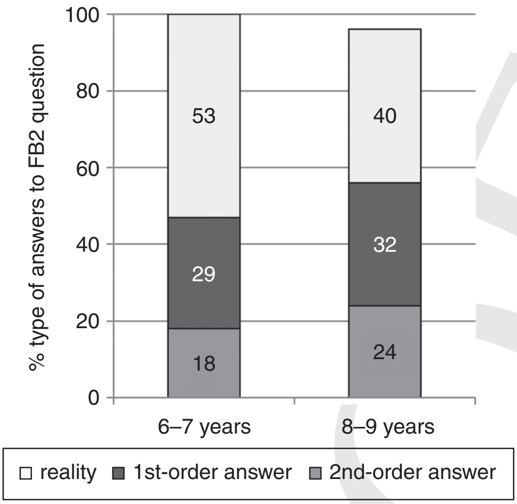



Figure 2.4 Type of answers to the second-order question in the low verbal task

Half of the movies were modeled after the so-called *Smarties* task and the other half after the *Sally-Ann* task (Wimmer and Perner 1983). The essence of these tasks is that either the content of a container is changed (*Smarties*), or an object is moved from one hiding place to another (*Sally-Ann*). Protagonists do not see all the changes and therefore build false beliefs.

The results of the second-order question are given in Figure 2.4. These results are somewhat different from the verbal false belief task. As in the verbal false belief test, participants had difficulty with second-order questions, but there was a large number of reality answers.[5] All participants performed at ceiling for the first-order questions. Again, adults performed at ceiling.

## 6 Discussion

This chapter started by showing the tight relation between complement clauses and belief ascription. It also stressed the importance of second-order embedding, because a first-order embedding representation is not generated on the basis of recursion. It is, therefore, the case that first-order belief ascription can be expressed in not only complement clauses, but also in discourse, direct speech, *according-to*-phrases, and in dislocated clauses. The answer to why the

[5] Additionally, thirty-five English 6 and 7 year olds were tested. They showed a strong preference for the first-order answer.

complement clause is so efficient at expressing second-order beliefs lies in the nature of what is embedded: the clause should just express a bare proposition. As soon as more meaning is embedded, recursive embedding is not available anymore. This can be seen in the difference between the sentences with propositional attitude verbs and those with evaluative verbs.

It is also suggested that the tight relation between complements and beliefs is universal. Although we have not shown that in this chapter, several chapters in this volume suggest that the relation is universal (Sauerland, this volume; Rodrigues et al., this volume).

Two experiments were presented showing how to test multiple embedding of beliefs. The results reveal that second-order belief ascription is developed at a fairly late age. A possible explanation for this is that understanding and reporting on second-order beliefs involves subtle information. However, the subtlety of information could not be the full explanation, since children can acquire subtle linguistic information at a very young age. It is quite conceivable that this relatively late acquisition reflects differences across languages. The language acquisition task then is to find the appropriate constructions to express thoughts and beliefs. Which constructions are designated for certain parts of language could differ across languages. Recursion is one of the phenomena where languages vary. Specifically, languages differ in the constructions that allow recursion, i.e., similar constructions across languages differ in their ability to enter recursion. For instance, Germanic languages allow recursive compounding, but Romance languages resist it. Recursive possessives (*John's father's brother's car*) are fine in, for instance, English and Japanese (Terunuma and Nakato, this volume), but more restricted in Dutch or German (Hollebrandse and Roeper 2014; Pérez-Leroux et al., this volume; Pérez-Leroux et al. 2012).

Returning to belief reports and embedded sentences, some children (even at fairly older ages) gave explanations of the kind in (24). These are interesting because they are combinations of the single-embedded complement clause and the anaphoric discourse case (3). Examples such as these indicate that children seem to be aware of the different systems. The children in (24) are at this age aware of recursion (PP-recursion occurs earlier) (Terunuma and Nakato, this volume), but what these children are not yet fully aware of is which construction to use to express beliefs about beliefs. The example in (24) might very well reflect the cross-linguistic possibilities.

(24) omdat ze koekjes wou gaan kopen en dat Sam zei dat
because she cookies wanted go buy and that S. said that
"because she wanted to go and buy cookies and Sam said that."

Child 313, age 9;6

This last observation is important in a cross-linguistic perspective. Given the biological basis of language, the variation found in child language should be reflected in adult languages cross-linguistically. It is still an open question as to how flexible the possibilities across languages are to express second-order beliefs.

# 3 Recursion in Language and the Development of Higher-Order Cognitive Functions: An Investigation with Children Acquiring Brazilian Portuguese

*Letícia M. S. Corrêa, Marina R. A. Augusto, Mercedes Marcilese, and Clara Villarinho*

Language is a distinguishing component of human cognition. In the last decade, its role in the integration of information from different cognitive domains and a possible role for recursive operations in the development of higher-order cognitive functions have been emphasized (Spelke and Tsivkin 2001; de Villiers and Pyers 2002; de Villiers 2005, 2007; Spelke and Kinzler 2007; de Villiers and de Villiers 2009).

In this chapter, the relationship between recursion in language and higher-order cognitive abilities is approached in the context of children's comprehension of particular recursively generated structures: embedded nominal modifiers, as demonstrated in (1), and complement sentences of mental verbs, as shown in (2).

(1) The **second green ball**.

(2) Mary thinks **that Ann believes that the lollypop is in the big box**.

The former illustrates how recursion in language can contribute to the formulation of specific reference by bringing together two different dimensions (i.e., an attributive and a relational property) for the identification of a given individual or set of individuals in a broader set. The latter illustrates how language can present one's state of knowledge or belief about the knowledge or belief of someone else, each of them being either true or false, independently. It is therefore possible for language to express second-order false beliefs, which is an ability that is probably unique to human cognition.

The literature on children's language has presented the ability to cope with the former as a relatively late achievement and the ability to cope with the latter as a condition for the achievement of second-order false belief reasoning. What would make the ability to cope with embedded nominal modifiers a late achievement? Could it be a limitation stemming from the developmental state of the system that computes grammatical relations (by only enabling conjunction in the earliest stages) or of the systems that interact with language in particular tasks, which may override early computational abilities? How would language contribute to the development of second-order false beliefs? Perhaps by enabling recursion in the highest node of a sentential structure or by being a recursive system, regardless of the nodes that allow recursive operations in a particular language?

A set of studies that were aimed at clarifying these questions is presented in this chapter. The rationale is the following: if a computational system operating recursively can be identified with the faculty of language in the narrow sense (Hauser et al. 2002), it can be expected that recursive operations are implemented as soon as the development of performance systems allows. Moreover, a late achievement of the ability to deal with recursion would be counterproductive, given the cognitive gains that can be associated with recursion in language. By the same token, given that languages vary with regard to the nodes that allow for recursion, having higher-order cognitive achievements dependent on recursion in particular nodes (e.g., as the C node in the case of complement clauses) would also be counterproductive for human cognitive development.

The possible cognitive gains of recursion in language, the processing demands imposed by embedding, and the availability of recursion in early language development are considered here in the context of a minimalist conception of language and in relation to a model of on-line sentence computation, conceived in the light of minimalist assumptions.

This chapter is organized as follows. Section 1 resumes the structures in (1) and (2) in relation to the interplay between language and performance. Section 2 introduces experimental results obtained from Brazilian Portuguese (BP) speaking adults and children regarding the comprehension of DPs with recursive nominal modifiers. They are intended to demonstrate that adults' most immediate analysis of recursive nominal modifiers is compatible with the pattern of children's errors in a forced-choice task. In Section 3, a second-order false belief task is reported, in which embedded and paratactic structures were contrasted. Their results enable the role of recursion in the development of the late state of the Theory of Mind (ToM) to be relativized. In Section 4, a procedural account of the embedded structures considered here is provided. It allows for a clear characterization of the processing demands that these structures impose. These demands may, on the one hand, prevent children from succeeding in the analysis of embedding in the DP and, on the other, they may count as an advantage for the accomplishment of second-order false belief tasks. Section 5 resumes the specific research questions and the discussion on the relationship between recursion in language and higher-order cognitive functions that motivated this enterprise.

The aim of this chapter is twofold: to introduce some experimental results that can contribute to the discussion of the questions raised above, and to provide a procedural characterization of the processing demands that recursive structures impose.

## 1 A Minimalist Conception of Language and the Interplay between Language and Performance Systems

In the minimalist program (see Chomsky 1995), language is constituted of a lexicon and a set of universal operations that apply recursively on the formal features of lexical items in the computation of linguistic expressions. The semantic and the interpretable formal features of lexical items enable language to interact with broader cognition and linguistic expressions in order to be legible by conceptual/intentional systems at the semantic interface. The iterative merging of lexical items gives rise to syntactic objects, which can be recursively merged into syntactic objects of the same type. In actual language use, recursion enhances the combinatorial possibilities for the encoding of reference (3), and provides preciseness for the establishment of complex relations between propositions (4).

(3) [The [second [green ball]]].

(4) [A thinks [that B believes [that the lollypop is in the big box]]].

In (3), the complex DP with recursive nominal modifiers encodes reference to a particular element in a subset (i.e., green balls), which is identified by means of its ordinal position in a row. The same degree of preciseness is not achieved by the coordinate adjectives in the DP in (5). This DP describes a ball that is the second one in a row and happens to be green (i.e., the second ball, which is green). However, the identification of the second ball in the subset of green balls, as in (3), cannot be discarded.

(5) The second and green ball.

In (4), the sentence containing complement clauses of mental state verbs provides precise information regarding A's and B's thoughts, unlike (6), which requires pragmatic inferences for the relationship between propositions to be established.

(6) The lollypop is in the big box. B believes that. A thinks that.

The preciseness in meaning that embedding provides has been characterized in terms of the Principle of Propositional Exclusivity, which states that "embedding organizes meaning by excluding (irrelevant) meanings" (Hollebrandse et al. 2008:2).

Embedding in the DP and in the CP provides, therefore, precise means for the encoding of specific reference, as the result of a set membership operation, as in (3), and for the expression of complex relations between propositions, which may be true or false. The sentence in (4), for instance, would express a second-order false belief if any of the propositions encoded by the complement clauses were false.

Recursion in thought and recursion in language are then intrinsically related, with respect to the expression of complex reasoning in sentence production. The comprehension of recursively generated linguistic expressions can, consequently, promote engagement in higher-order reasoning operations, such as those involving set membership and ToM. Interplay between language and cognitive development can, therefore, be expected.

The availability of recursion in early grammar has been, nevertheless, called into question (Roeper 2011). According to Roeper, language development proceeds from what he calls direct recursion (i.e., coordination) to indirect recursion (i.e., embedding), which is considered to explain the difficulty 5-year-olds have in coping with recursive nominal modifiers, as in (1). The processing of embedded structures is, indeed, particularly demanding, as the literature on child language, aphasia and specific language impairment (SLI) can attest (Grodzinsky 1989; Corrêa 1995; Gordon et al. 2001; Novogrodsky and Friedmann 2006; Jakubowicz 2011). The comprehension of recursive nominal modifiers in particular seems to be hard for 4 year olds (Matthei 1982). The comprehension of complex sentences with complement clauses subcategorized by mental verbs also seems to be particularly hard for children when these clauses express a false belief. It has, in fact, been argued that the ability to cope with double-embedded complement clauses, as in (2), is a fundamental factor in the achievement of the latest stage of the development of ToM, namely, the ability to engage in second-order false belief reasoning (Hollebrandse et al. 2008). The current discussion regarding recursion in early language and higher-order reasoning abilities suggests, therefore, that the cognitive gains that may stem from recursion are not available to young children, and that there are higher-order cognitive abilities that crucially depend on it.

It is, nevertheless, difficult to infer the computational power of children's internal language from acquisition data alone. It is not clear, for instance, whether the internal language of young children is not able to operate recursively (i.e., by means of indirect recursion), when it is in principle possible that the computational system allows for the embedding of syntactic objects of the same type, provided the necessary processing conditions are satisfied, once children figure out the nodes that allow for recursion in a particular language. We hypothesize that specific task demands may create difficulty for children to reveal their language-internal capabilities. In order to address such a possibility, Experiment 1 deals with the long-term investigated recursive nominal modifiers structure, focusing on the task demands and comparing children's performance to adults' behavior. Our main questions are: would children fail to process embedded structures when the task demands are minimized? Would the development of higher-order abilities be required in order for children to overcome particular linguistic task demands?

As for the role of recursion in language in eliciting complex reasoning processes (as second-order false belief reasoning), would it be necessary for complement clauses to express second-order false beliefs? Or would paratactically related structures be able to elicit second-order false belief reasoning, given that recursion in language may be enough for promoting or making evident the possibilities of recursive thought? In a language that allows recursion in the C node, such as BP, what is the balance between processing cost and preciseness when complement clauses express a false belief?

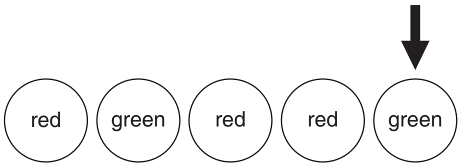
The experiments reported in the next sections were intended to answer these questions.

## 2 Children's Comprehension of Recursive Nominal Modifiers

Children's comprehension of recursive nominal modifiers is a topic that has undergone a resurgence in recent years, given the renewed interest in recursion in language that the minimalist program in generative linguistics has motivated. In minimalist terms, the core grammatical computations are limited to recursion. Recursion is hypothesized to be the only uniquely human component of the faculty of language, identified with the faculty of language in the narrow sense (Hauser et al. 2002). In this context, language development proceeding from direct (i.e., coordination) to indirect recursion (i.e., embedding) can be thought of as a means of reconciling the fundamental role of recursion in language with children's attested difficulties with different forms of embedding (Roeper 2011).

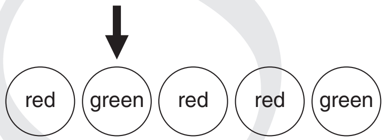
The claim that children parse embedded structures as conjoined ones (Roeper 2011) is supported by data from forced-choice tasks, which required 3-to-4-year-old English-speaking children to identify the referent of a complex DP with recursive modifiers (Matthei 1982; Roeper 1972). Forced-choice tasks have an executive control component: the participant may have to inhibit an immediate response in order for the task to be accomplished (Rodrigues and Marcilese 2014). In this task, children were requested to show the particular referent described by a complex DP with an ordinal modifier in a row (7).

(7) The second green ball




The critical experimental condition (i.e., the biasing condition) presented the element described by the color attribute at stake in the position informed by the ordinal modifier, thereby inducing what has been described as a conjoined interpretation (8).

(8) [The [[second (and) green] ball]]
(conjoined reading)




The pattern of children's responses in this condition is suggestive of a conjoined interpretation. Similar results obtained in a cognitively simpler task with sequences of attributive adjectives in German (such as *the big black balls*, interpreted as *the big balls and the black balls*) (Bryant 2006 *apud* Roeper 2011) suggest that it is not the counting but rather the parsing of these recursive structures that makes the task difficult for children. Does it imply that children's internal language is unable to compute embedding? Adults' processing of this structure in a similar task can be informative in this regard.

An eye-tracking forced-choice task experiment was conducted with adult speakers of BP (Marcilese 2011; Marcilese et al. 2013). Eye-fixation measures can reveal the most immediate response to a given stimulus: a response cannot be inhibited in light of subsequent information, unlike pointing. This experiment was intended to contrast the immediate eye-fixations with the pointing responses in order to evaluate the extent to which the former must be inhibited. The visual stimulus and the oral instruction (*Show me X*) were either presented simultaneously (as in previous studies with children) or sequentially, with the audio instruction preceding the presentation of the visual array. The type of visual array was also manipulated as in previous studies, giving rise to a biased and to an unbiased condition.

The participants were twenty-four adult speakers of BP (age range: 18–42 years). It was predicted that adults would immediately search for the position informed by the ordinal modifier, a choice to be inhibited if the DP was properly parsed. It was also predicted that the sequential presentation would facilitate the search for the subset defined by the color attribute in order for the

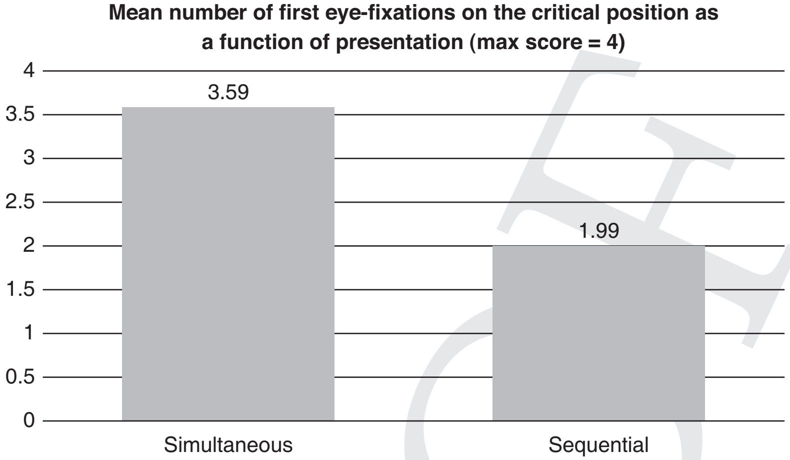



Figure 3.1 First eye-fixations as a function of presentation

second element in the subset to be identified. In this condition, the participants had already parsed the sentence when the visual array was presented, whereas in the simultaneous one, the participants were likely to map a potential DP onto a referent as the sentence parsing unfolded. The number of first fixations on the critical position (i.e., the position in the visual array that corresponds to the meaning of the ordinal modifier) was the dependent variable. The results of a 2 (presentation) × 2 (visual array) ANOVA (in which *presentation* is a between-subject factor and *visual array* a within-subject factor) revealed a significant main effect of *presentation*, with more first fixations on the critical position in the simultaneous presentation condition than in the sequential presentation one ($F(1,22) = 8.01$ $p < 0.01$) (see Figure 3.1). No other significant effect was obtained, suggesting that regardless of the bias created by the color of the second element in a row, this position is immediately searched for by adults.

Given these results, an experiment was conducted with BP-speaking children, making use of a forced-choice task in which the audio instruction preceded the presentation of the visual array, unlike the previous studies carried out on English speakers. As in those studies, a biasing condition was presented. The participants were forty-seven BP-speaking children (twenty-four girls) in three age groups, balanced for sex: one group consisted of fourteen children (mean age 4;7); another group consisted of eighteen children (mean age 5;5); and the other group consisted of fifteen children (mean age 6;4). The results of a 3 (*age*) × 2 (*visual array*) ANOVA revealed a main effect of *age* ($F (2.44) = 4.47$, $p = 0.01$), with progressively more targeted responses in the older children (see

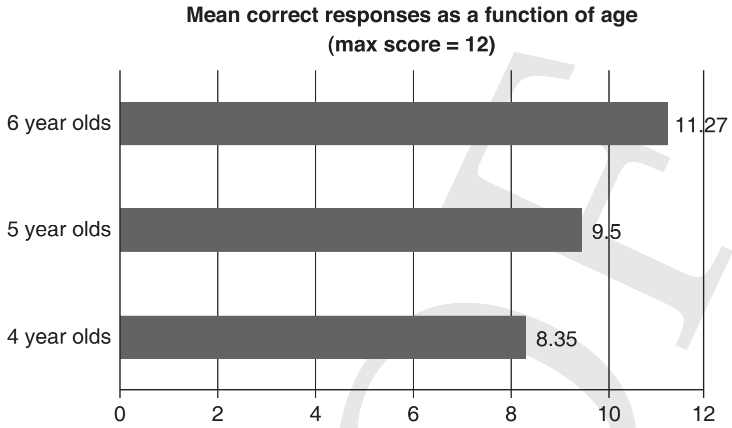



Figure 3.2 Mean correct responses as a function of age

Figure 3.2). A main effect of *visual array* was also obtained (F (2.44) = 19.52, p <0. 001), with significantly more target responses in the unbiased condition (see Figure 3.3). The effect of the two-way interaction was not significant.

Children's ability to cope with recursive nominal modifiers increased with age in both conditions. Unlike Matthei's (1982) study, in which the data of children ranging from 3;9 to 6;3 (mean age 5;1) were analyzed together, in the experiment discussed here, it was possible for a developmental curve to be created in which the 6 year olds' performance was almost at ceiling. Unlike adults, children were affected by the visual array, with the biased condition being more difficult to them, as has been demonstrated in previous studies. Unlike Metthei's data, however, in which children's performance appears to be at the chance level in both conditions (mean 1.82 for the biased and 2.52 for the unbiased condition, the maximum score being 4), the children in this experiment performed well above chance in both conditions except for the 4-year-old group in the biased condition (see Figure 3.3). If children's internal language could not compute embedding, more non-target responses would be expected, even in the unbiased condition. Although the data presented in Matthei's study are difficult to compare, given the absence of age groups, the better overall performance demonstrated in the study with BP-speaking children is likely to be explained by the fact that the task minimized the immediate mapping of the ordinal modifier with a linear corresponding position in the row, in so far as children were able to parse the sentence before matching its interpretation on the visual array. The position of the color adjective in relation to the noun also varies between Portuguese and English. This difference, however, is not likely to explain the relatively good performance of the BP-speaking children. In fact,

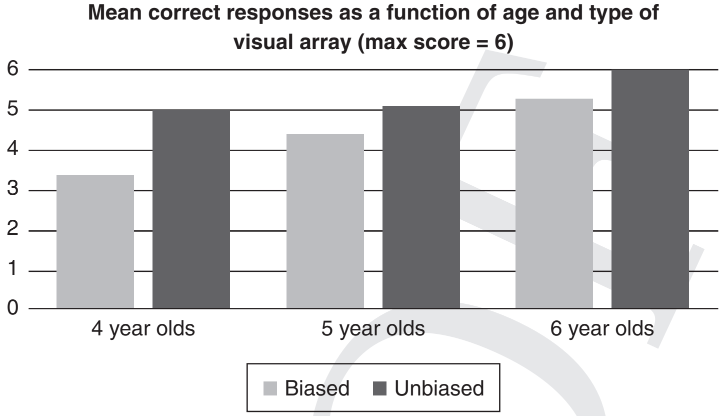



Figure 3.3 Mean correct responses as a function of age and type of visual array

the effect of the order of the attributive adjective in this language would favor a misanalysis of the DP.

The results just reported, in relation to adults' tendency to look at the critical position regardless of the visual array, seem to indicate that children have difficulty in inhibiting the most immediate response based on the sentence analysis, though coping with the processing demands may also be hard for them.

In sum, there is no compelling evidence to suggest that children's internal language is unable to compute recursive structures. The sort of processing demands that have to be overcome by 5 year olds will be considered in Section 5.

## 3 Embedded and Paratactic Structures in a Second-Order False Belief Task

As for second-order false belief reasoning, the need for complement structures to sustain false belief reasoning has been called into question. Given that recursion is an inherent property of language, this property may be enough to promote or to contribute to the development of recursive reasoning. We have hypothesized that in a language that allows recursion in C, such as BP, the production of a complement sentence plays a facilitating rather than a deterministic role in sustaining that higher cognitive function reasoning. An experiment was conducted with BP-speaking 6 year olds, in which paratactic and complement sentences were contrasted (Marcilese et al. 2009; Villarinho 2012). It was intended to identify the conditions that favor children engaging in second-order false belief reasoning (see Hollebrandse, this volume). More specifically, the question addressed was: would paratactically related structures be able to elicit second-order false belief reasoning?

The task was presented as a guessing game involving the child and two experimenters. The child (C) had to hide an object (a lollipop) from the two experimenters (A and B) in one of three possible boxes (Box 1, Box 2, and Box 3). Then, Experimenter A expressed her belief concerning the location of the lollipop by means of either a paratactic (9) or an embedded structure (10), while Experimenter B pretended not to hear it. Subsequently, Experimenter B tried to guess Experimenter A's belief, and expressed it either by means of parataxis (11) or embedding (12). Mental verbs used in the first person and their paratactic counterparts were accompanied by a gesture pointing to the head, expressing doubt in a dramatized way.

(9) *Para mim, o pirulito está na caixa X.*
For me, the lollipop is in box X.

(10) *Eu acho que o pirulito está na caixa X.*
I think that the lollipop is in box X.

(11) *Na minha ideia, pra ela, o pirulito está na caixa X.*
In my mind, for her, the lollipop is in box X.

(12) *Eu penso que ela acha que o pirulito está na caixa X.*
I think that she believes that the lollipop is in box X.

The child was then asked (i) to predict where Experimenter A would look for the object, based on Experimenter A's belief (a first-order task), and (ii) to judge whether Experimenter B had correctly guessed where Experimenter A would look for the object (a second-order task).

The type of question intended to elicit a second-order false belief judgment was considered to be a factor that might affect children's performance. Yes/No questions and WH-questions were used. WH-questions were expected to present more difficulties for the children. In order to minimize this cost, WH-in situ was used.[1] Apart from that, the structures of the WH-questions were varied (i.e., with or without embedding), since it would be the structure that might prime the children's responses more immediately. Three types of questions were then used: (i) Yes/No (13); (ii) WH-question without embedding (14); and WH-question with embedding (15). The independent variables were the type of structure of the sentence expressing the second-order false belief (i.e., paratactic or embedded) and the type of question eliciting the second-order

[1] In BP, WH-in situ is not restricted to echo questions, and its use is pragmatically adequate in the interaction created.

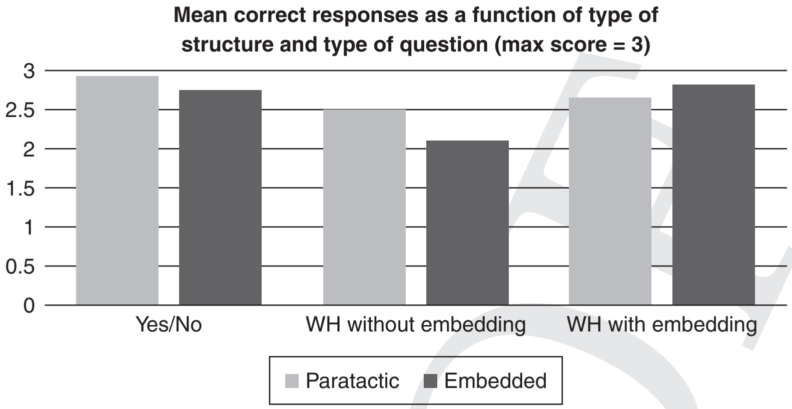



Figure 3.4 Mean correct responses as a function of type of structure and question

false belief reasoning (i.e., Yes/No; WH- without and with embedding). The dependent variable here was the number of correct responses to the second-order false belief task.

(13) *Ela (B) adivinhou meu pensamento?*<br>
[She (B) guessed my (A) thought?]<br>
Did she (B) guess my (A) thought?

(14) *Pra ela (B), eu (A) vou procurar o pirulito onde?*<br>
[For her I (A) will look for the lollipop where]<br>
For her (B), where am I (A) going to look for the lollipop?

(15) *Ela (B) acha que eu (A) vou procurar o pirulito onde?*<br>
[She thinks that I (A) will to look for the lollipop where?]<br>
Where does she (B) think that I (A) am going to look for the lollipop?

The participants were seventy-two BP-speaking children aged 5;8 to 6;8 years (forty-two girls; mean age: 6;2). The data were submitted to a 2 (type of structure) × 3 (type of question) ANOVA. The type of structure did not give rise to a main effect (F(1,66) = 1,33, p = 0.25). There was nevertheless a main effect of type of question (F(2,66) = 7,69, p < 0.001) (mean: 2.85 for Y/N; 2.31 for WH- without embedding; 2.75 for WH- with embedding). Responses to Y/N questions were almost at ceiling. WH-questions made the task harder for children. A significant two-way interaction was not obtained ($F(2,66) = 1,83$, $p = 0.17$). A pair-wise comparison revealed, nevertheless, that the difficulty created by a WH-question without embedding was particularly manifested when the structure presenting the second-order false belief was embedded ($p < 0.01$).

These results indicate that 6 year olds are able to engage in second-order false belief reasoning, regardless of the type of structure by which false beliefs are expressed. They also show that the type of question that elicits the task response is a factor that affects children's performance. Embedding facilitates the eliciting of a second-order false belief judgment, in so far as WH-questions without embedding (as in *For B, where am I going to look for the lollipop?*) made the task harder for children, and this difficulty is particularly manifested when the false beliefs had been presented by means of complement clauses.

In sum, there is no evidence suggesting that second-order false belief reasoning is unattainable on the basis of paratactic structures. The eliciting of such reasoning is nevertheless more effective when the WH-question contains a mental state verb with a complement clause.

## 4 General Discussion

The results obtained with BP-speaking adults and children contribute to answering the specific questions of the investigation presented here:

(i) Would children process embedded structures when the task demands are minimized?

Regarding nominal modifiers, the pattern of behavior in the biased condition does not justify restricting the computational operations of children's grammar to a conjoined-clause analysis. The fact that adults immediately looked for the absolute position indicated by the ordinal modifier and were not affected by a biasing visual array suggests that the meaning of the ordinal modifier is most immediately mapped and that they are able to inhibit this immediate response as a function of their analysis of the sentence. The youngest children do not seem to be able to do so, and the development of this ability is likely to account for the age effect. Unlike previous results, children's performance in the unbiased condition is quite consistent, even in the youngest group, suggesting that they are able to identify a subset on the basis of the attributive adjective and to restrict the search for a particular position in this subset. This would not be expected if embedding were not computed by their internal language by the age of five.

The conjoined-clause analysis of relative clauses, a hypothesis put forward in the early 1980s (Tavakolian 1981), has been shown to overlook the task-specific demands that could explain the pattern of children's responses presented in its support (Hamburger and Crain 1982; Corrêa 1995). By the same token, this analysis is not likely to explain the present data. The present data are suggestive of the full operation of recursion in the DP, even though parsing abilities, as far as they interact with higher-order functions (e.g., executive functions, which include working memory), undergo development. In Section 5, this point will be specifically considered.

(ii) Would paratactically related structures be able to elicit second-order false belief reasoning?

The results of the experiment reported in Section 3 demonstrate that paratactic structures can promote second-order false belief reasoning, although embedding in the CP contributes to organizing the meaning that elicits the children's responses. Since embedding in the CP is available in BP, it is not possible to disregard the possible role of complement clauses of mental verbs in the development of the abilities under assessment. The fact, however, that parataxis can promote second-order false belief reasoning in the context of the experiment reported here makes it possible that the achievement of the late stages of ToM is independent from embedding in the CP. Preciseness in meaning would then be the major cognitive gain that embedding provides. Preciseness in meaning is, nevertheless, required in social interaction to a greater or lesser degree. The overall balance between processing cost and preciseness is a relevant point to be considered in a broader discussion of the relationship between language and cognition, especially regarding different cultures. This balance can be considered on the basis of a procedural account of the demands presented by the processing of complement clauses that express a false belief.

## 5 The On-Line Computation of Recursive Structures

The demands imposed by the processing of embedding structures can be ascribed to computational cost, to particular parsing conditions, and to conditions affecting the integration of information at post-syntactic stages. In this section, syntactic computation is considered in an on-line perspective with respect to the parsing and interpretation of the structures just discussed in order to clarify the sort of abilities required for the most effective use of the computational power provided by recursion in language.

The on-line computation of linguistic expressions in sentence production and comprehension is assumed here to be carried out by the sort of universal computational operations characterized as the faculty of language in the narrow sense. Minimalist derivations facilitate a relationship to be established between the generation of linguistic expressions in the context of a model of the internal language combinatorial possibilities and on-line computation, as derivations start from a particular lexical array. The algorithmic procedures of a syntactic derivation nevertheless have to be adapted when on-line computation is considered. Being so, a brief presentation of the basic properties of a model of on-line minimalist computation (Corrêa and Augusto 2007, 2011) is required in order for computational cost and overall processing demands to be considered. These are:

(i) bi-directional computation: top-down generation of functional skeletons and bottom-up generation of syntactic objects (SOs) headed by lexical items;
(ii) parallel derivational spaces (see Uriagereka 1999; Nunes 2001);
(iii) assembly of independently computed SOs (NPs, DPs, and VPs), in the CP skeleton at the structural position that corresponds to the linear canonical order;
(iv) left-to-right transfer of partially built phrase markers (the on-line equivalent to phases) to the interface levels (P-A in production; C-I in comprehension), thereby enabling the immediate mapping of DPs onto referents as the linguistic stimulus is scanned from left to right in comprehension (Augusto et al. 2012).

Computational cost can be characterized as a function of:

a) the number of functional nodes that feed computation (in particular, the nodes of the same kind to be selected forming recursively merged SOs) (Jakubowicz 2003);
b) the number of SOs to be computed in the parallel derivational spaces, which is likely to tax working memory;
c) alteration in the canonical word order pattern.

The overall processing cost in sentence comprehension has to include, among other factors:

a) dependency on look-ahead, in order to prevent the closure of a possible constituent (due to the transferring of a potential phase) and the need for reanalysis (Kimball 1973; Crocker 2009);
b) the presence of intervening elements in the processing of long-distance dependencies (Grillo 2009);
c) the cost of post-syntactic processes related to scope, referential mapping and truth value ascription (see Reinhart 1999).

Given these basic points, the on-line computation of DPs with recursive nominal modifiers (16), in left-to-right parsing, is sequentially represented in Figures 3.5 and 3.6.

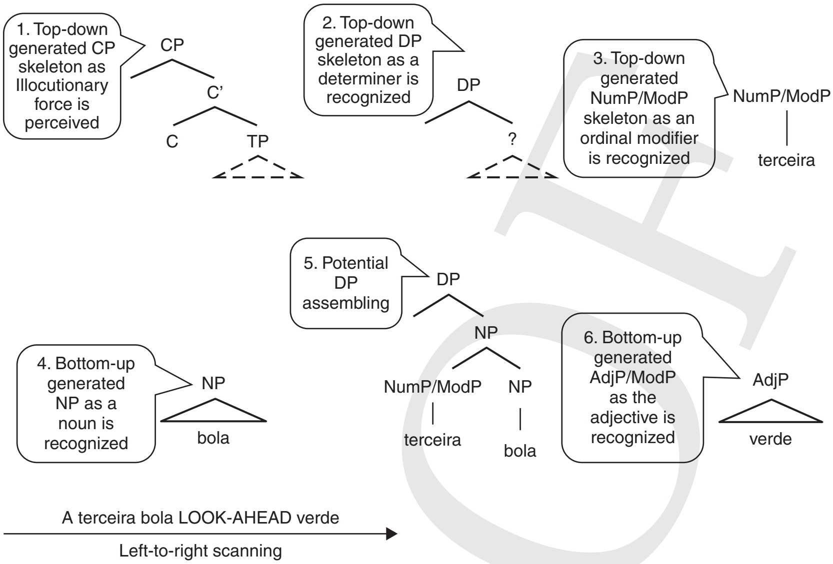



Figure 3.5 On-line computation until a potential DP border is detected and recognition of a post-nominal modifier

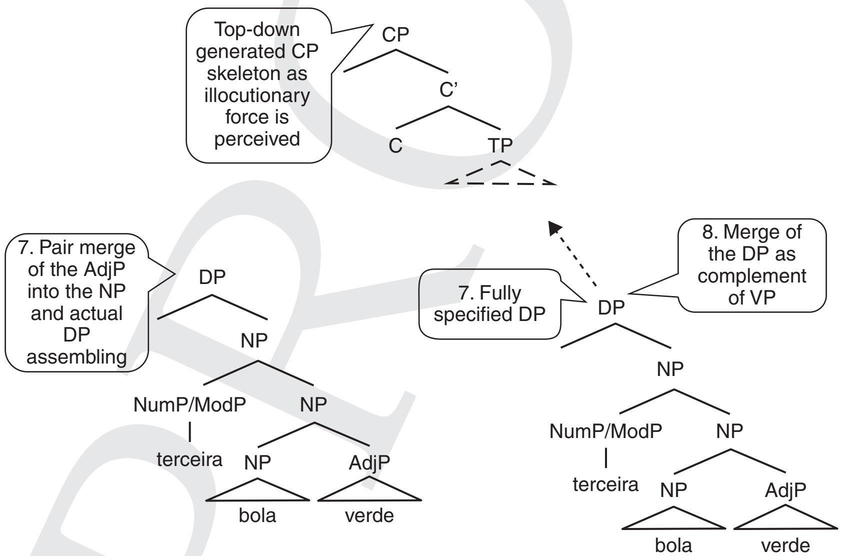



Figure 3.6 Incorporation of the post-nominal adjective in a recursive structure and merging of the generated DP as a complement to the verb

(16) *Mostre* ***a terceira bola verde***
[Show the third ball green]
Show the third green ball.

Figure 3.5 shows that the parsing of a complex DP with an ordinal modifier as proposed here involves its processing in a parallel derivational space and the independent bottom-up generation of an AdjP to be merged to the NP prior to the merging of the DP with the top-down generated tree from CP.

The assembling of the AdjP to the NP in the DP depends on a look-ahead strategy, avoiding the early closure of the DP. Otherwise, the incorporation of the post-nominal adjective into the structure after the early closure of the DP would require reanalysis, adding processing cost.

Alternatively, considering that the DP had been closed and no access to its internal structure (merging to the NP) would be available, the AdjP to be integrated into the structure would be merged to the DP itself, leading to the assembling of an appositive reduced clause, in the sense of Cinque (2006b) and de Vries (2006) (or as a late merge, in terms of Chomsky 2001) (see Figure 3.7). Such a structure would be compatible with a conjoined interpretation of the modifiers in relation to the noun.[2]

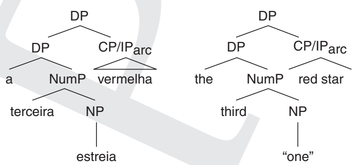
Hence, in so far as a look-ahead strategy is necessary during the incremental parsing of the structure, its processing demands go beyond the computational cost added by recursion, although they are derived from it.

Returning to the research questions, would the development of higher-order abilities be required in order for children to overcome specific task demands in the processing of recursive nominal modifiers?

Given this account, it is possible that young children have difficulty in making effective use of look-ahead in the parsing of recursive noun modifiers, which is an executive control function involved in the short-term storage in working memory (see Baddeley 1997). This ability may contribute to the inhibition of a

[2] It is proposed, nevertheless, that the early closure of the DP and the incorporation of the adjective as an appositive reduced relative clause (i) by children would not only apply to Portuguese (ii), but also to languages with pre-nominal adjectives, such as English, (iii):

(i) [CP-rrc/arc OP/RPi [C' (C) [IP … ti …]]]
(ii) [A terceira estrela] (que é) vermelha/ The third star which is red
(iii) [The third "one"] (which is) red star/ The third one which is a red star



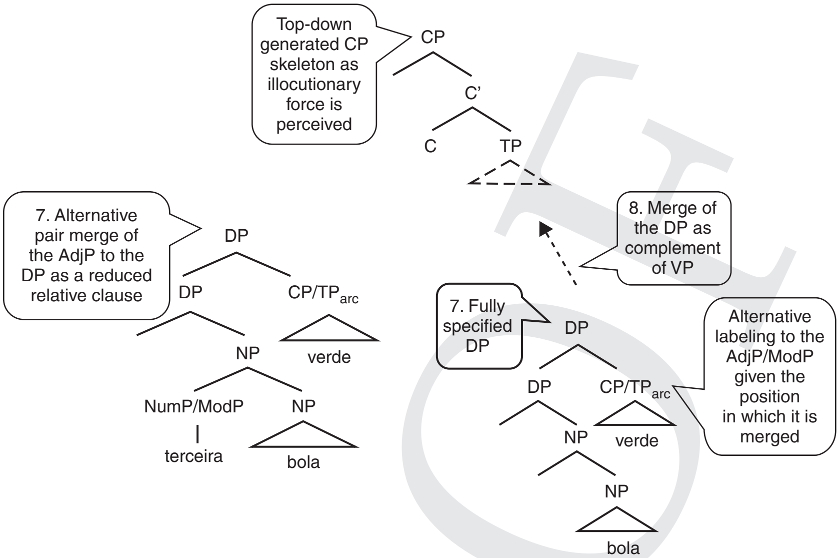



Figure 3.7 Alternative incorporation (with no look-ahead) of the post-nominal adjective in an appositive structure and merge of the generated DP as a complement to the verb

response based on the immediate search for the position corresponding to the meaning of the numeral in a row in the experimental task that has been used to assess children’s comprehension of recursive noun modifiers, even though each of these abilities may undergo specific development.

As for the on-line parsing of complement clauses, as in (17), Figure 3.8 is presented, omitting steps 1–7 for the sake of space.

(17) *Maria acha que Pedro acredita* ***que o menino viajou***.
M. thinks that P. believes that the boy travelled.
Maria thinks that Pedro believes that the boy has travelled.

According to this on-line model, the parsing of a structure proceeds left to right. Thus, the recognition of a complementizer indicates that a sentence has to be integrated into another sentence, signaling that a complete proposition is still not available. CPs embedded into CPs provide different propositions. They may be evaluated in terms of truth values, but the ultimate truth value to be ascribed has to consider the whole proposition. This means that although there are phases which may be dynamically spelled-out and transferred to the interfaces, the ascription of a truth value has to be delayed until the whole complex sentence is parsed. The difficulty with multiple embedded CPs (i.e.,

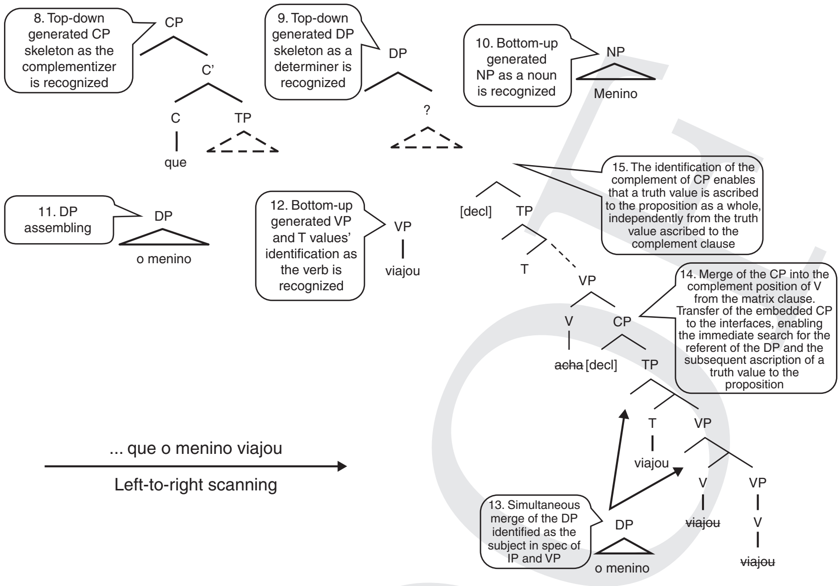



Figure 3.8 Merge of the complement clause and transferring of elements to the interfaces, enabling truth values to be ascribed to the propositions

complement clauses) stems, therefore, from keeping the main clause active in memory while the complement clauses are analyzed.

The results of the experiment in Section 3 suggest that paratactically generated structures can provide information that elicits second-order false belief judgments as embedded sentences do. Precise questions, such Yes/No questions and WH-questions with a complement clause nevertheless facilitate the task. It therefore appears that once children can keep the main clause active while complement clauses are analyzed and semantically interpreted, a false belief judgement can be elicited.

Again, the development of executive control abilities in keeping syntactic information available in working memory may be a crucial factor for the interplay between language and higher-order cognition.

## 6 Final Remarks

This chapter focused on the relationship between recursion in language and higher-order cognitive functions based on children's comprehension of recursive nominal modifiers and complement sentences expressing a false belief. Current views were discussed on the state of recursion in children's internal language and on the role of recursive structures in promoting the development of the reasoning process involved in second-order false belief judgments (de Villiers 2005; Hollebrandse et al. 2008; Roeper 2011) in light of experimental data from BP-speaking adults and children.

Two considerations motivated the pursuit of the set of studies that gave rise to these data (Corrêa et al. 2009; Marcilese 2011; Villarinho 2012; Marcilese et al. 2013):[3] given the fundamental role of recursion in language computation and the cognitive gains that can be associated with it, should the implementation of recursive operations be expected to be a late developmental achievement? Should the development of reasoning processes be dependent on the availability of recursion in a particular node (CP), which may vary across languages? The working hypotheses guiding the investigations reported here were: (i) recursion is operative in early language, once children figure out the nodes that allow for recursion in a particular language, provided the necessary processing conditions are satisfied; and (ii) recursion in language, regardless of the nodes that allow it in a particular grammar, is enough to promote or to make explicit recursive reasoning. For languages that allow recursion in C, complement sentences provide an optimal device for preciseness in the expression of this complex reasoning process. It is nevertheless the balance between preciseness and processing cost that is likely to determine how recursive thought on false beliefs is linguistically expressed.

The specific research questions were: (i) would children fail to process embedded structures when the task demands are minimized; and (ii) would paratactically related structures be able to elicit second-order false belief reasoning?

The results of an eye-tracked forced-choice task experiment on adults' comprehension of recursive nominal modifiers revealed that the presentation of the task affected performance. The results of the experiment carried out with children showed that the overall performance improved considerably in relation to the data of previous studies when the verbal command preceded the presentation of the visual array. Even though the biased condition was still harder for children, particularly in the 4-year-old group, they did not seem to be unable to carry out a syntactic parsing that enabled the proper scope of the ordinal modifier to be delimited.

The on-line procedure described in Section 5 suggests that it is the development of the ability to rely on look-ahead in order to avoid the early closure of a DP that makes the processing of embedded nominal modifiers hard for

[3] The doctoral dissertations of Marcilese (2011) and Villarinho (2012) were developed in the context of the project (FAPERJ E-26/112.273/2008: *Recursividade, custo de processamento, habilidades numéricas e teoria da mente: relação entre língua e habilidades cognitivas superiores* [Recursion, processing cost, numerical abilities and Theory of Mind: on the relationship between language and higher-order cognitive abilities]) of the first author and had the second author as joint supervisor.

children. This is a higher-order cognitive ability that is likely to account for the development of the comprehension of recursive noun modifiers, together with the ability to inhibit the first visual search. In sum, it is our contention that children are linguistically prone to take this advantage as soon as they are able to employ look-ahead strategies and inhibit the immediate visual search response.

As for false belief judgments, paratactic structures allow for a second-order false belief judgment to be provided. This conclusion is particularly relevant to prevent a deterministic view predicting that the possible absence of a CP recursive node in a language affects reasoning processes. The preciseness brought about by embedding in the CP can be nevertheless advantageous. It was shown that the type of question affected children's performance. Prompting a second-order false belief judgment by means of a WH-question with a complement clause (e.g., *Where does she (B) think that I (A) am going to look for the lollipop?*) is more effective than doing so by means of a WH-question without embedding (e.g., *For her (B), where am I (A) going to look for the lollipop?)*, even though the former is in principle more costly than the latter. This lower cost is nevertheless overridden by the precise interpretation provided by the embedded structure once children are able to keep the main clause active until its truth value can be ascribed.

In sum, the possibility of computing recursive structures together with the development of higher-order functions seem to account for the uniquely human capacity to codify scope relations dependent on set membership and second-order false beliefs in language and to make use of language as a means of engaging in complex cognitive reasoning.

# 4 Embedding as a Building Block of Evidential Categories in Kotiria

*Kristine Stenzel*[*]

## 1 Introduction

East Tukano (ET) languages[1] are spoken in the Brazil-Colombia border region of northwestern Amazonia, and are known in the typological (and formal semantic) literature for their complex systems of obligatory evidential marking[2] (Willett 1988; de Haan 2001a, 2001b; Faller 2002; Aikhenvald 2003, 2004, 2012; Stenzel and Gomez-Imbert 2018), discussed in Section 1. This study focuses on the four 'firsthand' evidential categories of Kotiria, examining its evidential system from semantic-functional (Section 2) and syntactic (Section 3) perspectives in order to provide some initial answers to two related questions: (i) to what extent can evidentials be viewed as recursive constituents in Kotiria, and (ii) what can we infer about the relationship between underlying syntactic structure and the development of systems with multiple evidential categories?

## 2 Evidentials in East Tukano Languages

Grammaticalized evidentiality occurs in approximately a quarter of the world's languages (Aikhenvald 2004:17) and is obligatorily marked in only a fraction of these. Languages of the ET family require verb-final evidential markers in all *realis* (for some authors, 'present' or 'past') declarative sentences, while interrogative and directive sentence types have distinct clause modality morphemes

[*] My research on East Tukano languages has received support from NSF (doctoral grant 0211206), NSF/NEH DEL Program (FA-52150-05; BCS-1664348), ELDP/SOAS (MDP-0155), the Brazilian National Council for Scientific and Technological Development (CNPq), the Brazilian Ministry of Education's Program for Continuing Academic Development (CAPES, Estágio Senior grant), the Instituto Socioambiental, and the Federal University of Rio de Janeiro. My thanks to Marcus Maia, Bruna Franchetto, Cilene Rodrigues, and the reviewers for encouragement, input, and suggestions that have greatly enriched this chapter.

[1] The sixteen remaining ET languages are Bará/Waimajã, Barasana, Desano, Karapana, Kotiria/Wanano, Kubeo, Makuna, Pisamira, Siriano, Taiwano/Eduuria, Tanimuca/Retuarã, Tatuyo, Tukano, Tuyuka, Wa'ikhana/Piratapuyo, and Yuruti. I adopt use of the self-name *Kotiria* 'water people' at the request of speakers with whom I work; the names Wanano/Guanano/Uanano also occur in the literature.

[2] Understood, following Willett (1988:55), to be "the linguistic means of indicating how the speaker obtained the information on which s/he bases an assertion."

in the same verb-final slot. For example, the Wa'ikhana *realis* statement in (1) has the evidential (VISUAL, perfective) suffix *–di*; (2) is a question with the interrogative suffix *–adi*, and (3) is a directive with the imperative suffix *–ya*.

(1) *tina topʉ nʉkʉpʉde so'õpʉ ihidi*

| | | | | |
|---|---|---|---|---|
| *tí-~dá* | *tó-pʉ* | *~dʉkʉ́-pʉ́-dé* | *~so'ó-pʉ* | *ihí-**di*** |
| AN-PL | AN-LOC | forest-LOC-OBJ | DEIC:DIST-LOC | COP**-VIS.IMPF.1** |

'They (our Wa'ikhana ancestors) lived out there in the forest.'[3]

(2) *no'opʉ ihiadi keo?*

| | | |
|---|---|---|
| *~do'ó-pʉ́* | *ihí*-adi | *keó* |
| Q-LOC | COP**-INT** | caiá |

'Where is *caiá* fish trap (located)?'

(3) *o'õ duhiya.*

| | |
|---|---|
| *~o'ó* | *duhí**-ya*** |
| DEIC.PROX | sit**-IMP** |

'Sit here.'

Most ET evidential systems have paradigms of inflectional morphemes conflating information about source of evidence, animacy, person, number, and tense or aspect, such as the *–di* suffix in (1). (For other ET languages, see Barnes 1984, 2006; Malone 1988; Ramirez 1997; Gomez-Imbert 2007, 2011; the grammatical overviews in González de Pérez and Rodríguez de Montes 2000; Stenzel and Gomez-Imbert 2018).

Comparison of individual ET evidential systems reveals variation both in the number of categories each system contains and the morphosyntactic means employed to express them. Silva (2012:253–261) discusses six categories for Desano, while Strom (1992:90–91) identifies only three optional categories in Retuarã. Most ET evidential systems have four or five categories, which tend to be marked by inflectional verbal suffixes, although some languages, including Kotiria, also employ periphrastic constructions for INFERENCE and/or NONVISUAL evidence (see Sections 2.4–2.5, and Ramirez 1997:132–140 for discussion of similar constructions in Tukano).

[3] Unless otherwise specified, all data is from the author's own fieldwork. The first line gives the utterance in the practical orthography; the second and third lines have morphological information and glosses, followed by a fourth line with free translation. The second line also has phonological information: nasalization and glottalization (both morphemic suprasegments) are represented by a '~' indicating a nasal morpheme, e.g., *~dʉkʉ* [nʉ̃kʉ̃́] in (1), and by an apostrophe in glottalized roots, e.g., *~o'o* [õʔṍ] in (3). Additionally, an acute accent indicates high tone, low tone is unmarked, and = indicates a cliticized morpheme (low toned). [ʉ] corresponds to [ɨ] a high, central, unrounded vowel.

Table 4.1 *Tuyuca evidentials (Barnes 1984:258)*[4]

| | | VISUAL | NONVISUAL | APPARENT (INFERENCE) | INFORMED (HEARSAY) | ASSUMED |
|---|---|---|---|---|---|---|
| PAST | Other (1/2) | *–wɨ* | *–tɨ* | *–yu* | *–yiro* | *–hĩyu* |
| | 3msg | *–wi* | *–ti* | *–yi* | *–yigɨ* | *–hĩyi* |
| | 3fsg | *–wo* | *–to* | *–yo* | *–yigo* | *–hĩyo* |
| | 3pl | *–wa* | *–ta* | *–ya* | *–yira* | *–hĩya* |
| PRESENT | Other (1/2) | *–a* | *–ga* | – | – | *–ku* |
| | (*2)/3msg | *–i* | *–gi* | **–hĩi* | – | *–ki* |
| | (*2)/3fsg | *–yo* | *–go* | **–hĩo* | – | *–ko* |
| | (*2)/3pl | *–ya* | *–ga* | **–hĩra* | – | *–kua* |

ET evidential systems generally have a HEARSAY category indicating ‘secondhand’ sources of information, and up to four contrasting categories of ‘firsthand’ evidence. All ET systems include a VISUAL category. VISUAL markers are always inflectional and their default semantics indicate directly acquired sensory information (involving the speaker as witness to or participant in the related event or state). Their use is extended to statements of general fact, a tendency observed in languages with systems of obligatory, multi-valued evidentials (Aikhenvald 2003:13). The NONVISUAL category indicates other sensory (e.g. auditory) sources or otherwise not directly observable information sources, such as the speaker’s own internal physical sensations. INFERENCE markers code the speaker’s conclusions based on observed ‘after-the-fact’ evidence, while those of the ASSERTION category (ASSUMED in Barnes 1984) indicate a second kind of inference or reasoned supposition based on collective experience, known patterns of behavior, or shared cultural knowledge ‘internalized’ by the speaker (Givón 1982:42–45; Willet 1988:61).[5]

Table 4.1 shows the Tuyuca evidential markers presented in Barnes (1984), the seminal article on ET evidentiality. It illustrates many of the common features: paradigms with third/non-third person organization and distinctions of number, gender, and tense/aspect. The sentences in (4) are representative examples from this work.

(4) a. VISUAL *diiga ape-**wi***
‘He played soccer.’ (I saw him play.)
b. NONVISUAL *diiga ape-**ti***

4 Malone (1988) offers additional insight on the development and internal organization of the Tuyuca markers.

5 Several dialects of Peruvian Quechua also distinguish ‘individual’ and ‘mutual’ knowledge sources (see Hintz and Hintz 2014).

'He played soccer.' (I heard the game and him, but I didn't see it or him.)

c. APPARENT *diiga ape-**yi***
'He played soccer.' (I have seen evidence that he played: his distinctive shoe print on the playing field. But I did not see him play.)

d. INFORMED *diiga ape-**yigi***
'He played soccer.' (I obtained the information from someone else.)

e. ASSUMED *diiga ape-**hiyi***
'He played soccer.' (It is reasonable to assume that he did.)

(Barnes 1984:257)[6]

## 3 The Kotiria Evidential System: Functional and Semantic Aspects

Kotiria evidentials constitute one of the four major subcategories of 'clause modality' markers – the final morphological elements of verbs in finite, independent clauses – alongside markers of *irrealis* statements, directive sentences, and interrogatives (Stenzel 2008, 2013).[7] The Kotiria five-category system is typical of the ET family in that it has a single 'secondhand/hearsay' category and four 'firsthand' categories. However, detailed comparison shows that it has diverged in several other significant ways.[8]

First, almost all person, gender, and number distinctions have been neutralized in the Kotiria system, the sole exception being the VISUAL category, which codes a simple number-neutral first/non-first-person distinction. Second, Kotiria evidentials do not code tense distinctions *per se*. Although temporal notions may often be inferred, internal category distinctions essentially express aspectual distinctions, orienting to the speaker's access to the source of information (further discussed below; see also Stenzel 2013:275–280). Figure 4.1 shows the five categories and a set of distinguishing semantic features; examples and additional information on each category follow.

### *3.1 Hearsay*

Markers of secondhand sources of evidence are not frequent in everyday Kotiria speech (but see Stenzel (2017) for some interesting examples). When

[6] Barnes's categories APPARENT, INFORMED, and ASSUMED correspond respectively to the categories I label as INFERENCE, HEARSAY, and ASSERTION.

[7] It should be noted that subordinate clauses, which are not specifically discussed in this chapter, do not have any form of finite clause modality marking; they are nominalized by morphemes indexing the subject of the matrix clause, or by the switch-reference suffix *–chʉ*. For further discussion, see Stenzel (2016).

[8] The patterns described for Kotiria also hold for Wa'ikhana, its closest sister language.

<table>
<tr><th colspan="6">FEATURES</th><th>FORMS</th><th>CATEGORIES</th></tr>
<tr><td rowspan="2">secondhand</td><td colspan="5">quotative</td><td>–yu’ka</td><td rowspan="2">HEARSAY</td></tr>
<tr><td colspan="5">diffuse</td><td>–yu’ti</td></tr>
<tr><td rowspan="8">firsthand</td><td rowspan="6">external</td><td rowspan="5">direct</td><td rowspan="4">visual</td><td rowspan="2">1st</td><td>perf.</td><td>–i</td><td rowspan="4">VISUAL</td></tr>
<tr><td>impf.</td><td>–ha</td></tr>
<tr><td rowspan="2">non1st</td><td>perf.</td><td>–re</td></tr>
<tr><td>impf.</td><td>–ra</td></tr>
<tr><td colspan="3">nonvisual</td><td>koa-ta–</td><td>NONVISUAL</td></tr>
<tr><td colspan="4">indirect</td><td>–ri hi–</td><td>INFERENCE</td></tr>
<tr><td colspan="4" rowspan="2">internal</td><td>perf.</td><td>–a</td><td rowspan="2">ASSERTION</td></tr>
<tr><td>impf.</td><td>–ka</td></tr>
</table>

Figure 4.1 Kotiria evidentials (slightly adapted from Stenzel 2013:272)

delivering information from a secondary source, Kotiria speakers prefer to quote the speaker directly in a sentence with a finite speech verb *~di* [nĩ] ‘say’[9] and a fully finite sentential complement, thus preserving the original speaker’s choice of evidential (or other clause modality marker appropriate to the utterance).[10] In Kotiria, dependent clauses of all types have nonfinite (i.e., ‘evidential-less’) nominalized verbs. In (5), for instance, the subordinate clause has no evidential or other clause modality marking and is nominalized by *–~da*, which indicates coreferentiality with the first-person plural subject of the main clause.[11]

(5) *mari kherokã wa’aduana, wa’aka wʉria me’re.*
*~barí* *khé-ro-~ka* *wa’á-dua-**~da*** *wa’á-ka*
1PL.INC be.fast-SG-DIM go-DESID-(1/2)PL go-ASSERT.IMPF

*wʉ́-ria=~be’re*
fly-CLS:round.elongated=COM/INST
‘(When) we want to go (somewhere) quickly, we go by plane.’
(lit: We, wanting to go (somewhere) quickly, go by plane.)

[9] This is a generic speech verb that can refer to many different kinds of speech acts, e.g., ‘say,’ ‘order,’ ‘suggest,’ or ‘request,’ depending on the context. *~di* is moreover used for different types of internal speech, e.g., ‘think,’ ‘wonder,’ or ‘ask oneself’.

[10] The chapters by Sauerland and by Hollebrandse in this volume also point out the frequent use of recursive structures (complement clauses) with speech and ‘mental state’ verbs to describe or preserve the ‘propositional attitudes of others,’ and discuss interpretive shifts related to truth value as evidence of underlying contrasts between subordinating and coordinating clause relations. Similarly, Thomas’s chapter discusses imperative complements of reportative evidentials and verbs of reports and requests as instances of recursive ‘Speech Act Potentials,’ Such constructions also mediate the speaker’s commitment to the propositional content of the embedded element in that embedded directives are “asserted to hold of the subject of the embedding verb, rather than understood to hold of the speaker.”

[11] See also (20) and (21) below.

Moreover, there are no complementizers comparable to English 'when' in the free translation of (5), or to 'that' in English sentences such as 'I know *that* vegetables are good for me' and 'Mom said *that* I should always eat them.' Kotiria quoted speech sentences thus constitute a rare case of embedded 'clause modality' marking, because they have independent, finite-verb coding on both the matrix speech verb *~dí* 'say' and on whatever matrix verb occurs in the embedded speech clause. We can see this clearly in the sequence of quoted sentences in (6), from a Kotiria narrative, in which matrix and embedded clauses are marked.

(6) a. *"sa wa'awa'a hi'na" nimaa.*
[[***sá*** *wa'á-wa'a* ***~hí'da***] *~dí-~ba-**a***]
**EXRT** go-go **EXRT** say-FRUS-**ASSERT.PERF**
' "Let's get out of here!" (The mother) urged (her son, in vain).'

b. *"ñaina hira. mʉ'ʉre chʉri" nia.*
[[*~yá-~ida* *hí-**ra***] [*~bʉ'ʉ́-ré chʉ́-**ri.***] *~dí-**a***]
be.bad-NMLZ.PL COP-**VIS.IMPF.2/3** 2SG-OBJ eat-**ADMON** say-**ASSERT.PERF**
' "(These) are evil beings. Otherwise they'll eat you," (she) said.'

c. *"soro pahpekʉ niha" nia.*
[[*sóró* *papé-kʉ́* *~dí-**ha***] *~dí-**a***]
not.now play-(1/2)MASC be.PROG-**VIS.IMPF.1** say-**ASSERT.PERF**
' "Not now. I'm playing," (the son) said.'

The speaker in (6a) is a woman enjoining her son to escape with her from some dangerous beings that have appeared at their house, her sentence composed with the exhortative construction *sa … ~hi'da* 'Let's X.' Her first clause in (6b) is a statement of fact, marked by the VISUAL evidential *–ra* (non-first-person, imperfective), while the second is a warning, taking the admonitive suffix *–ri*.[12] When her son responds in (6c), he does so with the VISUAL evidential *–ha* (first-person, imperfective). Because these sentences are all lines from a traditional narrative, the speech verb *~di* 'say' itself consistently takes the perfective ASSERTION marker *–a*, the default suffix used in 'narrator' speech (see Section 2.3).

Directly quoted speech can also occur in day-to-day situations, the main difference being that the speech verb *~di* generally takes one of the VISUAL suffixes, as in (7), with the VISUAL perfective suffixes *–i* and *–re*. The speaker in (7) is explaining to a group of teachers and students how, urged by the Kotiria school director, José, and pedagogical consultant, Lucia, he came up with the drawing that was chosen to be their new logo. Each sentence of quoted speech

[12] The exhortative (6a), admonitive (6b), and imperative *–ga* (7b) are markers in the subcategory of 'directive' clause modality (Stenzel 2013:269).

has finite clause modality marking independent from the clause modality marking on the speech verb itself. (7a) is a question taking the speculative interrogative morpheme *–kari*, while (7b) is a directive with the imperative marker *–ga*.

(7) a. *Yʉ'ʉ, tiro Jose, Lucia ãnire: "Do'se bahuro yoabokari?" mari nii.*

| | | | |
|---|---|---|---|
| ***yʉ'ʉ́*** | *tí-ró* | ***Jose Lucia*** | ***~a=~dí-ri*** |
| 1SG | AN-SG | | so/thus=say-NMLZ |

| | | | | |
|---|---|---|---|---|
| **[[*do'sé*** | ***bahú-ro*** | ***yoá-bo-kari*]** | ***~barí*** | ***~dí-i*]** |
| Q | appear-SG | do/make-DUB-**SUPP** | 1PL.INC | say-**VIS.PERF.1** |

'I, Jose and Lucia (wondering/speculating): "What should (the logo) show?" we said (asked ourselves).'

b. *"yʉ'ʉre inventaga" nire.*

| | | |
|---|---|---|
| **[*yʉ'ʉ-re*** | **[*inventa*[13]*-ga*]** | ***~di-re*]** |
| 1SG-OBJ | invent/create-IMP | say-VIS.PERF.2/3 |

' "(You) come up with it," (they) said to me.'

Yet regardless of speakers' clear preference for quoted speech, HEARSAY evidential suffixes can still be easily elicited and their referential differences understood:

> *–yu'ka* is 'quotative' in nature (8a), while *–yu'ti* indicates a more 'diffuse' referent (8b).

(8) a. *tiro wʉ'ʉpʉ wa'ayu'ka*

| | | |
|---|---|---|
| *tí-ró* | *wʉ'ʉ́-pʉ́* | *wa'á-**yu'ka*** |
| AN-SG | house-LOC | go-**HSAY.QUOT** |

'He went home.' (The speaker has heard this from someone specific.)

b. *tiro wʉ'ʉpʉ wa'ayu'ti*

| | | |
|---|---|---|
| *tí-ró* | *wʉ'ʉ́-pʉ́* | *wa'á-**yu'ti*** |
| AN-SG | house-LOC | go-HSAY.DIFF |

'He went home.' (The speaker indicates rumor-like information from a nonspecific source.)

### *3.2 Visual*

Kotiria VISUAL suffixes (*–i*; *–ha*; *–ra*; *–re*) are the most frequently occurring evidential markers in everyday speech. They also display the greatest number of internal distinctions: agreement to first versus non-first-person subject, and

[13] An example of code-switching in which the Portuguese verb *inventar* 'invent/create' is suffixed by the imperative *–ga*.

imperfective versus perfective aspect.[14] From a functional/semantic perspective, VISUAL markers indicate that the speaker has experienced or has directly observed the event (9)–(12), though their use is also extended to statements of fact, as in (13).

(9) *yʉ'ʉse'e bu'ewa'a yoatii*
*yʉ'ʉ́-se'e bu'é-wa'a yoá-ati-**i***
1SG-CONTR study/learn-go do/make-IMPF-**VIS.PERF.1**
'(But/In contrast) I was always going away to study.'

(10) *mipʉre sã yakotiria yare bu'ena phiro wahcheha*
*~bí-pʉ́-ré ~sa=yá-ko-ti-ri-a yá-re*
now-LOC-OBJ 1PL.EXC.POSS=POSS-water-VBLZ-NMLZ-PL POSS-CLS:generic
*bu'é-~da phí-ro waché-**ha***
study-(1/2)PL be.big-SG be.happy-**VIS.IMPF.1**
'Now we're very happy to have our own Kotiria learning (writing system or school).'

(11) *õpʉ hira yʉ pho'na*
*~ó-pʉ́ hí-**ra** yʉ=~pho'dá*
DEIC.PROX-LOC COP-**VIS.IMPF.2/3** 1SG.POSS=children
'Here he (a missing dog) is, my sons.'

(12) *marire sõ'oi sĩ'a phitiboka du'tire*
*~barí-ré ~so'ó-í ~si'á phití-boka du'tí-**ré***
1PL.INC-OBJ DEIC.DIST-LOC torch COLL-meet request-**VIS.PERF.2/3**
'(Our father) asked us to meet (him) there with torches.'

(13) *phũria khʉariro hira tiro*
*~phurí-a khʉá-ri-ro hí-**ra** tí-ró*
poison-PL hold/have-NMLZ-SG COP-**VIS.IMPF.2/3** AN-SG
'It (a viper) is extremely poisonous.'

### *3.3 Assertion*

Like the VISUAL markers, ASSERTION markers (*–a*; *–ka*) are suffixed to the matrix verb and have distinct perfective and imperfective forms, with person distinctions neutralized. ASSERTION markers express reasoned suppositions as well as statements of fact based on the speaker's own previous experience or on

[14] As noted earlier, the aspectual distinctions in the VISUAL category qualify the speaker's relationship to the source of information rather than directly indicating temporal details of the event (Stenzel 2013:275–280).

shared cultural, historical, or physical knowledge of the world. The perfective suffix *–a* is the default evidential marker in myths and traditional narratives, e.g. (6) above and (14) below. The imperfective form occurs both in statements of general knowledge, such as (15), and to express the speaker's internal experiences and feelings (16) – although in most ET languages, NONVISUAL markers are used for this purpose.

(14) *phanopʉre hiatiga mahsayahkaina*

| | | |
|---|---|---|
| *~phadó-pʉ-re* | *hí-ati-**a*** | *~basá-yáká-~ídá* |
| do/be.before-LOC-OBJ | COP-IMPF-**ASSERT.PERF** | people-steal-NMLZ.PL |

'In the olden days there were people-stealers.'

(15) *mia wa'i dainakãre chʉka tiro*

| | | | | |
|---|---|---|---|---|
| *~bí-a* | *wa'í* | *dá-~ídá-~ká-ré* | *chʉ́-**ka*** | *tí-ró* |
| sardine-PL | fish | be.small-NMLZ.PL-DIM-OBJ | eat-**ASSERT.IMPF** | AN-SG |

'It (a bass) eats sardines (and) small fish.'

(16) *phũriyʉ'dʉaka*

*~phurí-yʉ'dʉ-a-**ka***

hurt-INTNSF-AFFEC-**ASSERT.IMPF**

'It hurts a lot.'

### 3.4 Inference

This evidential construction, shown in (17) and (18), indicates the speaker's conclusions about an event or state of affairs, based on observed results or consequences found in a specific context.

(17) *yʉ mahkʉre wãharokari hire*

| | | |
|---|---|---|
| *yʉ=~bak-ʉ́-ré* | *~wahá-roka-**ri*** | ***hí-re*** |
| 1SG.POSS=child-MASC-OBJ | kill-DIST-**NMLZ(INFER)** | **COP-VIS.PERF.2/3** |

'My son's been killed.'

Context: the speaker's son has gone off hunting and has failed to return at the expected time. The speaker infers the worst-case scenario.

(18) *ãyo tihpa wa'ari hira*

| | | | |
|---|---|---|---|
| *~a=yó* | *tipá* | *wa'á-**ri*** | ***hí-ra*** |
| so=do | be.flat | go-**NMLZ(INFER)** | **COP-VIS.IMPF.2/3** |

'So! This one (a basket) is (has been) flattened.'

Context: the speaker finds a basket pushed in on one side after being stored in an overstuffed closet.

### 3.5 *Nonvisual*

This construction indicates evidence from sensory sources other than sight, and is composed with serialized verbs *koa-ta* 'make.noise-come.' In Kotiria, use of the NONVISUAL generally indicates auditory evidence, as in (19).[15]

(19) *numia ña'aina taa nia koatara*

| | | | | |
|---|---|---|---|---|
| *~dubí-a* | *~ya'á-~ida* | *tá-á* | *~dí-a* | ***koá-ta-ra*** |
| woman-PL | catch-NMLZ.PL | come-(3)PL | be.PROG-(3)PL | **make.noise-come-VIS.IMPF.2/3** |

'Women-kidnappers are coming.'
Context: from inside the longhouse, the speaker hears a group of men approaching in the middle of the night on a bride-napping mission (the custom in former times).

## 4 Kotiria Firsthand Evidentials in Morphosyntactic Perspective

The information in Figure 4.1 and general descriptions in Section 2 have provided an overview of the semantic and functional features of each evidential category. We turn now to some additional observations that will help us look at the system from a more structural perspective.

First, though the Kotiria evidential system clearly presents five contrasting *semantic* categories, we should note that these five categories are actually coded by just two distinct morphosyntactic structures. The HEARSAY, VISUAL, and ASSERTION categories are coded by suffixes on the matrix verb (i.e., the final inflectional morphemes). In contrast, the NONVISUAL and INFERENCE categories are expressed by constructions involving embedding of the matrix verb as a nominalized complement to an auxiliary copula *hi* (for INFERENCE) or serialization *koa-ta* (for NONVISUAL). These verbal constituents are then marked as finite by a final suffix that can only be from the VISUAL or ASSERTION categories, as we see in (20)–(23), with auxiliary verbs and final suffixes indicated in bold, and nominalized complements surrounded by parentheses.[16]

[15] Serial verb constructions are extremely productive in Kotiria and are used to express a variety of adverbial (primarily spatial/directional), aspectual, and modal notions (discussed in detail in Stenzel 2007, 2013). In the NONVISUAL construction, the root *koa* is serialized with the motion verb *ta* 'come,' indicating cislocative directionality: that the sound or feeling comes *toward* the speaker from an external origin. While the initial root *koa* synchronically indicates general sensory (other than visual) information, it appears to have had the more specific semantics of 'make noise' in former times, with the construction grammaticalizing from a verbal root indicating 'the sound X makes' (Stenzel, in prep).

[16] The 'nominalized complement + aux. verb' structure occurs in several common constructions, including the highly productive 'progressive,' in (6c) and (19). Suffixes used to nominalize complement clauses agree with the person/number of the subject, except for INFERENCE, in which the complement takes the generic nominalizer –*ri*, given that focus is on a resultant state and/or affected patient, and the agent/cause in such contexts is generally unknown, making agreement impossible.

**NONVISUAL**

(20) *borasʉ̃ka'a wa'aro koataa*
*borá-~sʉ-ka'a* (*wa'á-**ro***) ***koá-ta-a***
fall-arrive-do.moving go-**(3)**SG **make.noise-come-ASSERT.PERF**
'He (the curupira, an evil creature) fell right down.'
Context: from inside a shelter, a man hears and feels the creature collapsing to the ground.

(21) *ã yoa tu'sʉ, pairore nʉnʉ wãharo, toi yairose'e tirore nʉnʉti ña'aro koatare.*
*~a=yoá tu'sʉ́ pá-iro-re ~dʉdʉ́ ~wahá-ro to-i*
so=do finish ALT-NMLZ.SG-OBJ follow/chase kill-(3)SG REM-LOC

*yai-ro-se'e tí-ró-ré ~dʉdʉ́-ati*
jaguar-SG-CONTR AN-SG-OBJ chase-IMPF

(*~ya'á-**ro***) ***koá-ta-re***
catch-**(3)**SG **make.noise-come-VIS.PERF.2/3**
'While (the dog) was out chasing another animal, a jaguar caught him.'
Context: a father and son hunting in the forest hear the sounds of their dog under attack.

**INFERENCE**

(22) *bayʉ'dʉkã wa'ari hia*
*bá-yʉ'dʉ-~ka* (*wa'á-ri*) ***hí-a***
decompose-INTNSF-DIM go-NMLZ(INFER) COP-ASSERT.PERF
'(The body) had decomposed completely.'
Context: four years later, the man (from example (20)) returns to the place where the dead creature's body had fallen and finds no remains.

(23) *yoatapʉ wihatu'sʉri hira*
*yóá=ta-pʉ* (*wihá-tu'sʉ-**ri***) ***hí-ra***
be.far=REF-LOC MOV.outward-finish-**NMLZ(INFER)** **COP-VIS.IMPF.2/3**
'They've just escaped.'
Context: the women-kidnappers (from example (19)) enter the longhouse and find only empty hammocks.

Since the four firsthand categories display just two basic structural patterns, we can reorganize some of the information from Figure 4.1 into a more structurally oriented representation, as in Figure 4.2, which calls attention to the direct or embedded nature of each category. VISUAL and ASSERTION stand out as the two basic, or 'core,' categories of firsthand evidence (whose morphemes occur directly affixed as finite-verb inflection), while NONVISUAL

Table 4.2 *Feature values for Kotiria firsthand evidential categories*

| | | |
|---|---|---|
| **VISUAL** | +sensory | +direct |
| **NONVISUAL** | +sensory | –direct |
| **INFERENCE** | –sensory | –direct |
| **ASSERTION** | –sensory | +direct |

| SOURCE OF FIRSTHAND KNOWLEDGE | CATEGORY<br>Direct<br>Embedded<br>(intransitive)<br>(transitive) | FORMS | | ASPECT/PERSON | |
|---|---|---|---|---|---|
| +sensory | **VISUAL** | | *–i*[17]*–ha* | perf.<br>impf. | 1st |
| | **NONVISUAL** | *V(–NMLZ) koa-ta* | *–re*<br>*–ra* | perf.<br>impf. | non1st |
| –sensory | **INFERENCE** | *V(–ri) hi* | *–a* | | |
| | **ASSERTION** | | *–ka* | perf.<br>impf. | |

Figure 4.2 Kotiria firsthand evidential categories: direct (VISUAL; ASSERTION) and embedded (NONVISUAL; INFERENCE)

and INFERENCE are clearly categories expressed by embedded complement constructions (involving auxiliary verbs themselves taking finite, core category morphology).

From this structural perspective, we are moreover able to propose an alternative and simpler (when compared to Figure 4.1) matrix by which we can identify each of the four firsthand categories. It is based on just two features: [±sensory], indicating the source of information, and [±direct], indicating the morphosyntactic coding means employed (–direct = 'embedded').

Taking the reassessment further, we arrive at the representation in Figure 4.3, which builds on the notion that the semantic features [±sensory] and [±direct] have structural reflexes. The [+direct] core categories (VISUAL and ASSERTION) emerge as the two basic categories of 'evidential aspect.' These share an

[17] First-person VISUAL suffixes cannot occur as the final markers in NONVISUAL or INFERENCE constructions.

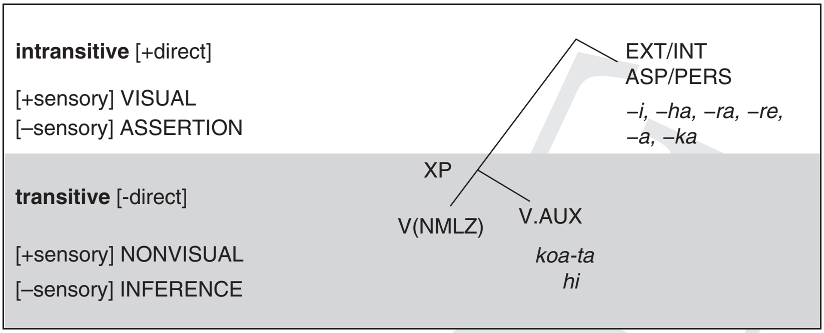



Figure 4.3 The transitive structure of Kotiria firsthand evidentials

underlying *transitive* structure that permits embedding of an XP complement through which additional semantic distinctions can be expressed. The VISUAL and ASSERTION categories (both [+direct] but distinguished by different values for the [±sensory] feature) are thus understood to reflect the simple, 'intransitive' aspectual values. The [-direct] 'embedded' categories (NONVISUAL and INFERENCE) represent the 'transitive' values, expressed by addition of an embedded complement. In other words, the 'intransitive' values of the two direct evidential aspectual categories, occurring as final suffixes on the matrix verb, return the default semantic readings related to the VISUAL or ASSERTION categories. The 'transitive' values, which ensure readings of NONVISUAL or INFERENCE evidentiality, are coded indirectly and require an internal argument in the shape of an embedded auxiliary verb+nominalized V construction, which itself still takes final core category morphology.

## 5 Discussion

Some preliminary answers to the questions posed earlier will now be presented. First, regarding evidentials as recursive constituents in Kotiria, we note that embedding is clearly a structural feature of the NONVISUAL and INFERENCE evidential constructions. Yet these do not exemplify the 'Russian doll' kind of *specific* recursion, in which a type X linguistic expression occurs within another type X expression. Rather, they constitute examples of *general* recursion, understood as concatenation within hierarchically embedded structures, cases in which "a complex syntactic object K [is] recursively defined into combinations of (smaller) syntactic objects (which may be complex or simplex)" (van der Hulst 2010:xxi).

Recursion in Kotiria evidentials should moreover be viewed in 'top-down' perspective, with embedding functioning to add detailed levels of description to already existing, more general categories (Harder 2010:237; Mithun 2010:35).

Thus, recursion is a resource for creating ever more “abstract relationships among events and ideas” (Mithun 2010:20). Embedding in the Kotiria system provides the means for deriving more semantically specific NONVISUAL and INFERENCE distinctions within the two basic [+direct] categories.

Two additional observations seem pertinent at this point. The first is that the recursion described here is qualitatively different from languages that allow repetition of the same evidential marker within a clause. Aikhenvald (2004:95–96) notes that such repetition may serve pragmatic purposes such as focus, or may signal particular discourse genres, an example being the reiterative use of the HEARSAY marker *ràki* in Karajá narratives, as we see in the small excerpt in (24).

(24)

| | | | | | |
|---|---|---|---|---|---|
| *Bydolyke* | ***ràki*** | *ijoi* | *r-a-hu-re* | *ijyy-my* | *ar-e-lyy-kre* |
| Pirarucu | **QUOT** | people | 3A-theme-finish-PAST | story-DAT | 1A-theme-tell-FUT |

| | | | | | |
|---|---|---|---|---|---|
| *Aõma* | ***ràki*** | *ijoi* | ***ràki*** | *waximy* | *rare* |
| Thus | **QUOT** | people | **QUOT** | to fish | went |

| | | | | |
|---|---|---|---|---|
| *Tai* | *ta* | ***ràki*** | *r-e-hemyny-re* | ***ràki*** |
| So | then | **QUOT** | 3A-theme-arrive-PAST | **QUOT** |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Tai* | *ta* | ***ràki*** | *bydolek* | *ràki* | *r-i-my-my* | *r-y-i-myhy* |
| So | then | **QUOT** | pirarucu | QUOT | 3A-theme-catch-SUB | 3A-theme-be-CONT |

| | | | |
|---|---|---|---|
| ***ràki*** | *r-i-my-my* | ***ràki*** | *r-y-i-myhy* |
| **QUOT** | 3A-theme-catch-SUB | **QUOT** | 3A-theme-be-CONT |

‘I will tell the story about the pirarucu which is said to have killed the people. So, it is said that the people (it is said) went fishing. So then, it is said, that they arrived (it is said). Then, it is said, that they were said to catch (the pirarucu). It is said that catching, it is said, they were.’ (Maia 2007:299)

Repetition of evidentials in these cases reinforces, rather than alters, the semantics of the markers. In contrast, the Kotiria embedding expands the evidential system from three contrastive categories to five.

A second, related observation is that the recursive process creating new, contrastive, categories within the Kotiria system is also qualitatively different from the full embedding that occurs with the speech verbs shown in (6), repeated as (25).

(25) a. *“sa wa’awa’a hi’na” nimaa.*

| | | | |
|---|---|---|---|
| [[***sá*** | *wa’á-wa’a* | ***~hí’da***] | *~dí-~ba-**a***] |
| **EXRT** | go-go | **EXRT** | say-FRUS-**ASSERT.PERF** |

‘“Let’s get out of here!” (The mother) urged (her son, in vain).’

b. *"ñaina hira. mʉ'ʉre chʉri" nia.*
[[*~yá-~ida* *hí-**ra***] [*~bʉ'ʉ́-ré chʉ́-**ri***] *~dí-**a***]
be.bad-NMLZ.PL COP-**VIS.IMPF.2/3** 2SG-OBJ eat-**ADMON** say-**ASSERT.PERF**
'"These are evil beings. Otherwise they'll eat you," (she) said.'

c. *"soro pahpekʉ niha" nia.*
[[*sóró* *papé-kʉ́* *~dí-**ha***] *~dí-**a***]
not.now play-(1/2)MASC be.PROG-**VIS.IMPF.1** say-**ASSERT.PERF**
'"Not now. I'm playing," (the son) said.'

In each line, the speech verb is fully finite (evidentially marked) and has as its complement a quoted-sentence that is equally finite (having evidential or other clause modality marking, e.g. the admonitive *–ri* in (25b)). Such sentences represent the sole instance 'α within α' type recursion, constructs with one evidentially marked sentence occurring within another.

Numerous examples of quoted speech occur in Kotiria narratives and the speech verb invariably takes the default evidential marker *–a* ASSERTION perfective that marks 'narrator' speech and other kinds of shared cultural knowledge. Future investigation of quoted speech in day-to-day interaction, as in (7), will show what kinds of semantic nuances result when other evidential category markers occur on speech verbs, and what kinds of perspective 'shift' may occur in such constructions (cf. Sauerland and Schenner 2006).

Further considering evidential marking in everyday speech, recall that VISUAL suffixes are the most common, being either the sole markers in clauses (their 'intransitive' use) or the final suffixes in more complex INFERENCE and NONVISUAL ('transitive') constructions. This leads us to question whether, particularly in the latter case, they undergo semantic 'bleaching' of their default value of 'visual/direct sensory' source of information. Indeed, it might seem strange for VISUAL suffixes to occur in constructions specifically indicating NONVISUAL evidence; yet we should not let labels confuse us. When VISUAL suffixes are the sole markers on a verb, they indicate 'visual' or 'directly experienced' evidence, the default interpretation of their core semantics and unmarked value within the wider domain of sensory evidence. When these same suffixes occur in other evidential constructions, such as the marked NONVISUAL, they still code general sensory evidence, but their specific visual base is bleached, bringing their perfective/imperfective aspectual values to the fore (Stenzel 2013:283).[18]

[18] Some analyses of East Tukano languages propose VISUAL as an 'unmarked' evidential category. Gomez-Imbert (2007:66–67) attributes a Ø value for 'visual' in Tatuyo, this being merely the default reading for direct sensory evidence. Silva (2012:256) presents a similar analysis of Desano; see also discussions of visuals in Tariana [Arawak] (Aikhenvald 2003:293–96) and Hup [Nadahup] (Epps 2005: 623–25), languages in the same geographic region.

Although VISUAL suffixes are the most frequent verb-final markers, even in both types of 'transitive' evidential constructions, we should recall that ASSERTION suffixes also occur. In Section 2.3, we saw that the ASSERTION perfective *–a* is the default marker of narrator speech, and there is no evidence that it has any particular semantic effect when combined with either of the transitive category constructions. This semantic 'neutrality' contrasts with use of the ASSERTION imperfective *–ka* (one function of which is to express the speaker's feelings). When this suffix is the final marker in an INFERENCE construction, such as (26), it constitutes another semantic resource: to express 'mirativity,' that is, surprise or recognition of a cognitive situation that "is new to the speaker, not yet integrated into his overall picture of the world" (DeLancey 1997:36).

(26) *yʉ'ʉ khãriyʉ'dʉa wa'ari hi'ka*

| | | | |
|---|---|---|---|
| *yʉ'ʉ́* | *~kharí-yʉ'dʉ-a* | *wa'á-**ri*** | ***hí-ka*** |
| 1SG | sleep-INTNSF-AFFEC | go-**NMLZ(INFER)** | **COP-ASSERT.IMPF** |

'I've been asleep a long time!'
Context: the speaker is a 'dead' creature (the same mentioned in (17)) that has been magically revived and restored to consciousness.

This is an additional example of how embedding and diverse combinations of markers drawn from within a finite system are used to express increasingly fine-grained semantic nuances. Such cases reinforce van der Hulst's observation that syntactic and conceptual complexity can mirror each other, and that syntax can use recursive structures to "express complex thoughts which themselves display this kind of combinatorial capacity" (van der Hulst 2010:xxii).

We can also hypothesize, based on crosslinguistic studies of grammaticalization of evidentials (see Anderson 1986; de Haan 2001b), that Kotiria's two transitive categories, NONVISUAL and INFERENCE, are likely recent additions. Anderson (1986:275), among others, notes that INFERENCE markers often derive historically from 'perfects,' and the Kotiria INFERENCE construction indicates this path of development. As for the NONVISUAL, we observe a synchronic process of reanalysis from a clearly recognizable lexical source (see note 15). Both transitive categories not only require more phonological material in their expression than markers of the intransitive categories, but their lexical origins are still recognizable and we see evidence of semantic extension and bleaching. The core (i.e., intransitive) evidential categories, on the other hand, are expressed by suffixes that in some cases fuse information from several grammatical categories, and their original sources, whether lexical or grammatical, are no longer recoverable. Considering the parameters of grammaticalization proposed by Heine and Kuteva (2005:15), which include reanalysis and extension of grammatical meaning, semantic bleaching, and phonetic reduction, we can assume the system to be composed of older and more recently emerged categories with different paths of development.

Nevertheless, we should recognize that the Kotiria system imposes inherent limits, in that only a certain number of combinations are actually possible. This leads us to the second question posed earlier, relating underlying structure to how the evidential system appears to have developed. I have proposed that in Kotiria, the firsthand evidential categories have an underlying transitive structure (Figure 4.3). This structure allows embedding, thus creating combinatory possibilities that permit the expression of both older core and additional, newer, and more refined, evidential notions. However, this same transitive structure limits embedding to a single hierarchical level, thus blocking the development of an unending stream of new categories, at least by way of embedding. The number of possible derivable semantic distinctions is further constrained by the fact that the array of available markers is also finite.[19] In all, we appear to find a plausible link between structure and semantics that contributes to our understanding of how the five-category Kotiria evidential system has been progressively shaped.

It is moreover notable that observations of how structure constrains the Kotiria system complement crosslinguistic analyses of the semantic composition of evidential categories and the conceptual primitives that underlie them. We find that multi-valued systems tend to express similar core category semantics related to three basic kinds of evidence: Direct/Attested, Indirect/Reported, and Indirect/Inferred, each with possible subdivisions similar to those observed in Kotiria (Willett 1988; Plungian 2001; Aikhenvald 2004). Indeed, though many languages have a large repertoire of optional evidential and often related epistemic markers, languages with obligatory evidential coding tend to stay within a five-to-six category limit. Aikhenvald (2004:60–66) notes few languages with more than five categories: Foe (Kutubuan, Papua New Guinea), described as having six categories, and Central Pomo (Pomoan, California), with seven. Among Amazonian languages, six categories – with strikingly similar semantics to the categories found in Kotiria – is also the noted upper limit (Aikhenvald 2012:249).

Indeed, the Kotiria data suggest that we need to look more closely at how languages with obligatory evidential marking end up encoding these distinctions. We know that evidential categories can arise from diverse sources and at different points during a language's diachronic development; thus, we should not expect to find exact parallels to the Kotiria system – even within the same language family. Nonetheless, it would be interesting to see if the structural limitations observed in Kotiria are somehow mirrored in other languages. Obviously, not all languages use embedding as a strategy for coding evidential

[19] I am grateful to Cilene Rodrigues (personal communication) for pointing out the parallel between this observation and the conclusions presented in Hale and Keyser (1993) regarding universal limitations on the number of thematic roles.

categories, but the Kotiria system shows that embedding is certainly one of the structural resources available to languages to express evidential meanings within what appears to be a universally limited set of semantic distinctions.

This chapter has examined embedding as a structural component of evidential categories in Kotiria (Wanano), an ET language of northwestern Amazonia. Earlier studies of Kotiria evidentiality emphasized the functional distinctions of its five semantically contrastive categories, four of which express types of firsthand evidence. Shifting attention to the structural means used to express these four categories, this study shows that embedding is a strategy by which more fine-grained evidential meanings emerge within a general [±sensory] distinction. It proposes two underlying types of evidential aspect, characterized by the features [±sensory] and [±direct], and argues that both share the same underlying transitive structure from which the four firsthand categories are morphosyntactically derived: two by means of direct suffixation (the 'intransitive' values) and two by way of embedding (the 'transitive' values). It concludes that while there is no specific recursion involving evidential markers, general recursion occurs as a means for developing more detailed semantic notions. However, it also points out that two features inherent to the system establish constraints on the number of derivable distinctions: a single hierarchical level of embedding and a limited number of morphological markers. The resulting combinatory possibilities allow for a set of evidential distinctions that, taken as a whole, reflect the general semantic primitives attested for evidentials crosslinguistically.

# 5 Embedded Imperatives in Mbyá

*Guillaume Thomas*

## 1 Introduction

This chapter discusses the interpretation of embedded imperatives in Mbyá, a Tupi-Guaraní language spoken in Argentina, Brazil, and Paraguay.[1] It contributes to the description of recursive structures in Tupi-Guaraní languages, which are well represented in this volume, with contributions by Duarte, Vieira, and Lima and Kayabi. Vieira gives an inventory of recursive structures in Tupinambá and Mbyá Guaraní, which include recursive embedding of clauses under verbs with sentential complements, recursive embedding of causative morphemes, and recursive possessive marking. Clausal subordination and possessive recursion are also discussed respectively by Duarte in Tenetehára and by Lima and Kayabi in Kawaiwete. I argue that the embedding of imperatives in Mbyá is an instance of recursive embedding of ForceP, the projection of a Force head located in the left periphery of the clause, which encodes information that constrains the illocutionary force of utterances of the sentence. The focus of the present study on speech reports and reportative evidentials also makes it relevant to another set of studies in this volume, united by their attention to recursion in the expression of speech and/or attitude reports and composed of the contributions by Hollebrandse, Sauerland, Correa et al. and Stenzel.

## 2 Embedded Imperatives in Mbyá

### *2.1 Overview of the Phenomenon*

As the following examples illustrate, Mbyá imperatives such as (1) are attested in construction with the reportative evidential *je* and as complements of the verbs *he'i* ('say') and *jerure* ('ask to'):[2]

[1] Many thanks to the Mbyá consultants who made this work possible. For comments and criticism, I am grateful to Salvador Mascarenhas, Philippe Schlenker, Benjamin Spector, Yasutada Sudo, and the audience at presentations at the Institut Jean Nicod, Sinfonija 5 in Vienna, NELS 43 in New York and the workshop on Recursion in Brazilian languages in Rio. All errors are mine.

[2] For a discussion of the place of clausal subordination in recursive structures in Guarani Mbyá, see Vieira, this volume.

(1)

| | | |
|---|---|---|
| | E-me'ẽ | ka'ygua. |
| | 2.SG.IMP-give | mate. |

'Give the mate!'[3]

(2)

| | | |
|---|---|---|
| E-me'ẽ | ka'ygua | je. |
| 2.SG.IMP-give | mate | EVID. |

'Give the mate (I heard)!'

(3)

| | | | |
|---|---|---|---|
| Aureliano | he'i | e-me'ẽ | ka'ygua. |
| Aureliano | 3.say | 2.SG.IMP-give | mate |

'Aureliano said give the mate.'

(4)

| | | | |
|---|---|---|---|
| Aureliano | o-jerure | e-me'ẽ | ka'ygua. |
| Aureliano | A3.ask-to | 2.SG.IMP-give | mate. |

'Aureliano asked you to give the mate.'

Imperatives cannot be embedded under verbs other than *he'i* and *jerure*. The following list of verbs was tested and it was confirmed that they are ungrammatical with imperative complements:

(5) *Porandu* ('ask wh-'), *kuaa* (know), *rovia* ('believe'), *pota* ('want'), *eja* ('let').

(6)

| | | | |
|---|---|---|---|
| *Felipe | o-ikuaa/o-guerovia | e-me'ẽ | ka'ygua. |
| Felipe | A3-know/A3-believe | 2.SG.IMP-give | mate. |

(7)

| | | | | |
|---|---|---|---|---|
| *Felipe | o-eja | e-me'ẽ | ka'ygua | (aguã). |
| Felipe | A3-let | 2.SG.IMP-give | mate | (PURP). |

(8)

| | | | | |
|---|---|---|---|---|
| *Felipe | o-porandu | e-me'ẽ | (pa) | ka'ygua. |
| Felipe | A3-ask | 2.SG.IMP-give | (Q) | mate. |

Embedded imperatives have received some attention recently. It had been claimed that imperatives cannot be embedded (see Han 1998; Katz and Postal 1964; Palmer 1986; Platzack and Rosengren 1997; Rivero and Terzi 1995; Sadock and Zwicky 1985). This generalization was explained by analyzing imperatives as a clause type associated with directive speech acts, and making the hypothesis that speech acts cannot be embedded for semantic reasons. More recently, however, new cross-linguistic investigations have revealed that embedded imperatives are attested in a variety of languages, including Mandarin (Chen-Main 2005), Slovenian (Rus 2005), and English (Crnič and Trinh 2009). For a recent overview of this debate, see Kaufmann (2014).

[3] Mate is a drink prepared by steeping dried leaves of Yerba Mate in hot water; a *ka'ygua* is a gourd that is used to drink mate.

### 2.2 *Fieldwork Practices*

The Mbyá data for this chapter were elicited in the Mbyá community of Kuña Piru in the province of Misiones, Argentina, during two field trips (winter 2012/2013, and winter 2011/2012). I worked with three consultants: Aureliano Duarte, Cirilo Duarte, and Germino Duarte.

Elicitation sessions were conducted in Spanish, without the intervention of a translator. All three consultants were fluent in Mbyá and in Spanish. They were native speakers of Mbyá who had been schooled in Spanish (primary and secondary education, and vocational training) and used Spanish in their professional lives.

The research presented in this chapter is based on three tasks: elicitation of judgments of acceptability of sentences, elicitation of judgments of well-formedness on discourses, and elicitation of judgments of truth-value, following the methodology of Matthewson (2004).

Before each elicitation session, the consultants gave their consent for the elicitation session to be recorded and/or transcribed, as well as for the resulting data to be used in scientific conferences and publications.

The orthography that was used for the data I elicited is the one that is *de facto* used in Misiones, in written publications in Mbyá. Mbyá examples taken from publications or scientific articles are reproduced with the original orthography.

## 3 Distribution of Embedded Imperatives

### 3.1 *Imperatives*

Mbyá verbs agree in person and number with their arguments following a split-S system (Dooley 2006). Agreement markers are prefixed to the verb root. Imperatives have a defective agreement paradigm, which is restricted to singular and plural second person subjects. Only the singular agreement is specific to the imperative mood, as illustrated in the following table:

(9) *-me'ẽ* ('to give'), indicative mood vs imperative mood:

| Person/Number | Indicative | Imperative |
|---|---|---|
| 1.SG | A-me'ẽ | |
| 2.SG | Re-me'ẽ | E-me'ẽ |
| 3.SG/PL | O-me'ẽ | |
| 1.INCL.PL | Ña-me'ẽ | |
| 1.EXC.PL | Ro-me'ẽ | |
| 2.PL | Pe-me'ẽ | Pe-me'ẽ |

This defective verb form has a number of semantic properties that motivate its description as an imperative mood (see Kaufmann 2011 for a discussion of characteristic properties of imperatives). First, one cannot challenge an imperative by denying its truth, as illustrated by the following examples:

(10) A: E-me'ẽ ka'ygua Aureliano pe.
2.SG.IMP-give mate Aureliano to.
'Give the mate to Aureliano.'

B: # Añete-'ỹ.
true-NEG
# 'That's not true.'

In this respect, imperatives contrast with universal deontic statements formed with the modal operator *va'erã:*

(11) A: Re-me'ẽ va'erã ka'ygua Aureliano pe.
A2.SG-give must mate Aureliano to.
'You must give the mate to Aureliano.'

B: Añete-'ỹ.
true-NEG
'That's not true.'

Secondly, the use of an imperative is infelicitous when the speaker does not want the addressee to perform the action that is described by the imperative. Here again, the restriction applies to imperatives but not to universal deontic statements:

(12) #E-me'ẽ ka'ygua Aureliano pe, va'eri nd-a-ipota-i re-me'ẽ
ka'ygua
2.SG.IMP-give mate Aureliano to but NEG-A1.sg-want-NEG A2.sg-give
mate
ichupe.
him.to
# 'Give the mate to Aureliano! But I don't want you to give him the mate.'

(13) Re-me'ẽ va'erã ka'ygua Aureliano pe, va'eri nd-a-ipota-i re-me'ẽ
A2.SG-give must mate Aureliano to but NEG-A1.sg-want-NEG A2.
sg-give
ka'ygua ichupe.
mate him.to
'You must give the mate to Aureliano, but I don't want you to give him the mate.'

Likewise, the use of an imperative is infelicitous when the speaker does not have the authority to direct the addressee to perform the action it describes, contrary to universal deontic statements:

(14) # E-me'ẽ ka'ygua, va'eri nd-a-ikuaa-i re-me'ẽ va'erã pa.
2.SG.IMP-give mate but NEG-A1.SG-know-NEG A2.sg-give FUT Q
# 'Give the mate, but I don't know if you will give it.'

(15) Re-me'ẽ va'erã ka'ygua, va'eri nd-a-ikuaa-i re-me'ẽ va'erã pa.
A2.SG-give must mate but NEG-A1.SG-know-NEG A2.SG-give FUT Q
'You must give the mate, but I don't know if you will give it.'

Finally, imperatives can be used to perform different kinds of directive speech acts beyond orders, such as invitations and permissions:

(16) Context: When you visit someone at their place, they usually invite you to sit down:
E-guapy.
2.SG.IMP-sit
'Sit down.'

(17) E-ka'y-'u, re-ka'y-'u-che vy.
2.SG.IMP-mate-drink A2.SG-mate-drink-want SS
'Drink some mate, if you want to.'

### *3.2 The Reportative Evidential je*

The particle *je* is a reportative evidential. The use of *je* indicates that the evidence that supports the speaker's utterance is hearsay. In the absence of hearsay evidence, or if the speaker has direct evidence to support his utterance, the use of *je* is infelicitous:

(18) Juan o-jau je.
Juan A3-bathe EVID
'Juan was bathing (I heard).'

(19) Felicity of (18) in various contexts:
a. The addressee's brother asks him: "Where was Juan this morning?" The addressee didn't see Juan, but his wife told him that Juan was bathing at the lake. FELICITOUS
b. This morning, the addressee went to the lake and he saw Juan bathing. During the afternoon, his brother asks him "Where was Juan this morning?" INFELICITOUS

Reportative evidentials have been analyzed either as epistemic modals or as illocutionary modifiers (see e.g., Faller 2002, 2007, 2011; Matthewson 2007, 2012; Murray 2010; Peterson 2010; see also section 5.3). I will discuss three facts that support an analysis of *je* as an illocutionary modifier.

First, *je* is felicitous when the speaker knows that the prejacent is false:

(20) Maria o-menda je, va'eri chee nd-a-rovia-i.
Maria A3-marry EVID, but I NEG-A1.SG-believe-NEG
'Maria got married, I heard, but I don't believe it.'

(21) Maria o-menda je, va'eri a-ikuaa n-o-menda-i-a.
Maria A3-marry EVID, but A1.SG-know NEG-A1.SG-marry-NEG-NMLZ
'Maria got married, I heard, but I know she didn't get married.'

Secondly, *je* is not embeddable in complements of verbs of attitude and in antecedents of conditionals:

(22) A-ikuaa Maria o-menda-a.
A1.SG-know Maria A3-marry-NMLZ
'I know that Maria got married.'

(23) *A-ikuaa je Maria o-menda-a.
A1.SG-know EVID Maria A3-marry-NMLZ
Intended: 'I know that (I heard) Maria got married.'

(24) *A-ikuaa Maria je o-menda-a.
A1.SG-know Maria EVID A3-marry-NMLZ EVID.
Intended: 'I know that (I heard) Maria got married.'

The following examples show that *je* is unacceptable in the antecedent of a conditional. The unacceptable sentence in (25a) should be compared to the acceptable sentence (25b), whose meaning is similar to the intended interpretation of (25a). In (25b), the so-called impersonal form *hea* ("someone said") of the verb of report *he'i* (Dooley 2006) is used, rather than the reportative evidential, in order to convey hearsay. (25a) should also be compared to (26), which shows that the conditional without the reportative evidential *je* is well formed.

(25) Context: The speaker's father told him that he killed a jaguar yesterday (which is illegal), and that no one had seen him. But today the speaker can hear people saying that his father killed a jaguar.

a. *Che-iru o-juka je ramo jaguarete, mava'erã o-echa ra'e.
B1.SG-father A1.SG-kill EVID DS jaguar, someone A3-see MIR
Intended: 'If someone said that my father killed a jaguar, someone must have seen him.'

b. Hea ramo che-iru o-juka-a jaguarete, mava'erã
say.IMPRS DS B1.SG-father A1.SG-kill-NMLZ jaguar, someone
o-echa ra'e.
A3-see MIR
'If someone said that my father killed a jaguar, someone must have seen him.'

(26) Che-iru o-juka ramo jaguarete, mava'erã o-echa ra'e.
B1.SG-father A1.SG-kill DS jaguar, someone A3-see MIR
'If my father killed a jaguar, someone must have seen him.'

Finally, utterances modified by *je* cannot be felicitously challenged by denying that the speaker heard that the prejacent was true:

(27) Aureliano o-ĩ je Aristobulo py.
Aureliano A3-be EVID Aristobulo LOC
'Aureliano is in Aristobulo, I heard.'

Anhete'ỹ! #O- ĩ, va'eri mava'eve n-o-mombe'u-i ndevy pe!
false A3-be but nobody NEG-A3tell-NEG you to
'That's false! #He is, but nobody told you this!'

The first of the two aforementioned tests shows that the speaker is not committed to believing the propositional content of the reported utterance, so much so that she might even believe its negation. This is expected if *je* is an illocutionary modifier that conveys that the person who is responsible for the speech act is neither the speaker nor the addressee but a third individual, as proposed by Faller (2002) for the Quechua reportative evidential *–si*. On the contrary, if *je* was a universal epistemic modal with a realistic modal base, denying the truth of the propositional content would be contradictory.

The second of these tests only shows that *je* cannot be embedded under verbs of attitudes and in the consequent of conditionals. This is expected if *je* is an illocutionary operator (i.e., a modifier of speech act potentials, SAPs) and is unattested in these environments for type theoretic reasons: complements of verbs of attitude and antecedents of conditionals must denote propositions, and SAPs do not have the type of propositions.

The third test shows that the evidential contribution of *je* cannot be challenged directly, which is expected if *je* is an illocutionary operator that does not affect the propositional content of the speech acts it modifies.

Interestingly, *je* can be embedded in the complement of the verb of report *he'i*, which as we have seen also embeds imperatives. In such contexts, *je* does not constrain the evidential base of the utterance. For instance, (28) is felicitous even if the speaker has direct evidence that Juan said that Maria got married (i.e., he was there when Juan said that):

(28) Juan he'i je Maria o-menda-a.
Juan A3.say EVID Maria A3-marry-NMLZ
'Juan said that Maria got married.'

The effect of *je* on the reported assertion remains to be investigated (one outstanding question is whether *je* indicates that Juan had indirect hearsay evidence that Maria got married). If *he'i* can select a complement that denotes a SAP, and *je* is a SAP modifier, then it is expected that *je* can occur in its complement.

### *3.3 Embedded Imperatives are not Quotations*

Let us now convince ourselves that Mbyá embedded imperatives are not quotations. A first piece of evidence is that there is no indexical shifting in these constructions. Imagine that a speaker (Aureliano) says (29) to Germino in the presence of Cirilo, but Germino does not hear it.

(29) E-me'ẽ ka'ygua Cirilo pe.
2.SG.IMP-give mate Cirilo to
'Give the mate to Cirilo.'

Cirilo could report (29) to Germino using (30a) or (30b). This shows that the first person pronoun in the embedded imperative has not shifted, i.e., is not interpreted as in a quotation.

(30) a. E-me'ẽ je ka'ygua chevy pe.
2.SG.IMP-give EVID mate me to
'Give me the mate, I heard.'

b. He'i e-me'ẽ ka'ygua chevy pe.
3.say 2.SG.IMP-give mate me to
'He said give me the mate.'

A second piece of evidence is that a quantifier can bind a pronoun in an imperative used as the complement of *he'i*. If three speakers each say (31) to the addressee, but she does not hear it, another speaker can report it to her as in (32):

(31) E-me'ẽ ka'ygua chevy pe.
2.SG.IMP-give mate me to
'Give me the mate.'

(32) Ha'ejavive he'i e-me'ẽ ka'ygua ichu pe.
everyone 3.say 2.SG.IMP-give mate him to
'Everyone said give him the mate.'

## 4 Interpreting Embedded Imperatives

In Section 3.1 we observed that matrix imperatives are infelicitous when the speaker does not want the addressee to perform the action described by the imperative, or when the speaker has no authority over the action. Interestingly, these properties are not shared by embedded imperatives, in the sense that the speaker does not have to desire that the action be performed, nor must she have authority over it. This is shown by the felicity of the following sentences:

(33) E-me'ẽ je chevy pe ka'ygua, va'eri nd-a-ipota-i.
2.SG.IMP-give EVID me to mate, but NEG-A1.SG-want-NEG
'Give me the mate, I heard, but I don't want it.'

(34) He'i e-me'ẽ chevy pe ka'ygua, va'eri nd-a-ipota-i.
3.say 2.SG.IMP-give me to mate, but NEG-A1.SG-want-NEG
'She/he said give me the mate, but I don't want it.'

(35) E-me'ẽ je ka'ygua, va'eri nd-a-ikuaa-i re-me'ẽ va'erã pa.
2.SG.IMP-give EVID mate but NEG-A1.SG-know-NEG A2.SG-give must Q
'Give the mate, I heard, but I don't know if you have to give it.'

(36) He'i e-me'ẽ ka'ygua, va'eri nd-a-ikuaa-i re-me'ẽ va'erã pa.
3.say 2.SG.IMP-give mate but NEG-A1.SG-know-NEG A2.SG-give must Q
'He said give the mate, but I don't know if you have to give it.'

This does not mean that there are no constraints on embedded imperatives however; the author of the imperative that is being reported is still subject to these requirements, as the next examples demonstrate:

(37) #Aureliano he'i e-me'ẽ ichu pe ka'ygua, va'eri nd-o-ipota-i.
Aureliano 3.say 2.SG.IMP-give him to mate, but NEG-A3-want-NEG
'Aureliano said give him the mate, but he doesn't want it.'

(38) #Aureliano he'i e-me'ẽ ka'ygua ichu pe, va'eri nd-o-ikuaa-i re-me'ẽ va'erã pa.
Aureliano 3.say 2.SG.IMP-give mate him to but NEG-A1.SG-know-NEG A2.SG-give must Q
'Aureliano said give him the mate, but he doesn't know if you have to give it.'

Imperatives embedded under *he'i* or *jerure* and *je* differ with respect to the encoding of the recipient of the reported speech act. When reporting an imperative with *je*, the recipient of the reported directive speech act has to be the addressee of the reported speech act. To illustrate, assume that Aureliano says (39) to Germino, in the presence of Cirilo and Vera:

(39) E-me'ẽ ka'ygua Cirilo pe.
2.SG.IMP-give mate Cirilo to
'Give the mate to Cirilo.'

If Germino and Vera did not hear what Aureliano said, Cirilo can report it to Germino as (40). However, (40) would be infelicitous as a report of (39) to Vera, since in that case Vera would interpret incorrectly that she was the recipient of Aureliano's order. In sum, when reporting an imperative with *je*, the addressee of the reported utterance is understood to be the same as the addressee of the reporting utterance.

(40) E-me'ẽ je ka'ygua.
2.SG.IMP-give EVID mate
'Give the mate (I heard)!'

When reporting an imperative with *he'i* or *jerure*, the identity of the addressee of the reported utterance can be specified by the indirect object of the embedding verb. In the absence of indirect object, it is understood that the addressee of the reported utterance is the same as the addressee of the reporting utterance. Let us illustrate. Assume that Aureliano said (41) to Vera, in the presence of Cirilo and Germino:

(41) E-me'ẽ ka'ygua Cirilo pe.
2.SG.IMP-give mate Cirilo to
'Give the mate to Cirilo.'

If Germino and Vera did not hear what Aureliano said, Cirilo can report it to Germino as (42). Reporting it to Germino as (43) would be infelicitous, since Germino would then assume that Aureliano's order was directed to him. However, Cirilo can use (43) to report (41) to Vera:

(42) Aureliano he'i Vera pe e-me'ẽ ka'ygua.
Aureliano 3.say Vera to 2.SG.IMP-give mate
'Aureliano said to Vera give the mate!'

(43) Aureliano he'i e-me'ẽ ka'ygua.
Aureliano 3.say 2.SG.IMP-give mate
'Aureliano said give the mate!'

## 5 Embedding Speech Act Potentials

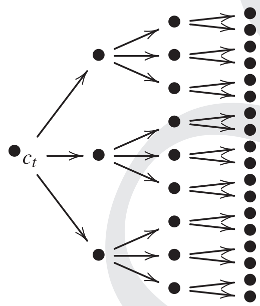
In this section, I present Krifka's analysis of SAPs and their embeddings (Krifka 2014), and I will propose an analysis of *je* as a speech act modifier in this framework.

## *5.1 Speech Act Potentials*

We begin with the definition of the model frames in which linguistic expressions are interpreted. The formalism follows Krifka (2014), with some minor modifications for the sake of simplicity. There are four basic types: individuals (objects and events, *e*), truth-values (true and false, *t*), indices (world/time points, *s*) and contexts (identifying speaker $c_s$, addressee $c_a$, and utterance time $c_t$; type symbol *c*). Functional types are defined from these basic types in the usual way.

A model contains a set of entities *E* and a set of indices *I*. *I* is ordered by a relation of precedence ≤, which is not linear but generates a tree structure: ≤ is transitive, reflexive, and left linear. A maximal subset *I′* of *I* that is linear is called a history. In the following set of indices, there are eighteen different histories. An option space is a rooted set of histories:

(44) A set of indices with eighteen histories:



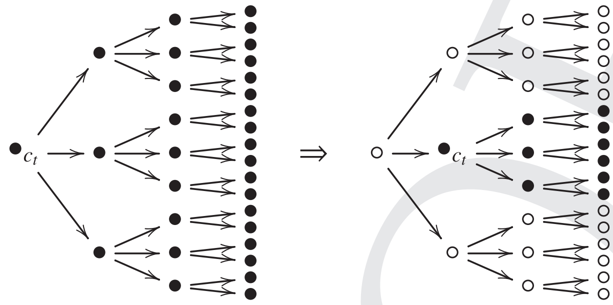

A context *c* is a triple $<c_s, c_a, c_t>$ where $c_s$ is a speaker, $c_a$ is an addressee, and $c_t$ is an index of utterance. A common ground *CG* is a set of contexts.[4] Note that every index of utterance is the root of an option space such as (44), which represents its possible future histories, and is at the end of a linearly ordered set of indices, which represents its past.

A proposition is a function from indices to truth-values, as we might expect. A speech act, however, is a function from indices to indices. Let us assume that the performance of a speech act *A* by a speaker $c_s$ can be analyzed as an action in which $c_s$ takes up certain commitments *C* with the addressee $c_a$ as a witness. We may represent the performance of A in an option space as a mapping from an old index of utterance in which it is not the case that some individual *a* has commitments *C* with *b* as a witness, to a new index of utterance in which *a* is the speaker $c_s$, *b* is the addressee $c_a$, and

[4] Here, I am departing slightly from Krifka's terminology.

it is true that $c_s$ has commitments $C$ with $c_a$ as a witness. This is represented in the following diagram:

(45) A speech act is an update of the context that moves every utterance index forward in its option space:



This movement from indices to indices is defined with the auxiliary notion of index incrementation in (46):[5]

(46) For any indices $i$ and $i'$, $i'$ is the incrementation of $i$ with condition $F$ $(i < i'[F(i')])$ if and only if:

$i \leq i'$ and

$F(i')$ and

$\forall i''[i \leq i'' < i' \rightarrow \neg F(i'')]$ and

for all formulas $G$ such that $F$ and $G$ are logically independent:

$\forall i'', i'''[(i \leq i'' \leq i \wedge i \leq i'' \leq \mathrm{i}) \rightarrow G(i'') = G(\mathrm{i}''')]$

i.e., $i < i'$, and $i'$ is maximally like $i$ with the exception that $F$ is true of $i'$.

We may now define a SAP as a function that maps a speaker $x$, an addressee $y$ and an index $i$ to an index $i'$ that increments $i$ with some condition relating $x$ and y:

(47) $\lambda y.\ \lambda x.\ \lambda i.\iota i'[i \leq i'[F(x)(y)(i')]]$

A speech act results from the update of a common ground $CG$ with a SAP $A$:

(48) $CG + A = \{<c_s, c_a, A(c_a)(c_s)(c_t)> \mid <c_s, c_a, c_t> \in CG\}$

## *5.2 Illocutionary Operators*

The analysis of speech acts in terms of SAPs must include a theory of the conditions that different types of speech acts impose on indices: how does the

[5] I will assume that time is discrete. This makes things simpler, but it is not a necessary assumption.

world change when an assertion or an order is issued, and how can we capture this change propositionally using the notion of index incrementation?

Krifka represents the index change characteristic of specific speech acts with dedicated illocutionary predicates, such as ASSERT for assertion. These predicates are part of the denotation of illocutionary operators, which are defined as functions from propositional contents to SAPs. In (49), an illocutionary operator ASSERT is defined in terms of the predicate ASSERT:

(49) $[\![\text{ASSERT}]\!] = \lambda p.\ \lambda y.\ \lambda x.\lambda i.\iota i'[i \leq i'[\textit{ASSERT}(p)(x)(y)(i')]]$

Illocutionary operators like ASSERT occupy a ForceP in the LF of sentences, as illustrated in the following examples:

(50) Juan o-jau.
Juan A3-bathe
'Juan was bathing.'

(51) $[_{ForceP}$ $[_{Force}$ ASSERT$]$ $[_{IP}$ PAST Juan ojau$]]$

(52) $\lambda y.\ \lambda x.\ \lambda i.\iota i'[i \leq i'[\text{ASSERT}([\![IP]\!])(x)(y)(i')]]$

Krifka (2014) does not present a detailed analysis of illocutionary predicates, but he suggests that they should be analyzed in terms of commitments, following Alston (2000). In (53) I give a tentative 'commitment' semantics for the predicate ASSERT:

(53) ASSERT$(p)(x)(y)(i)$ is true iff in *i, x* is committed to act as though she believes that *p* and *y* is a witness to this commitment.

Imperatives are speech acts that introduce directive commitments. A directive illocutionary operator DIRECT is defined in (54), which allows us to analyze the imperative sentence in (55) as in (56):

(54) $[\![\text{DIRECT}]\!] = \lambda P.\ \lambda y.\ \lambda x.\ \lambda i.\iota i''[i \leq i'[\text{DIRECT}(P)(x)(y)(i')]]$

(55) E-me'ẽ ka'ygua.
2.SG.IMP-take mate
'Give the mate!'

(56) $[\![[_{ForceP}\ \text{DIRECT}\ [_{VP}\text{Eme'ẽ ka'ygua}]]]\!] = \lambda y.\ \lambda x.\ \lambda i.\iota i'[i \leq i'[\text{DIRECT}([\![VP]\!])(x)(y)(i')]]$

A commitment semantics for the illocutionary predicate direct is proposed in (57):

(57) DIRECT$(P)(x)(y)(i)$ iff in *i, x* is committed to act as though she wants *y* to do/have *P*.

The notion of taking a commitment has been given a model-theoretic analysis by Condoravdi and Lauer (2010, 2011) and Lauer (2013). Condoravdi and Lauer (2011) define it as follows:

(58) If an agent *a* takes on a commitment, he thereby excludes possible future states in which:
a. the agent does not act according to the commitment AND
b. the commitment is not voided before the agent fails to act according to the commitment AND
c. the commitment does not count as violated.

This definition presupposes that commitments to act are evaluated in branching world-models, which are already part of Krifka's analysis of SAP. This allows us to make the commitment semantics of ASSERT and DIRECT as follows:

(59) At an index *i*, an agent is committed to act as though she believes that p iff there is no index $i'$ such that $i < i'$ and:
a. the agent does not act as though she believes that *p* at $i'$ AND
b. the commitment is not voided before the agent fails to act as though she believes that *p* AND
c. the commitment does not count as violated.

(60) At an index *i*, an agent is committed to act as though she wants *p* iff there is no index $i'$ such that $i < i'$ and:
a. the agent does not act as though she wants y to do/have *p* at $i'$ AND
b. the commitment is not voided before the agent fails to act as though she wants *p* AND
c. the commitment does not count as violated.

### *5.3 Analyzing* je *as a Speech Act Potential Modifier*

In Section 3.2, I argued that *je* is an illocutionary modifier. Faller (2002) analyzes the reportative evidential *si* of Quechua as an illocutionary modifier that manipulates the conditions of sincerity of a speech act. Speech acts are decomposed into a propositional content, a statement of sincerity conditions, and an illocutionary force. Unmodified assertions are analyzed as in (61). By uttering this sentence, a speaker *s* performs a speech act of assertion whose propositional content is the proposition that it is raining, and that is sincere if and only if the speaker believes that it is raining.

(61) Para-sha-n
rain-PROG-3
p = 'It is raining.'
ILL = ASSERTS(p)
SINC = {*Bel*(*s, p*)}

Faller proposes that the speaker of an utterance modified by *si* is not committed to believing the propositional content *p* of the utterance. This accounts for the fact that speakers can express disbelief about *p*. Since assertion is tied to sincerity conditions of belief, Faller proposes that illocutionary acts modified by *si* have a force of 'presentation' of *p*. The sincerity conditions associated with this illocutionary force require that some individual who is neither the speaker nor the addressee performed an assertion of *p*. Note that the sincerity conditions do not commit the speaker to believing that someone said that *p*. This accounts for the impossibility to challenge utterances modified by *si* by denying that the speaker was told that/heard *p*.

(62) Para-sha-n-si
rain-prog-3-si
p ='It is raining.'
ILL = PRESENT(p)
SINC = $\{\exists s_2[Assert(s_2,p) \wedge s_2 \notin \{h, s\}]\}$

Let us try to adapt Faller's proposal in Krifka's theory of SAPs. As an illocutionary modifier, *je* denotes a function from SAPs to SAPs, and it is adjoined to a ForceP:

(63) Juan o-jau je.
Juan a3-bathe EVID
'Juan was bathing, I heard.'

(64) $[_{ForceP}$ $[_{Evid}$ je] $[_{ForceP}$ $[_{Force}$ ASSERT] $[_{IP}$ past Juan ojau]]]

The effect of *je* on the sincerity conditions of speech acts can be captured by quantifying over the 'speaker' argument of the modified SAP. As defined in (65), the effect of *je* on the interpretation of an utterance is to shift the speaker argument of the embedded SAP to some individual other than the speaker $c_s$ or the addressee $c_a$:

(65) $[\![\text{je}]\!] = \lambda A.\lambda y.\lambda x.\lambda i.u'[\exists z[z \notin \{x,y\} \wedge i' = A(z)(y)(i)]]]$

(66) $[\![[[_{FP}\ \text{ASSERT}\ [_{IP}\ \text{PAST Juan ojau}]\ ]\ \text{je}]]\!] =$
$\lambda y.\lambda x.\lambda i.\iota i'[\exists z[z \notin \{x,y\} \wedge i' = \iota i''[i \leq i''[\text{ASSERT}[\![IP]\!])(z)(y)(i'')]]]$

(67) $CG + [\![[[_{FP}\ \text{ASSERT}\ [_{IP}\ \text{PAST Juan ojau}]]\ \text{je}]]\!] =$
$\{\ \langle c_s,c_a,\iota i > [\exists z[z \notin \{c_s,c_a\} \wedge i = \iota i'[c_t \leq i'[\text{ASSERT}([\![IP]\!])(z)(c_a)(i')]]]$
$\mid \langle c_s, c_a, c_t) \in CG\}\rangle$

## 6 Embedding Imperatives

### *6.1 Embedded Imperatives*

Imperatives denote directive SAPs. They have the same type as assertive SAPs, and they can therefore be embedded under *je*, which is an SAP modifier. The embedded imperative in (68) is parsed as (69):

(68) E-me'ẽ ka'ygua je
2.SG.IMP-take mate EVID
'Give the mate, I heard.'

(69) $[_{ForceP}\ [_{Evid}$ je$]\ [_{ForceP}\ [_{Force}$ DIRECT$]\ [_{IP}$ eme'ẽ ka'ygua$]]]$

The interpretation proceeds as for embedded assertions; *je* conveys that the person who is responsible for the embedded imperative is an individual who is neither the speaker nor the addressee:

(70) $[\![\text{je}]\!] = \lambda A.\lambda y.\lambda x.\lambda i.\iota i'[\exists z[z \notin \{x,y\} \wedge i' = A(z)(y)(i)]]]$

(71) $[\![[\text{je}\ [_{ForceP}\text{DIRECT}\ [_{VP}\text{eme'ẽ ka'ygua}]]]\!] =$
$\lambda y.\lambda x.\lambda i.\iota i'[\exists z[z \notin \{x,y\} \wedge i' = \iota i''[i \leq i''[\text{DIRECT}([\![VP]\!])(z)(y)(i'')]]]$

(72) $CG + [\![[\text{je}\ [_{ForceP}\ \text{DIRECT}\ [_{VP}\ \text{eme'ẽ ka'ygua}]]]\!] =$
$\{\ \langle c_s,c_a,\iota i[\exists z[z \notin \{c_s,c_a\} \wedge i = \iota i'[c_t \leq i'[\text{DIRECT}([\![VP]\!])(z)(c_a)(i')]]]]\rangle$
$\mid \langle c_s, c_a, c_t\rangle \ \notin CG\}\rangle$

In order to account for imperatives embedded under *he'i* and *jerure*, I assume that these verbs are ambiguous between a proposition selecting reading and an SAP selecting reading (cf. Krifka 2014):

(73) $[\![\text{he'i}_1]\!] = \lambda p.\lambda y.\lambda x.\lambda i.\exists i'[i' \leq i[\text{ASSERT}(p)(x)(y)(i)]]$

(74) $[\![\text{he'i}_2]\!] = \lambda A.\lambda y.\lambda x.\lambda i.\exists i'[i' \leq i \wedge i = A(x)(y)(i')]$

The analysis of *jerure* is similar:

(75) $[\![\text{jerure}_1]\!] = \lambda p.\lambda y.\lambda x.\lambda i.\exists i'[i' \leq i[\text{DIRECT}(p)(x)(y)(i)]]$

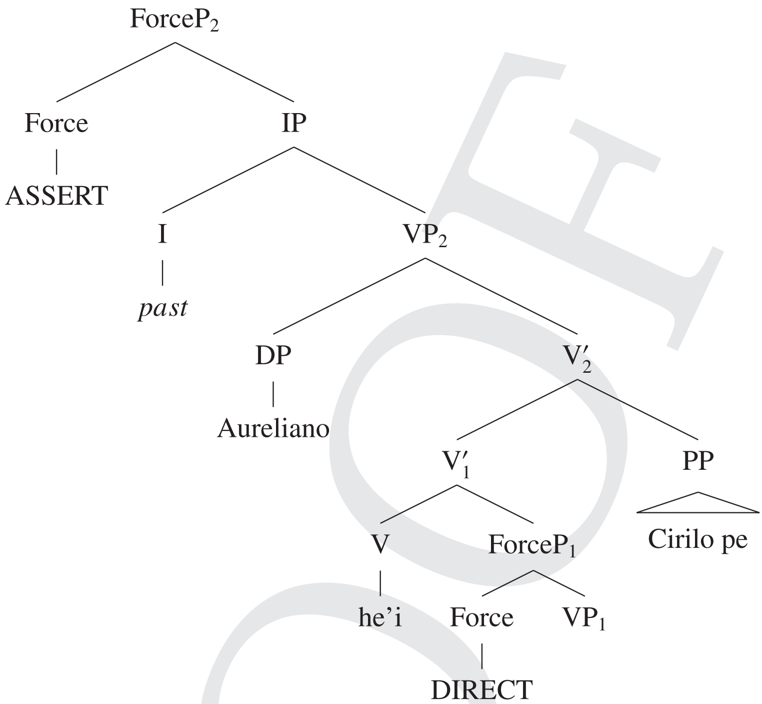
(76) $[\![\text{jerure}_2]\!] = \lambda A.\lambda y.\lambda x.\lambda i.\exists i'[i' \leq i \wedge i = A(x)(y)(i')]$

Let us illustrate the analysis with the following sentence:

(77) Aureliano he'i Cirilo pe e-me'ẽ ka'ygua chevy pe.
Aureliano 3.say Cirilo to 2.SG.IMP-give mate me to
'Aureliano said to Cirilo give me the mate.'

In (77), the complement of *he'i* is an imperative, i.e., a directive ForceP:

(78)




The interpretation proceeds as follows:

(79) $\llbracket \mathrm{VP}_1 \rrbracket = \lambda x.\lambda i.\mathbf{give}(i)(\mathbf{the\ mate})(c_s)(x)$

(80) $\llbracket \mathrm{ForceP}_1 \rrbracket = \lambda y.\lambda x.\lambda i.\iota i'[i \leq i'[\textsc{direct}(\llbracket \mathrm{VP}_1 \rrbracket)(x)(y)(i')]]$

(81) $\llbracket \mathrm{V}'_1 \rrbracket = \lambda y.\lambda x.\lambda i\exists i'[i' \leq i \wedge i = \iota i''[i' \leq i''[\textsc{direct}(\llbracket \mathrm{VP}_1 \rrbracket)(x)(y)(i'')]]]$

(82) $\llbracket \mathrm{VP}_2 \rrbracket = \lambda i.\exists i'[i' \leq i \wedge i = i''[i' \leq i''[\textsc{direct}(\llbracket \mathrm{VP}_1 \rrbracket)(\mathbf{Aureliano})(\mathbf{Cirilo})(i'')]]]$

(83) $\llbracket \mathrm{IP} \rrbracket =$
$\lambda i.\exists i'[i' < i \wedge \exists i''[i'' \leq i' \wedge i' = \iota i'''[i'' \leq i'''[\textsc{direct}(\llbracket \mathrm{VP}_1 \rrbracket)(\mathbf{Aureliano})(\mathbf{Cirilo})(i''')]]]]$

(84) $\llbracket \mathrm{ForceP}_2 \rrbracket = \lambda y.\lambda x.\lambda i.\iota i'[i \leq i'[\textsc{assert}(\llbracket \mathrm{IP} \rrbracket)(x)(y)(i')]]$

(85) $CG + \llbracket \mathrm{ForceP} \rrbracket = \{<c_s, c_a, \iota i[c_t \leq i[\textsc{assert}(\llbracket \mathrm{IP} \rrbracket)(c_s)(c_a)(i)]]> \mid <c_s, c_a, c) \in CG>\}$

The result of updating a common ground *CG* with (84) is a new *CG* whose utterance indices have been incremented with the condition that the speaker took up assertive commitments with the addressee as witness, with respect to the proposition that Aureliano directed Cirilo to give the mate to the speaker. This analysis accounts for the fact that the speaker does not take up the directive commitments of the embedded imperative. However, if the assertion is successful, the discourse participants will exclude from the common ground all triples $<c_s, c_a, c_t>$ in which the proposition in (83) that Aureliano took up these directive commitments is false.

Note also that although the speaker does not take up the directive commitment of the embedded speech act, she is still committed to the matrix assertion, as illustrated by the fact that she can be held responsible for the falsity of its propositional content:

(86) a. Aureliano he'i e-me'ẽ ka'ygua.
Aureliano 3.say 2.SG.IMP-give mate
'Aureliano said give me mate.'

b. Añete-'ỹ, nda-e'a-i.
true-NEG NEG-3.say-NEG
'That's false; he didn't say that.'

### *6.2 Restrictions on SAP Embedding*

As it stands, the proposed analysis of *je*, *he'i*, and *jerure* as SAP modifiers over-generates. Indeed, nothing in the analysis prevents the embedding of non-directive SAPs under these operators, but there are constraints on the speech acts that these operators can embed. As the following examples illustrate, *je*, *he'i*, and *jerure* cannot embed questions.

Questions are marked with the interrogative particle *pa*, as illustrated in (87). (88) shows that this particle is attested in interrogatives embedded under the verb *porandu* ('ask'):

(87) Juan pa o-ĩ ng-oo py?
Juan Q A3-be REFL-house in
'Is Juan at home?'

(88) Cirilo o-porandu Juan pa o- ĩ ng-oo py.
Cirilo A3-ask Juan Q A3-be REFL-house in
'Cirilo asked whether Juan is at home.'

(89a-e) shows that the use of *je* in interrogative clauses is ungrammatical:

(89) a. *Juan je pa o-ĩ ng-oo py?
b. *Juan pa je o- ĩ ng-oo py?

c. *Juan pa o- ĩ je ng-oo py?
d. *Juan pa o- ĩ ng-oo je py?
e. *Juan pa o- ĩ ng-oo py je?

(90) and (91) show that while declarative clauses can be embedded under *he'i*, interrogative clauses cannot:

(90) Cirilo he'i Juan o- ĩ -a ng-oo py.
Cirilo 3.say Juan 3-be-NMLZ REFL-house in
'Cirilo said that Juan is at home.'

(91) *Cirilo he'i Juan pa ng-oo py.

Finally, (92) and (93) show that purposive clauses can be embedded under *jerure*, but interrogative clauses cannot:

(92) Cirilo o-jerure Juan ng-oo py aguã.
Cirilo 3.ask Juan REFL-house in PURP
'Cirilo asked that Juan be at home.'

(93) *Cirilo o-jerure Juan pa ng-oo py (aguã).

Assuming that interrogative clauses marked with *pa* denote SAPs of question acts, how can we block their embedding under *je*, *he'i*$_2$, and *jerure*$_2$? I propose that *je* and *he'i*$_2$ select assertive or directive SAPs, and that *jerure*$_2$ selects directive SAPs. Furthermore, I propose that this selection is syntactic in nature. Why syntactic? Because the illocutionary force associated with an SAP cannot be 'read off' its semantic type, which is that of functions of type <e, <e, <s, s>>>. It is also unclear how one could retrieve the illocutionary force of the SAP from the extension of this function, i.e., from its graph.

Let us then assume that verbs bear an uninterpretable (Chomsky 1995) force feature that must agree with an interpretable feature of the same type on a force head. For the sake of simplicity, assume that uninterpretable force features are borne by verbs (V heads).[6] Verbs that bear uninterpretable ASSERTIVE features must agree with interpretable ASSERTIVE features on an ASSERT force head, and verbs that bear uninterpretable DIRECTIVE features must agree with interpretable DIRECTIVE features on a DIRECT force head. I propose that *je* and *he'i*$_2$ are subcategorized for ForceP complements bearing ASSERTIVE or DIRECTIVE features, while *jerure*$_2$ are subcategorized for ForceP complements bearing DIRECTIVE features only.

[6] In reality, a satisfying account of form/function mapping is likely to be more complicated, since intonation and morphosyntactic phenomena other than verb morphology are likely to be associated with a given type of speech act.

### *6.3 Cross-linguistic Perspectives*

Finally, let us consider some cross-linguistic consequences of this analysis. If embedded imperatives are embedded SAPs, we predict that verbs that select propositional complements should not embed imperatives. Indeed, SAPs are of type <e<e<ss>>>, while propositions are of type <st>. Only verbs that select SAPs as complements should embed imperatives. What are these verbs? I propose that only verbs that describe speech acts can have this type. In all languages, we will find verbs like *say* or *ask to*, which take propositional complements and convey that their agent performed a certain speech act (e.g., assertion for *say* or some directive speech act for *ask to*) with the propositional content that is denoted by their complement. In certain languages, these verbs may have a secondary reading, under which their type is lifted to take SAP complements.

In other words, we expect that verbs that embed imperatives will be verbs that describe speech acts when they select a propositional complement, like *say* or *ask to.* We do not expect imperatives to be embedded under verbs that do not describe speech acts, such as *know* or *dream.* This is a hypothesis that ought to be tested rigorously, but a preliminary survey of available data suggests that it is on the right track, as shown by the following summary of imperative embedding verbs in four genetically distinct languages:

(94) Verbs that embed imperatives cross-linguistically:
  a. Mbyá: *he'i* ('say'), *jerure* ('ask to').
  b. English: *say* (Crnič and Trinh 2009).
  c. Mandarin: *quan4* ('urge'), *yao1 qiu2* ('request') (Chen-Main 2005).
  d. Slovenian: *reci* ('say'), *vztrajati* ('insist'), *ukazati* ('order'), *svetovati* ('suggest'), and *'opozoriti'* (warn) (Rus 2005).

## 7 Relevance for the Study of Recursion in Natural Language

A form of recursion that is relevant to syntactic analysis is direct or indirect recursion in the production rules of a formal grammar (see e.g., Power 2002). The following examples illustrate direct (95) and indirect (96) recursion using rewrite rules of context-free grammars, where $A$, $B$ are non-terminals and $\alpha$, $\beta$ are terminals or non-terminals:

(95) $A \rightarrow A\alpha$

(96) $A \rightarrow \alpha B$
$B \rightarrow \beta A$

Before we answer the question of whether the analysis of embedded imperatives in Mbyá motivates the use of this type of recursion, let us discuss a second type of recursion, which is not defined as a property of functions or production rules, but as a structural property of derived syntactic trees. Pinker and Jackendoff write that "recursion refers to a procedure that calls itself, or to a constituent that contains a constituent of the same kind" (2005:203). It is the second option that interests us here. This concept of recursion can be applied to nodes of syntactic trees that dominate a node of the same category, as illustrated in the following example:

(97) $[_{S}$ NP $[_{VP}$ VS]]

The proposed analysis of embedded imperatives makes use of this second form of recursion, since matrix sentences are analyzed as phrases of category Force, and embedded imperatives are analyzed as constituents of category Force themselves. More precisely, the structure of a sentence that contains an imperative embedded under *he'i* or *jerure* matches the following description:

(98) $[_{ForceP}$ Force $[_{TP}$ … $[_{V0}$ V ForceP]]]

If we were to generate such structures using production rules of a context-free grammar, it would be natural to use the second form of recursion that we discussed in this section, in the form of indirectly recursive production rules:[7]

(99) ForceP → Force TP
TP → DP T′
T' → T VP
VP → $V_{force}$ ForceP
$V_{force}$→*he'i*$_2$ | *jerure*$_2$

Note that imperative clauses modified by the reportative evidential *je* are not recursive in either of these ways, since they only contain one phrase of category Force, to which *je* is adjoined:

(100) $[_{ForceP}$ *je* $[[_{Force}$ DIRECT] VP]]

In sum, the form of recursion that is hypothesized in this analysis of imperatives embedded under *he'i* and *jerure* is syntactic: there is syntactic recursion both in the sense that a phrase of category Force contains another phrase of the same category, and in the sense that this structure is most straightforwardly generated in a rewrite grammar using indirectly recursive

[7] Note that this analysis predicts that, everything else being equal, it should be possible to embed imperatives under embedded verbs of reports. At the time when the fieldwork for this chapter was done, my focus was on the possibility to embed imperatives and its consequence for the theory of speech act, rather than on the existence of recursive structures in Guarani. Because of this focus, no data relevant to second-degree embedding of imperatives were elicited. For a discussion of second-order embedding and semantic factors that limit it, see Hollebrandse, this volume.

production rules. Nevertheless, it is important to note that this syntactic analysis is motivated by semantic requirements: the analysis of *he'i* and *jerure* as SAP modifiers is motivated by the observation that imperatives embedded under these verbs are interpreted like matrix imperatives, with the difference that the directive commitments that they introduced are asserted to the subject of the embedding verb, rather than the speaker.

Finally, the present study is clearly relevant to the question of whether speech acts can be embedded. More precisely, I have proposed following Krifka (2014) that although speech acts as such are not denoted by linguistic expressions, the type of speech act that a speaker may perform is constrained by the SAP denoted by its utterance. SAPs may in turn be embedded, which is the current analysis of embedded imperatives in Mbyá.

*Part II*

# Recursion along the Clausal Spine

# 6 Word Order in Control: Evidence for Self-Embedding in Pirahã

*Cilene Rodrigues, Raiane Salles, and Filomena Sandalo*

## 1 (Absence of) Self-Embedding

Everett (2005, 2009), understanding the property of recursion as self-embedding (i.e., an XP contained within an another XP), argued in response to Hauser, Chomsky and Fitch (2002) that Pirahã,[1] a language from the Mura family, spoken by about 420 people in the Amazon region of Brazil, is a non-recursive grammar.[2] Linking implicit linguistic knowledge with culture, Everett's main claim is that the Pirahã grammar is constrained by a cultural restriction, which he named the *Immediacy of Experience Principle*.

(1) *Immediacy of Experience Principle*
Communication is restricted to the immediate experience of the interlocutors.
(Everett 2005:622)

However, Everett does not offer any profound explanation for how and why this principle can block self-embedding. For instance, he does not explain why the Pirahã community would have principle (1) and its grammatical consequences, whereas other communities, including other Amazonian tribes, do not. Thus, (1), as presented by Everett, does not improve our understanding of possible restrictions on self-embedding in Pirahã.

Everett's claims were first disputed by Nevins, Pesetsky and Rodrigues (2009a, 2009b). Relying on descriptions of the language published by Everett, the authors argued that there is no real evidence for lack of self-embedding in Pirahã. Nevins, Pesetsky and Rodrigues also showed that different languages around the world present constraints on self-embedding. German, for instance, blocks a second level of self-embedding within prenominal genitive possessive noun phrases (Roeper and Snyder 2005), as illustrated by the contrast in grammaticality between (2a) and (2b). The unacceptability of (2b) does not seem to

[1] The Pirahã language is also called *Apaitsiiso*.
[2] See Nimuendajú (1948) for a description of Mura.

reflect any known cultural constraint, such as principle (1); rather, it appears to be the result of an internal grammatical restriction. This cross-linguistic parametrization on self-embedding weakens Everett's claim about the cognitive scope of (1). If (1) is not responsible for the impossibility of recursive prenominal possessive noun phrases in German, it might also not be responsible for any potential lack of self-embedding in Pirahã.

(2) a. Hans-ens Auto
'Hans' car'

b. *[Hans-ens Auto]'s Motor
'Hans' car's motor'

(Nevins, Pesetsky and Rodrigues 2009a: 367)

In this chapter, we report new data, supporting Nevins, Pesetsky and Rodrigues' conclusion about the non-robustness of Everett's claims.[3] As we show, there is actually available evidence, mainly from word order in control configuration, that Pirahã allows self-embedding. Based on these new data, we can confidently conclude that Pirahã allows self-embedding, at least at the VP level.[4] The data presented here show that Pirahã licenses structures in which an XP can immediately dominate another identical XP; as in control configurations, VP is taken as the complement of a verb.

The new data we present here were collected in July 2012, at the University of Campinas/UNICAMP. As part of our linguistic research on Pirahã, we brought a monolingual, native speaker of Pirahã, named Hiahoai Pirahã (known among the Pirahã people and the local people as Capixaba), and a partially proficient speaker, Augusto Diarroi, known among the Pirahã people as Verão, to UNICAMP to work with us. They stayed at UNICAMP for a week. With the help of Augusto Diarroi, we elicited self-embedding at the sentential level and within DPs and prepositional phrases. The elicitations were done with the aid of drawings. We presented Hiahoai with drawings and he was supposed to describe in Pirahã the scenes that were in the drawings. We also used the sentence repetition procedure (Klem et al. 2015). Hiahoai Pirahã had to repeat Pirahã sentences that we pronounced. First, we elicited the sentences; then, when linguistically convenient, we

[3] Here, we will present the data involving sentential self-embedding. The data we collected on self-embedding within DP were non-robust. Although we elicited a couple of DPs showing multiple embedding with possessive phrases, we understand that more data is needed before we reach any conclusion about the structure of nominal expressions in this language. As for self-embedding within other domains see: Sandalo et al. (this volume) for self-embedding within prepositional phrases, Sauerland (this volume) for self-embedding within sentences and Salles (2015) for evidence of self-embedding within possessive DPs.

[4] Due to lack of time, we did not elicit non-control.

pronounced them back to Hiahoai and he repeated them back to us. In his repetition, he was asked to correct wrong word orders and other grammatical errors we made.

The chapter is organized as follows: Section 2 discusses word order in Pirahã, showing that the canonical order SOV can alternate with SVO if the object is heavy. Hence, when the object is sentential, the SVO order does not really tell us that the second sentence is only juxtaposed to the first one, as claimed by Everett. In Section 3, we present controlled clauses in complement position. As we will demonstrate, a controlled clause can appear before the main verb, resulting in an SOV order. Therefore, at least in control configurations, self-embedding seems to be possible in Pirahã. In addition, this section presents cases involving adverbial and negation scope, which corroborate our analysis and suggest that controlled clauses are embedded even if the word order is SVO. The scope of adverbs also indicates that control in Pirahã involves restructuring, as in German (Wurmbrand 2002). We conclude in Section 4 that: (a) SOV order is possible with controlled sentences; and (b) the word order SVO is also compatible with self-embedding. Hence, recursion in the sense of self-embedding is available in Pirahã.

## 2 Word Order and Heavy-NP Shift

Most languages around the world present a canonical or preferred word order. This order, however, can be disrupted by syntactic transformations. One example is the so-called heavy-NP shift (Ross 1967), by which a long/heavy nominal expression that functions as the verbal direct complement appears at the end of the sentence, separated from the verb by some intervening material.[5] The English and Portuguese data in (3) and (4) exemplify this. Although in both languages the direct object is canonically placed right after the verb, as the contrast between sentences (a) and (b) shows, this very same constituent can appear at the end of the sentence if it is long. Hence, while the examples in (b) are not acceptable, those in (c) are.

(3) a. I sang a song with my friends

b. *I sang with my friends a song

c. I sang with my friends a song that was written by a famous guitar player

[5] The noun phrase's structural complexity plays a role in NP-shifting as well. The more complex an NP, the more it tends to shift to the right (Ross 1967; Wasow and Arnold 2003). However, the NP length seems to be a decisive factor (Kimball 1973; Hawkins 1994). Hawkins, based on an analysis of a text corpus, concluded that NPs, independently of their internal complexity, do not shift much unless they exceed the length of other materials by at least four words.

(4) a. Eu comi pão ontem a noite
*I ate-1SG bread yesterday at night*

b. *Eu comi ontem a noite pão
*I ate-1SG yesterday at night bread*
'I ate bread yesterday night'

c. Eu comi ontem a noite pão de queijo recheado com tomate
*I ate-1SG yesterday at night bread of cheese stuffed with tomatoes*
e cebola
*and onions*
'I ate yesterday night cheese bread stuffed with tomatoes and onions'

Both English and Portuguese are SVO languages. Heavy-NP shift, however, is also possible in languages with different word orders, Basque being but one example. Although Basque exhibits some freedom in word order, it has a preference for SOV (5a) (Hualde and Ortiz de Urbina 2003). Nevertheless, when the object is heavy, as in (5b), the order shifts to SVO.[6]

(5) a. Jonek ipuinak kontatu zituen atzo
*Jon-ERG tales tell AUX yesterday*
'John told some tales yesterday'

b. Jonek esan du Mikelek erlojua galdu duela
*Jon-ERG say AUX Mikel-ERG watch lose AUX.COMP*
'Jon said that Mikel lost the watch'
(Hualde and Ortiz de Urbina 2003:451–452)

Everett's (1986, 1991) data suggest that Pirahã patterns like Basque with respect to heavy-NP shift. First, it is an SOV language, as shown in (6).

(6) a. ti xíbogi ti -baí
*1 milk drink-INTNSF*
'I really drink milk'

b. hi xápiso xaho -aí -i -haí
*3 bark eat-ATEL-PROX-RCERT*
'He will eat bark'

[6] Heavy-NP shift is so frequent and robust in the world's languages that it might be responsible for a historical change in Icelandic word order. This language used to be OV, but has changed to VO. Lightfoot (1979) argues that heavy-NP shift played an important role in this change.

c. hi káixihí xoab -á -há
*3 paca kill-REM-CCERT*
'He killed a paca'

(Everett 1986:201)

Contrary to Basque, Pirahã seems to be somewhat rigid in its SOV order, as a change in it (e.g., OSV) can cause different interpretations. Everett (1986) observes that if the sentence in (7) is pronounced without a pause after the first constituent, it means that 'milk drinks me', being, thus, semantically different from (6a). If a pause is placed after *xíbogi*, then this constituent is interpreted as a topic. Hence, (7) is semantically different from (6a).

(7) xíbogi ti i-baí
*milk 1 drink-INTNSF*

a. 'Milk drinks me'
b. 'Milk, I drink a lot of'

(Everett 1986:202)

However, similarly to Basque, in Pirahã, the SOV order can shift to SVO without compromising the meaning of the sentence, whenever the object is a heavy constituent.[7]

(8) tiobáhai koho-ái -hiab-a tomati gihió
*child eat-ATEL -NEG-REM tomato bean*
-kasí píaii taí píaii
*name also leaf also*
'(The) children do not eat tomatoes or beans or leaf(y vegetables)'

(Everett 1986:226, 295)

Taking into account the availability of heavy-NP shift in Pirahã is crucial to understand processes of sentential embedding in this language. Everett (2005) takes the fact that sentential objects usually appear after the verb, producing an SVO order, as in (9), to be evidence that Pirahã does not have sentential subordination. In his analysis, (9) is a case of quotation/direct speech report, which he analyzes as parataxis. That is, the second clause is analyzed as being

[7] Occurrence of heavy-NP shift in Pirahã was already acknowledged in Everett: "When these objects are larger than five or six syllables they tend to undergo movement to postverbal position. This is apparently a stylistic mechanism to avoid overcrowding of the space between S and V, reminiscent of 'Heavy Shift' " (1986:206).

juxtaposed to the first one, instead of being embedded under the matrix verb as its direct complement.[8]

(9) kohoibiihai hi gáí-sai hi hi xogi-hiab -iig -á gáihi
*Kohoibiihai 3 say*-NMLZ *3 3 want*-NEG-CONT-REM *that*
'Kohoibiihai said (that) he's not wanting that'

It is unclear, however, that the SVO order in examples like (9) is caused by parataxis. This order might be reflecting heavy-object shift. Suppose that in (9) the second sentence starts the derivation embedded under the matrix VP, as the direct object of the matrix verb, producing an underlying SOV order. Then, since this sentence is heavy, it shifts to a position at the end of sentence, resulting in the surface SVO order.[9] That is, (9), similarly to (8), can be a case of object shift, as schematized in (10).[10]

(10) [[YP [XP V]…]]

By analyzing (9) as a case of object shift, we predict that light sentences in object position should be able to precede the main verb in Pirahã. The next section shows that this prediction is correct. We will discuss cases of controlled clauses in complement position, pointing out that these clauses can surface either to the left or to the right of the main verb. Thus, in control configurations, both SOV and SVO order are possible. The SOV order confirms that, at least in control configurations, self-embedding is available in Pirahã.

## 3 Canonical Word Order in Control Configurations

Control is a grammatical phenomenon already attested in many languages around the world. It is a syntactic-semantic configuration in which the subject of a subordinated clause is co-referent with one of the arguments of the matrix predicate (either the subject or the object), behaving like an anaphor

[8] We will not discuss sentences with attitude report verbs, such *gai-sai*. These are not cases of control. See Sauerland (2010b) for evidence that these sentences might involve subordination.
[9] Heavy-NP shift might be the result of stylistic rules (Ross 1967), but it has been studied as a syntactic phenomenon as well. Pesetsky (1995) analyzes it as rightward adjunction to the VP. In contrast, Larson (1988) proposes that it results from leftward movement of everything inside the VP except a heavy-NP. Kayne (1994), following Larson's analysis, adds that light-NPs, as opposed to heavy-NPs, move leftwards to a higher specifier position. For the purpose of the present chapter, any of these analyses can be adopted. For expository reasons only, in the scheme in (10), the object moves rightwards.
[10] Malagasy is another example of an SOV language that shifts to SVO when the verbal complement is a finite clause (see Keenan 1976).

and thus subject to Principle A of Binding Theory.[11] The data in (11) and (12) illustrate control in English and Brazilian Portuguese.[12] In these sentences, the embedded null subject is obligatorily interpreted as co-referent with the matrix subject.

(11) John wants to take the train at 7a.m.

(12) O João quer pegar o trem às 7
*the João want-3SG take-INF the train at.the 7*
'John wants to take the train at 7'

Pirahã also seems to exhibit control. As shown in (13), in a sequence with two clauses, the second clause *kapiiga kagakai* 'paper study' has a null subject that is obligatorily co-referent with the matrix subject.[13]

(13) a. ti ogabagai kapiiga kagakai[14]
*I want paper study*
'I want to study'

b. ti ogabagai tiisi ikohaipiha
*I want fish eat*
'I want to eat fish'

(examples from our fieldwork, July 2012)

Crucially for the present discussion, the SVO order in (13) can alternate with an SOV order.

(14) a. ti kapiiga kagakai ogabagai
*I paper study want*
'I want to study'

[11] On Binding Theory, see Chomsky (1981) and Chomsky and Lasnik (1993).

[12] See Landau (2004) and Rodrigues (2004) for evidence that, in some languages, including Brazilian Portuguese, control is possible within finite and non-finite clauses.

[13] We have not yet verified if these configurations in Pirahã exhibit all the properties of obligatory control (e.g., a c-commanding antecedent is required, a sloppy reading under VP ellipsis is forced, a *de se* reading is and split antecedents are not allowed (Williams 1980)). However, desiderative verbs, such as 'want' are well-known triggers of obligatory control in many languages and we have already confirmed with our informant that in these sentences the null subject of the second clause is obligatorily co-referent with the matrix subject. Thus, it seems that the control structures we are discussing here are cases of obligatory control.

[14] In our transcription of Pirahã, we are omitting tone. In addition, since our focus is on syntax, and not the word-internal segmentation of affixes, in our transcriptions and glosses we will omit morphological divisions. These divisions might be relevant to better understand details of the structures we are analyzing (e.g., tense and aspect distinctions). However, at this point of our research, we are unable to verify them.

b. ti tiisi ikohaipiha ogabagai
*I fish eat want*
'I want to eat fish'

(examples from our fieldwork, July 2012)

(13) and (14) do not present any difference in meaning. The only difference observed is the word order itself. Notice that in both sentences, the dependent clause *kapiiga kagakai* is taken to be the complement of the matrix desiderative verb. Hence, these are cases of control into a complement.

The fact that the controlled clause in (14) is structurally placed between the matrix subject and the matrix predicate clearly suggests that the infinitival clauses are embedded under the matrix verb. This cannot be parataxis. There is no explanation for the SOV order if we analyze the infinitival clause as juxtaposed to the matrix clause. This was first pointed out by Nevins, Pesetsky and Rodrigues (2009a:375). Everett (1986) offers the sentence in (15) as grammatical in Pirahã, and Nevins, Pesetsky and Rodrigues correctly observed that the SOV order found in this sentence is incompatible with a parataxis analysis, being rather evidence for subordination. Nevins, Pesetsky and Rodrigues' observation was dismissed in Everett (2009), in which (15) is presented as ungrammatical.

(15) hi ti xap-I -sai xog -i -hiab -a
*3 1 go-*EP-NMLZ *want-*EP-NEG-REM
'He doesn't want me to go'

(from Everett 1986:278, in which it is presented as grammatical, but later as ungrammatical in Everett 2009)

During our fieldwork, we tested (15) as well as other sentences involving control within clauses in complement position. According to our informant, (15) is fine and, in this type of configuration, the order SOV is acceptable.[15]

As illustrated by (16), more than one level of embedding can occur, preserving the SOV order. Therefore, not only does self-embedding (i.e., SOV order) occur in Pirahã, but it is also productive.

(16) ti kapiiga kagakai ogabagai sogabagai
*I paper study want would-like*
'I would like to want to study'

[15] These sentences were elicited using the sentence repetition procedure. Hihoai Pirahã had to repeat Pirahã sentences that we pronounced. First, we elicited some sentences, then, one by one, we pronounced them back to Hiahoai and he repeated them back to us. In his repetitions, he was supposed to correct errors we were making. During this procedure, he had no problem in correcting wrong word orders (see the data in (25–26) for example). For sentences involving control into sentential objects, he gave us either SOV or SVO.

In conclusion, self-embedding in Pirahã is demonstrated by the availability of SOV order in control configurations. The question is, then, about the SVO order found in examples like (13). Is this order a reflex of parataxis? Studies on control in many different languages have demonstrated that in control, the controlled anaphor/null subject has to be c-commanded by its antecedent (Landau 2004; Rodrigues 2004). Hence, in (13), as well as in (14), (15), and (16), the second clauses have to be embedded within the matrix clause for the necessary c-command configuration to hold. Thus, the fact that these are cases of control is by itself evidence for self-embedding.

Another piece of evidence showing that the SVO order involves self-embedding comes from the scope of adverbial expressions. As shown in (17), adverbial expressions placed at the end of the second sentence can have different scopes. While *ahogio* 'yesterday' scopes over the entire sentence 'I would like to study in Humaitá', *maitai* 'in Humaitá' only scopes over the embedded predicate.

(17) ti sogabagai kapiiga kagakai maitai ahogio
*I would-like paper study Humaitá yesterday*
'Yesterday I would have liked to study in Humaitá'
(example from our fieldwork, July 2012)

It is very hard, if not impossible, to accommodate the scope of these elements within a paratactic analysis.[16] This would require some complicated discourse operation, which could semantically link an adverb placed after the second sentence to the first sentence.[17] For example, something along the following lines:

(18) [I would like. Study in Humaitá]. Yesterday

On the other hand, if the second sentence is analyzed as embedded under the first one, the scope of each adverbial expression follows straightforwardly:

(19) [[I would like [to study in Humaitá]] yesterday]

[16] Notice that if (17) were derived by parataxis, we would have to assume that the complement of the desiderative verb is a null pronoun, which categorically relates to the second clause. Without this assumption, the first chunk of the sentence, *ti sogabagai* 'I would like' would be an incomplete proposition. Another possibility is to understand that the two sentences are syntactically independent, but semantically dependent. This, however, would require some sort of semantic self-embedding. Therefore, Everett's (2005) claim that Pirahã allows only one event per utterance cannot be correct.

[17] This might be accommodated within a discourse analysis. Nevertheless, we don't know how such an analysis would be such that it would work only in Pirahã. Notice that it must exclude a narrow scope reading, in which the temporal adverb scopes over the second clause only. This scopal restriction seems to be very strong. We tried different contexts and different temporal adverbs, but Hiahoai was persistent in not allowing narrow scope readings.

*Maitá* 'in Humaitá' has scope over the embedded clause only, whereas *ahogio* 'yesterday' has scope over the entire sentence *ti sogabagai kapiiga kagakai maitai* 'I would like to study in Humaitá.'

The previous examples are all cases of subject control. However, object control seems to be available as well. In (20), for instance, the null subject of the embedded sentence is obligatorily co-referent with the indirect object of the matrix clause.

(20) ti kaai iaipaha tabo kabahai neai
*I house make wood gave-not you*
'I did not give you wood to make a house'
(example from our fieldwork, July 2012)

This example gives us more semantic evidence for self-embedding. The wide scope of the negation shows that the controlled clause is embedded under the matrix verb. If it were not embedded, we would expect the negation to have narrow scope, limited to the matrix clause. As the translation of (20) shows, the negation *–hai*, which appears as a suffix to the matrix verb, scopes over the entire clause. If the negation had narrow scope, (20) should mean (21).

(21) I did not give you wood. You make a house.

The wide scope of negation was another argument used by Nevins, Pesetsky and Rodrigues (2009a:375) in defense of sentential self-embedding in Pirahã. They argued that (22) cannot be two separated sentences, given that the second clause is under the scope of negation, which is placed within the matrix clause.

(22) ti xibíib-I-hiab-iig-á kahaí kai-sai[18]

*1 order-EP-NEG-CONT-REM arrow make-NMLZ*

a. 'I am not ordering you to make an arrow'
b. 'I will not let you make an arrow'
(example from Everett 1986:254)

[18] (20) differs from (22) with respect to word order (SOV (20) versus SVO (22)), and also with respect to the presence of the morpheme *–sai* in (22), which Everett (2005) takes to be a nominalizer. Taking *–sai* to be a nominalizer, one could argue that (22) is not a case of sentential self-embedding. This might be true for (22). However, if this is right, then the absence of *–sai* should be taken as extra evidence for sentential self-embedding in (20). Let us also emphasize that in the data, there is no occurrence of *–sai* in control configurations. This morpheme appeared only with the attitude report verb *gai-sai* 'to say.'

Everett (2009:375), in response to Nevins, Pesetsky and Rodrigues' observation, claimed that (22) does not have the meaning given in (a) or (b). According to him, the proper translation for (22), should in fact be:

(23) I am not ordering you. You make the/an arrow(s)![19]

Given this mismatch in data acceptability within Everett's publications, in our fieldwork we elicited the sentence in (20), as well as the sentence in (22). Our informant confirmed the meaning we are attributing to (20), as well as the meaning (a) for (22). Therefore, to the extent that the judgments we received from Hiahoai Pirahã are correct, the negation scopes over the second clause in both (20) and (22). And, importantly, according to Hiahoai, (20) cannot receive the reading in (21), and (22) does not mean (23). The reading in (21) corresponds in Pirahã to the sentence in (24), which is clearly structurally different from (20).

(24) Ti tabo kabahai niai abaago kaai iaipa
*I wood gave-NEG you alone house make*
'I did not give (you) wood. You make a house on your own!'
(example from our fieldwork, July 2012)

In sum, adverbial and negation scope indicate that sentential self-embedding is available in Pirahã in both SOV and SVO order.

One important issue in the analysis of these constructions is the size and complexity of the controlled structure. During our fieldwork, we tried the SOV word order with non-controlled 'finite' complements and it was judged as unacceptable. This is illustrated in (25)–(26). As shown in (25)–(26), any order but SVO was considered unacceptable in cases of non-controlled finite clauses.[20]

(25) aogi soa piao páobaha Kapoogo pi
*white saw water-river wet Kapoogo water*
'The foreigner saw Kapoogo taking a bath in the river'

(26) a. *aogi piao páobaha Kapoogo pi soa
b. *aogi piao páohaha pi Kapoogo soa
c. *aogi piao páobaha pi soa Kapoogo

[19] According to Everett (2009), (22) has many different interpretations.

[20] We conclude that non-SVO orders are unacceptable, because every time we pronounced the sentence in (25) in one of the orders in (26), Iaphohen repeated it back to us using SVO.

From this, we conclude that full finite complement clauses (full CPs) cannot precede the matrix verb. Only constituents smaller than CP are able to do so. Thus, from (14), repeated here as (27), the "sentential" constituent preceding the matrix verb in an SOV order is either a VP or TP.

(27) a. ti kapiiga kagakai ogabagai
*I paper study want*
'I want to study'

b. ti tiisi ikohaipiha ogabagai
*I fish eat want*
'I want to eat fish'

(28) shows that the complement of a desiderative verb might be a non-controlled constituent. In (28), the embedded sentence is understood as being 'Kapoogo to study'. Given that this sentence has an overt subject, it might be a full TP with the DP *Kapoogo* marked with nominative case. Nevertheless, (28) might as well be a case of exceptional case marking (ECM), in which the embedded subject is marked with accusative case. Pirahã does not make any morphological distinction between accusative and nominative case, and we do not have any data showing, directly or indirectly, the case that the embedded subject is checking. Therefore, we will not attempt to postulate a structure for (28). Interestingly, however, in this sentence, *Kapoogo*, the understood embedded subject, appears at the end of the sentence, after the desiderative main verb. This suggests that in an SOV order, the object cannot be larger than a VP.

(28) a. ti kapiiga kagakai sogabagai Kapoogo
*I paper study want Kapoogo*
'I want Kapoogo to study'

b. *ti Kapoogo kapiiga kagakai sogabagai[21]
*I Kapoogo paper study want*
'I want Kapoogo to study'

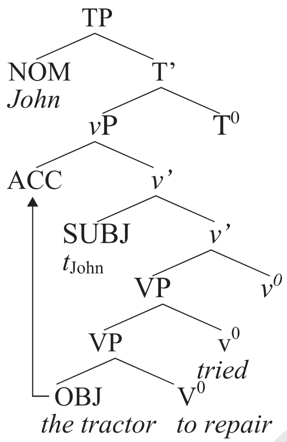
(examples from our fieldwork, July 2012)

This indicates that Pirahã might be similar to German, in that controlled complement clauses, like (27), are bare VPs. Wurmbrand (2001, 2002) did an extensive study on German control configurations, and convincingly argues that these constructions are cases of restructuring, which she analyzes as involving an embedded bare VP. The example in (29) exemplifies German control, and (30) shows the structure proposed by Wurmbrand.

[21] According to Hiahoai (26b) is fine, but it means 'I, Kapoogo, want to study'. Hence, (26b) is ungrammatical with the meaning we were looking for.

(29) weil Hans den Traktor zu reparieren versuchte
*since John the-ACC tractor to repair tried*
'since John tried to repair the tractor'
(example from Wurmbrand 2002:105)

(30)




Wurmbrand presents a series of arguments that German control is restructuring, clause union.[22] First, long passives are allowed (31), with the internal argument of the inner verb surfacing as the subject of the matrix clause. Second, the object of an extraposed controlled infinitival might be scrambled, appearing before the main verb (32).

(31) Der Lastwagen und der Traktor wurden/*wurde zu reparieren versucht
*[the truck and the tractor]-NOM were/*was to repair tried*
'They tried to repair the truck and the tractor'

(32) dass Hans den Traktor versucht hat zu reparieren
*that John the-ACC tractor tried has to repair*
'that John (has) tried to repair the tractor'
(examples from Wurmbrand 2002:104, 106)

[22] In Romance languages, restructuring is traditionally analyzed as involving v-to-v movement; the embedded verb adjoins to the matrix verb, and as a result a biclausal structure is reduced to a single clause (Aissen and Perlmutter 1983; Rizzi 1982). The analysis proposed by Wurmbrand differs from this traditional analysis, as it takes German restructuring to be configurations with a pruned embedded structure, i.e., a bare VP.

We did not check whether Pirahã licenses long passives and object scrambling. Long passives might actually not be possible to directly test in Pirahã, as Everett (1986) observes that Pirahã does not have passives. However, a strong piece of evidence for assuming that controlled complement clauses in Pirahã are bare VPs comes from the fact that these clauses cannot have temporal adverbs on their own. For example, in a sentence like (17), the temporal adverb cannot be interpreted as having scope over the embedded clause only. It must have scope over the entire sentence. Hence, (33) cannot be used to describe a situation like (34).[23]

(33) ti sogabagai tiisi ikohaipi ahogio
I want fish eat yesterday
'Yesterday, I wanted to eat fish'

(34) # 'Last week, I wanted to eat fish yesterday'

If this analysis is on the right track, in this section, we have shown that in Pirahã control configurations involves restructuring, as in German. In an SOV order, the verbal complement is a VP. Hence, Pirahã allows self-embedding because it can embed a VP under another VP.

Everett (1986) also analyzes this type of construction. His analysis is similar to ours in that he takes sentences like the ones shown above to be single clauses. Differently from us, however, he assumes the desiderative verb to be a morpheme, *-sog*, which attaches to the main verb.[24] His analysis is exemplified in (35).

[23] The unacceptability in (33) can result from the fact that it might be hard to conceive a situation in which a person had a week ago the desire of eating fish yesterday. But, of course, it is not impossible, as we have no problem with a sentence like 'a week ago, I wanted to eat fish yesterday during our special dinner, but I changed my mind.' We will leave it as it is, but it is important to observe that the unacceptability of (33) may not be due to syntactic structure, but rather a failure in the elicitation process. As we were dealing with a monolingual speaker, we acknowledge that this type of failure might have occurred. Notice that we tested different contexts and different temporal adverbs, and in all of them, Hiahoai was consistent in rejecting a reading with 'yesterday' modifying 'to eat fish.'

[24] In the history of control, the desiderative verb *want* has received different analyses. Although it is standardly assumed to be full a lexical head (cf. Landau 2000), Cinque (2006a) and Grano (2012), analyzing restructuring configurations, take *want* to be the instantiation of a functional head, which is part of a universal hierarchy. Cinque suggests that structures with *want* can be mono-clausal or biclausal. In mono-clausal structures, *want* takes the VP following it as its complement. In biclausal structures, the complement of *want* is an abstract verb, which, in turn, takes a CP as its complement. Conversely, Wurmbrand (2001, 2002), as shown in (30), presents a different analysis for restructuring, suggesting *want* to be a lexical head that selects a bare VP as its complement. In Pirahã, as we show in this chapter, there is no evidence that *want* is a functional head. In this language, functional heads appear as suffixes to the main verb. The verb in question does not behave as a verbal suffix in Pirahã, being rather a full verbal form.

(35) ti xoba-i-sog-abagai hiaitíihí ti xahaigí
*I see-EP-DES-FRUS Pirahã I brother*
'I want to see the Pirahã, who are my brothers'
(example from Everett 1986:212)

This analysis is tied to the fact that the SOV order was found with the desiderative verb in question and temporal adverbs placed at the end of the whole sequence have scope over the entire sentence, as in (33). There is, nevertheless, compelling evidence against taking the desiderative verb to be a morpheme attached to the main verb. First, control with SOV order seems to be productive with other verbs. For instance, (20), repeated here as (36), shows that control can occur with ditransitive verbs, such as *give*, which does not seem to be a bound morpheme. That is, even if we were to analyze *sog(abagai)* 'want' as a morpheme, we would still need an analysis of control in examples like (36).

(36) ti kaai iaipaha tabo kabahai niai
*I house make wood gave-NEG you*
'I did not give you wood to make a house'

Second, with the desiderative verb *sogabagai* 'want', the SOV order can alternate with SVO, as shown by (13b) and (14b) repeated below as (37a) and (37b), respectively. If the desiderative verb were a morpheme attached to the verb *ikohaipiha*, we would expect SVO order to be impossible.

(37) a. ti ogabagai tiisi ikohaipiha
*I want fish eat*
'I want to eat fish'
b. ti tiisi ikohaipiha ogabagai
*I fish eat want*
'I want to eat fish'

Third, as Everett (1990) observes, the desiderative verb *og*(*abagai*) can occur on its own, without being accompanied by any another verb. Therefore, it cannot be a verbal suffix. This is compatible with *og*(*abagai*) being a verb.

(38) a. xapisiooi hi **og**-i-hiab-a
*Xapisiooi he want-EP-NEG-REM*
'Xapisiooi doesn't want (it)'

b. ti baósaápisi **og-abagaí** gíxai go- baósaápisi
*I hammock want-FRUS you OBL hammock*
big- áo- b- í- i xai sigíaibe(?)

*show*-TEL-PERF-PROX-CCERT *be(?) same*
'I want the same hammock which you just showed me'

c. xitáíbígai xaoói kaab oá-bog-á-ta-haí
*Xitáíbígai foreigner much buy-come(?)*-REM-ITER-RCERT
xao xaigíagaó ogió hi xis **og**-á
*foreigner* LOG.PROG *much he animal want*-REM
'Xitáíbígai, the foreigner, bought a lot (of meat). That is, we are saying that he wants a lot of meat'
(data from Everett,1990:250, 276, 307; emphasis is our own)

Fourth, the fact that an adverbial expression placed at the end of the sequence can have scope over the second predicate only, *maitai* 'Humaitá' in (17), repeated here (39), shows that these are at least two VPs in these structures.

(39) ti sogabagai kapiiga kagakai maitai ahogio
*I would-like paper study Humaitá yesterday*
'Yesterday I would like to study in Humaitá'

In summary, there is plenty of evidence that the desiderative verb *want* in Pirahã is not a verbal affix, but a full verb.

## 4 Conclusion

Looking at constructions with control in Pirahã, we find evidence against Everett (2005, 2009) that this language allows self-embedding. Pirahã is similar to German in that control involves restructuring, with the embedded predicate being a bare VP, which is indeed merged in the complement position of the matrix VP. Hence, our analysis shows that self-embedding in Pirahã is possible, at least at the VP level. It is important to emphasize that we do not find evidence that sentential self-embedding (i.e., self-embedding at the CP level) is impossible in Pirahã. What our research shows is that self-embedding is indeed possible, as it occurs at the VP level. Therefore, to advance our understanding of the Pirahã grammar, we should now shift the focus of our attention, and instead of pressing on issues about the unavailability or availability of recursion/self-embedding in this language, we should rather look for evidence in favor of or against sentential self-embedding. Is sentential self-embedding unavailable in this language? If yes, what is blocking it? Are there any interface constraints that filter out representations with embedded CPs?

# 7 Switch-Reference Is Licensed by Both Kinds of Coordination: Novel Kĩsêdjê Data

*Rafael Nonato*

## 1 Introduction

Debates between disagreeing specialists are the bread and butter of scientific development. In areas like the documentation of individual indigenous languages, however, there is often a single specialist, with the inescapable consequence that no one else is in as good a position to make criticisms. This is my case as the sole linguist currently working on the documentation of Kĩsêdjê, a Jê language spoken in Central Brazil.[1]

In this chapter I advance a novel description of switch-reference marking in symmetric and asymmetric coordination in Kĩsêdjê. This description differs from the one I defended in Nonato (2014). The latter was assumed in the presentation delivered at the conference that gave rise to the present volume. My novel description arises from a new set of judgments collected in November 2014. These new judgments contradict the earlier ones I had based my previous description on. According to the old judgments, switch-reference marking could only be found in asymmetric coordination, never in symmetric coordination, whereas according to the judgments collected more recently, switch-reference actually does not seem sensitive to the distinction between symmetric and asymmetric coordination, being found in coordinate complexes of either type.

Such a state of affairs would not be surprising if I held tenable the assumption that the differences between symmetric and asymmetric coordination can be explained purely in terms of pragmatic implicatures (as Grice 1975; Schmerling 1975; Posner 1980; and Carston 1993, 2002 defend). However, I find it very hard to hold that assumption in the face of the various syntactic phenomena that have been found to distinguish between symmetric and asymmetric coordination: asymmetric coordination licenses a wider range of extraction types (Ross 1967; Lakoff 1986; Culicover and Jackendoff 1997; Postal 1998); only symmetric coordination licenses sloppy reconstruction (Nonato 2014); only

[1] I started working with the Kĩsêdjê in 2008, having since conducted ten field trips.

symmetric coordination licenses gapping (Levin and Prince 1986); asymmetric coordination in German licenses violation of verb-last in embedded clauses (Reich 2008); and CP coordination is always symmetric (Bjorkman 2011).

Ultimately, the question of whether switch-reference can provide further evidence for the study of the difference between symmetric and asymmetric coordination is not settled. In Section 4, I introduce some still unanswered empirical questions regarding the more subtle behavior of switch-reference when embedded in coordinate structures of different types, questions that I hope to pursue in future field trips.

This chapter, as well as many others in this volume,[2] is concerned with a precise determination of the recursive structure of clause-combining constructions. In the presentation I gave at the conference that gave rise to this volume, I relied on the sensitivity of switch-reference to coordination type to propose that there was a structural difference between the two types of coordination: symmetric coordination would come about through direct recursion and asymmetric coordination through indirect recursion (see Roeper 2011). Though the current data does not allow me to defend this theory, there are still, as I observe in Section 4, some open empirical questions regarding the sensitivity of switch-reference to coordination type which may prove productive in the study of the structure of coordination.

This chapter is organized as follows: in Section 1.1, I offer an overview of the main typological features of Kĩsêdjê; in Section 1.2, I introduce the distinction between symmetric and asymmetric coordination; and in Section 1.3, I introduce the phenomenon of switch-reference. Having dealt with these prerequisites, in Section 2, I present the judgments collected in November 2014 and the novel description of the Kĩsêdjê switch-reference marking system they constitute evidence for. In Section 3, I investigate the methodological shortcomings I believe affected the previous collections of judgments and expose how I think they were overcome in the more recent collection. I conclude this chapter in Section 4 by offering a panorama of the empirical and theoretical questions prompted by our current knowledge of the Kĩsêdjê switch-reference marking system.

### *1.1 Kĩsêdjê's Main Typological Features*

Kĩsêdjê is strictly head-last in the nominal domain and almost strictly head-last in the clausal domain (only modality, the highest head in the clausal domain, sits to the left of its complement). The verb always comes last in

[2] In particular the chapters contributed by Amaral and Leandro, Corrêa et al., Vieira, Duarte, Sauerland, and Storto et al.

the clause, to the right of its direct object in the case of transitive verbs. Any argument PPs will precede the verb and its direct object, and be preceded by adjunct PPs and adverbs. The order of the adjuncts can vary. Coming before all of the constituents mentioned above is the subject, with an obligatory modality particle (occurring only in main clauses) to the left of it. Some values of the modality particle license a further position to its left. In particular, the factual non-future value of the modality particle licenses a focus position to its left, and if a sentence inflected in the factual non-future modality contains a focused constituent, it must be dislocated to that position to the left of the modality particle. The scheme in (1) summarizes these observations.

(1) Word-order in the clausal domain
(Foc) [Mod [S (Adjuncts) (PP Args) [(DO) V]]]

As mentioned above, Kĩsêdjê is strictly head-last in the nominal domain. Nouns come to the left of determiners, and possessors to the left of nouns. There are no nominal categories of number and adjective (these concepts are expressed verbally and are realized through relative clauses, which are internally headed in this language). Adpositions are postpositions. Scheme (2) summarizes these observations.

(2) Word-order in the nominal domain
[[(Possessor) Noun] (Det) ] (P)

Kĩsêdjê is a dependent-marking language. There is no agreement, except for the obligatory presence of a resumptive pronoun marking the base position of dislocated arguments. A nominative-accusative frame is found in main clauses and an ergative-absolutive frame in embedded clauses. Most verbs have two forms, a morphologically simpler one that they appear in when heading main clauses and a morphologically more complex one that they appear in when heading embedded clauses. Case on noun phrases is marked by phrasal enclitics. There are distinct ergative and nominative enclitics. Noun phrases in the absolutive and accusative cases are unmarked. For pronouns, different series distinguish between the four cases, although the distinction between accusative and absolutive is only overtly marked in the third person and only in a phonologically restricted environment (see Nonato 2014:sec. 1.2). In the examples given in this chapter, I only gloss the distinctions overtly expressed in a word (for instance, if a verb does not have two distinct forms, I will not mark whether it is in the embedded form or the main form).

### 1.2 Symmetric and Asymmetric Coordination

Clausal coordination is symmetric when the ordering of the conjuncts does not have semantic effects, that is to say, when conjuncts can be swapped while keeping the truth condition of the original sentence (3), and clausal coordination is asymmetric when the order of the conjuncts is semantically relevant, that is to say, when changing their order results in a sentence with different truth conditions (4) (see Ross 1967; Lakoff 1986; Culicover and Jackendoff 1997; Postal 1998). Throughout this chapter, I mark conjunctions heading asymmetric coordination with an overhanging arrow ( $\overrightarrow{\text{and}}$ or $\overrightarrow{\&}$ ) and leave conjunctions heading symmetric coordination unmarked.

(3) Symmetric Coordination (SC)
a. Matthew dates a veterinarian and hopes to date a surgeon.
b. = Matthew hopes to date a surgeon and dates a veterinarian.

(4) Asymmetric Coordination (AC)
a. You can use this magic herb $\overrightarrow{\text{and}}$ get cured of cancer.
b. ≠ You can get cured of cancer $\overrightarrow{\text{and}}$ use this magic herb.

The semantic distinction between symmetric and asymmetric coordination has been correlated with a number of syntactic differences. I offer an overview of these properties in Nonato (2014: sec. 6.2).

### 1.3 Switch-Reference in Kĩsêdjê

Kĩsêdjê's clausal coordinators indicate whether the subjects of the clauses they conjoin are identical or different, a phenomenon Jacobsen (1967) named *switch-reference*. The form *ne* of the conjunction is used to coordinate clauses with identical subjects (5), and *nhy* is one of the forms used to coordinate clauses with different subjects (6).

(5) Same-subject "and"
Hẽn [∅ ˈpâj ]=**ne** [∅ khu-ku. ]
FACT.NFUT 3.NOM arrive =$\overrightarrow{\&}$.SS 3.NOM 3.ACC-eat
'He$_i$ arrived and (then) he$_{i,*j}$ ate it.'

(6) Different-subject "and"
Hẽn [∅ ˈpâj ]=**nhy** [∅ khu-ku.]
FACT.NFUT 3.NOM arrive =$\overrightarrow{\&}$.DS.3.NOM 3.NOM 3.ACC-eat
'He$_i$ arrived and (then) he$_{j,*i}$ ate it.'

In example (6), the form *nhy* of the different-subject coordinator is indicating agreement with the third person nominative subject of the following clause. Other forms of the different-subject coordinator will be used if the subject of the following clause is of the first, second or first inclusive persons. Overt agreement only occurs with nominative subjects. With the exception of *nhy*, the various forms of the different-subject coordinator are homophonous with the nominative pronoun they indicate agreement with. The pronoun itself is only pronounced if not adjacent to the agreeing coordinating conjunction, and suffers deletion otherwise (see Nonato 2014:ch. 4).

## 2 Both Coordination Types License Switch-Reference

In a field trip conducted in November 2014, I collected two consultants' judgments on the use of switch-reference markers in symmetric coordination. These judgments were intended to complement earlier ones collected in February 2013.[3] Both consultants, Kawiri Suyá and Jamthô Suyá, are native in Kĩsêdjê and fluent in Portuguese. They have been working with me as consultants for elicitation sessions since 2008 and 2010, respectively, over which time they have developed a remarkable degree of sensitivity to sentence naturalness/grammaticality, as well as relating naturalness/grammaticality to different speech contexts. The elicitation sessions were carried out separately with each consultant. Explanations and scenario-setting were done in Portuguese.

The empirical question I was trying to answer was whether symmetric coordination licensed switch-reference marking in the same way asymmetric coordination does. The only reliable way to answer that question is through the collection of specific judgments in elicitation sessions, as opposed to the inspection of sentences in text corpora. This is due to the fact that, to determine which of the two types of clausal coordination a coordinate complex instantiates, we are required to compare the relevant coordinate complex with a minimally different version of itself in which the clausal conjuncts are in the opposite order (see Section 1.2). There is obviously very little hope of finding the required minimally differing sentences in text corpora. On the other hand, in elicitation sessions they can be easily constructed and their grammaticality judged.

I collected judgments on different sets of sentences, each proposed against a different background. Given the variety of sentences over which I collected judgments, I could minimize the possibility that the overall results were skewed. The background contexts were defined with the help

[3] In Section 3, I turn my attention to the earlier, rejected judgments.

of a why-question. After fixing any grammaticality issues my consultants pointed out in the context-setting why-questions, I asked their judgments on the grammaticality of a few possible answers, all featuring symmetric coordination.

For reasons of space, in what follows I introduce only two of the eight sets of sentences collected. These particular sets were chosen because they allow me to exemplify the overall pattern the most convincingly. Both sets include (i) sentences differing only in conjunct order and (ii) sentences differing only in the choice of switch-reference marker (same-subject versus different-subject). These two sets also relevantly contrast in that one of them features symmetric coordination of clauses with different subjects and the other features symmetric coordination of clauses with identical subjects.

The examples all involve embedded symmetric coordination. They add a layer of complexity I could not dispense with. As I discuss in Nonato (2014:sec. 6.2.7), there is reason to doubt that main-clause symmetric coordination exists at all in Kĩsêdjê. When given the task of translating Portuguese sentences that feature main-clause symmetric coordination, my consultants produced sequences in which each clause had the intonation of an independent sentence. Independent sentence intonation in Kĩsêdjê is very clear, as it is characterized by sentence-final word lengthening and the addition of a final epenthetic vowel to the sentence-final word if it ends in a consonant.

The consultants' judgments were consistent. They agreed that symmetric coordination of clauses with different subjects must be marked with different-subject morphology, with the use of same-subject morphology explicitly ruled out. Conversely, they also agreed that symmetric coordination of clauses with identical subjects must be marked with same-subject morphology, with the use of different-subject morphology explicitly ruled out.

This is the same basic behavior found in asymmetric coordination (5)/(6). Switch-reference seems not to be among the phenomena sensitive to coordination type (see Section 1.2 for a list of such phenomena). As I already advanced, this conclusion is in contradiction with my previous theory regarding the matter. In Section 3, I introduce and discuss the judgments my previous theory was based on.

Examples (8), (9), and (10) make up one of the sets of sentences featuring symmetric clausal coordination that I collected judgments on. They were presented as possible answers to the why-question (7). The usual way that reasons are expressed in Kĩsêdjê is through asymmetric coordination: the left-hand-side conjunct expresses the reason or reasons for a situation, with the situation itself expressed in the right-hand-side conjunct. Obviously, nothing blocks the left-hand-side conjunct (the reason) from being syntactically complex, which is the case in all of the examples offered for judgment. In (8), (9), and (10), the left-hand-side reason-introducing conjunct is construed as the symmetric coordination of two clauses, each depicting an unrelated reason for buying a mattress.

It is this embedded symmetric coordinate complex we are interested in. As discussed previously, the dominating asymmetric coordinate complex provides an environment in which we can be sure to be dealing with proper symmetric coordination, as opposed to sequences of independent clauses.

(7) Context-setting question
Kuthe=n ka ntektxira atha py?
why= FACT.NFUT 2.NOM mattress that get
'Why did you buy that mattress?'

(8) Answer of the form $\left[\left[S_{i} \cdots\right]_{\alpha} \&_{DS} \left[S_{j} \cdots\right]_{\beta}\right]_{1} \vec{\&} \left[\cdots\right]_{2}$
Hẽn [[Ø-hondo sĩre ]$_{\alpha}$ **=wa** [kê i-mã Ø-khĩn]$_{\beta}$]$_{1}$
FACT.NFUT 3-exchange be.small =&.DS.1.NOM also 1-to 3-like
=ne [wi khu-py.]$_{2}$
=$\vec{\&}$.SS in.fact 3.ACC-get
'I bought it because it was cheap and I liked it.'
lit. [['Its exchange was small]$_{\alpha}$ **and** [I also liked it]$_{\beta}$ ]$_{1}$
a$\vec{\text{n}}$d [(then) I got it.']$_{2}$

Examples (8) above and (9) below only differ in the order of the conjuncts α and β. The Kĩsêdjê consultants considered both orders as truth-conditionally equivalent, which constitutes evidence that the coordination of α and β in (8) and (9) is indeed symmetric.

(9) Answer of the form $\left[\left[S_{i} \cdots\right]_{\beta} \&_{DS} \left[S_{j} \cdots\right]_{\alpha}\right]_{1} \vec{\&} \left[\ldots\right]_{2}$
Hẽn [[wa i-mã Ø-khĩn]$_{\beta}$
FACT.NFUT 1.NOM 1-to 3-like
**=nhy** [[kê Ø-hondo sĩre]$_{\alpha}$]$_{1}$
=&.DS.3.NOM also 3-exchange be.small

=wa [wi khu-py.]$_2$
=$\vec{\&}$DS.1.NOM in.fact 3.ACC-get
'I bought it because I liked it and it was cheap.'
lit. [['I liked it]$_\beta$ **and** [also its exchange was small]$_\alpha$ ]$_1$
$\vec{\text{and}}$ [(then) I got it.']$_2$

The symmetrically coordinated conjuncts α and β have different subjects, a fact reflected by the use of different-subject coordinating conjunctions (boldfaced) as heads of the relevant coordinate complexes in both examples. The exact morphological realization of the different-subject cordinating conjunction in each example is distinct because different-subject coordinating conjunctions agree in person with the subject of their right-hand-side conjunct. In one example, the agreement is with the subject of α (third person), whereas in the other it is with the subject of β (first person).

The use of a different-subject coordinating conjunction to combine α and β is obligatory, as the ungrammaticality of example (10) below attests. The only difference between (10) below and (9) above is the fact that (10) employs the same-subject coordinating conjunction in the position where (9) employs the different-subject coordinating conjunction.

(10) Answer of the form $\left[\left[S_i \cdots\right]_\beta \&_{SS} \left[S_j \cdots\right]_\alpha\right]_1 \vec{\&} \left[\cdots\right]_2$

*Hẽn [ [wa i-mã Ø-khĩn]$_\beta$ **=ne** [kê Ø-hondo sĩre ]$_\alpha$ ]$_1$
FACT.NFUT 1.NOM 1-to 3-like =&.SS also 3-exchange be.small
=wa [wi khu-py.]$_2$
=$\vec{\&}$DS.1.NOM in.fact 3.ACC-get
'I bought it because I liked it and it was cheap.'
lit. [[I liked it]$_\beta$ **and** [its exchange was small]$_\alpha$ ]$_1$
$\vec{\text{and}}$ [(then) I got it.']$_2$

Examples (12), (13), and (15) make up another set of sentences featuring symmetric coordination that I collected judgments on. These sentences were also presented as possible answers to specific why-questions. For reasons that I will discuss shortly, (12) and (13) were proposed as answers to (11), whereas

(15) was proposed as an answer to the minimally different question (14). Questions (11) and (14) differ only in the choice of subject, which is second person in (11) and third person in (14).

(11) Context-setting question

| Kuthe=n | ka | khupẽ | kapẽrẽ | ro | hwĩsôsôkô? |
|---|---|---|---|---|---|
| why= FACT.NFUT | 2.NOM | indians | language | INS | study |

‘Why do you study indigenous languages?’

The sentences in this second set share the same format as those in the set presented above: the relevant symmetric coordinate complex is the left-hand-side conjunct of a dominating asymmetric coordinate complex and expresses the reasons for the situation expressed in the right-hand-side conjunct. A relevant difference between the sets is the fact that in the previous set α and β had different subjects and in this set they have identical ones. To make sure that the coordination of α and β is symmetric in the examples below, I asked the consultants to judge whether (12) and (13), differing only in the relative order between α and β, were truth-conditionally equivalent. The consultants reported that they were.

(12) Answer of the form $\Big[[S_i \cdots]_\alpha \ \&_{SS} \ [S_j \cdots]_\beta\Big]_1 \ \vec{\&} \ \Big[\ldots\Big]_2$

| Hẽn | [ [wa | i-mã | khupẽ | kapẽrẽ | mba-j | khĩn]$_\alpha$ |
|---|---|---|---|---|---|---|
| FACT.NFUT | 1.NOM | 1-to | indians | language | know-EMB | like |

| **=ne** | [kê | khupẽ | patá | mã | i-mbra-j | hrãm]$_\beta$ ]$_1$ |
|---|---|---|---|---|---|---|
| =&.SS | also | indians | village | to | 1-move-EMB | want |

| =ne | [ wi | tho | hwĩsôsôkô. ]$_2$ |
|---|---|---|---|
| =$\vec{\&}$.SS | in.fact | 3.INS | study |

‘I study indigenous languages because I like to learn indigenous languages and also because I want to travel to indigenous villages.’

lit. [ [I like to learn indigenous languages]$_\alpha$

and [I want to travel to indigenous villages]$_\beta$ ]$_1$

and [(then) I study indigenous languages.]$_2$

(13) Answer of the form $\left[\left[S_i \cdots\right]_\beta \&_{SS} \left[S_j \cdots\right]_\alpha\right]_1 \vec{\&} \left[\ldots\right]_2$

Hẽn [ [ wa khupẽ patá mã i-mbra-j hrãm ]$_\beta$ ]$_1$
FACT.NFUT 1.NOM Indians village to 1-move-EMB want
=ne [kê i-mã khupẽ kapẽrẽ mba-j hĩn ]$_\alpha$
=&.SS also 1-to Indians language know-EMB like
=ne [ wi tho hwĩsôsôkô. ]$_2$
=$\vec{\&}$.SS in.fact 3.INS study
‘I study indigenous languages because I want to travel to indigenous villages and also because I like to learn indigenous languages.’

lit. [ [ I want to travel to indigenous villages ]$_\beta$
and [ I like to learn indigenous languages ]$_\alpha$ ]$_1$
and [ (then) I study indigenous languages. ]$_2$

In examples (12) and (13) above, α and β are connected via the same-subject coordinating conjunction *ne*, reflecting the fact that α and β have identical subjects. The ungrammaticality of example (15) – presented as a possible answer to (14) – shows that such marking is obligatory.

(14) Context-setting question
Kuthe=n Khupyt=ta khupẽ kapẽrẽ ro hwĩsôsôkô?
why= FACT.NFUT K.=NOM indians language INS study
‘Why does Khupyry study indigenous languages?’

(15) Answer of the form $\left[\left[S_i \cdots\right]_{2} \&_{DS} \left[S_i \cdots\right]_{\pm}\right]_1 \vec{\&} \left[\cdots\right]_2$

*Hẽn [ [Ø khupẽ patá mã Ø-mbra-j hrãm]$_\beta$ ]$_1$
FACT.NFUT 3.NOM indians village to 3-move-EMB want
**=nhy** [kê kh-wã khupẽ kapẽrẽ mba-j khĩn]$_\alpha$
=&.DS.3.NOM also 3-to indians language know-EMB like
=ne [ wi tho hwĩsôsôkô. ]$_2$
=$\vec{\&}$ SS in.fact 3.INS study

'He studies indigenous languages because he wants to travel to indigenous villages and also because he likes to learn indigenous languages.'

lit. [ [He wants to travel to indigenous villages]$_{\beta}$

and [he likes to learn indigenous languages]$_{\alpha}$ ]$_1$

and [ (then) he studies indigenous languages. ]$_2$

Note that (15) does not differ from (13) only in terms of the coordinating conjunction connecting α and β: it also differs with respect to the subject of those clauses. This difference does not weaken the demonstration. Example (15) is identical in structure to (12) and (13). As a matter of fact, it is also identical in truth conditions in the context in which the sentences were presented. The reference of the subjects of α and β in all three examples is the same, namely, myself (*Khupyry* is what the Kĩsêdjê call me).

These two sets of judgments, added to the other six sets I collected but don't present here, constitute convincing evidence that, in Kĩsêdjê, switch-reference marking is as contrastive in symmetric coordination as it is in asymmetric coordination. This result wouldn't be surprising at all if we assumed that the difference between symmetric and asymmetric coordination could be explained purely in terms of pragmatic implicatures (as Grice 1975; Schmerling 1975; Posner 1980; and Carston 1993, 2002 defend).

I find it hard to hold such an assumption, however, in the face of the various syntactic phenomena that have been found to distinguish between symmetric and asymmetric coordination. I listed those I am aware of in this chapter's introduction. Given these phenomena, it is unexpected that switch-reference should prove to be completely insensitive to coordination type. The judgments collected in November 2014 and partly presented above, however, don't show that switch-reference is *completely* insensitive to coordination type. In Section 4, I discuss contexts in which I have not yet been able to determine whether switch-reference behaves the same way in symmetric coordination as it does in asymmetric coordination. But before going there, I introduce in the next Section the previously collected judgments – the ones superseded by the judgments collected in November 2014 – and discuss the methodological shortcomings that played a role in their (mis)collection.

## 3 Superseded Data and Reflections on Methodology

In my former descriptions of the Kĩsêdjê system of switch-reference marking (Nonato 2014:ch. 6, as well as the presentation I delivered at the conference that gave origin to this volume), I stated that switch-reference is marked exclusively in asymmetric coordination and cannot be marked in symmetric coordination. I was basing that description on judgments such as (16) and (17). In the field trip I took in November 2014, these very sentences were again subjected to judgment and were this time considered ungrammatical. Given such a turn of events, I proceeded to collect judgments about eight other sets of sentences featuring switch-reference and symmetric coordination, as I reported in the previous Section.

(16) *Superseded judgment:* ✓ in 2012, * in 2014
[<u>Hwĩsôsôk kandêjê</u>=ra kôre hwĩsôsôk tá mã pa ]$_1$=n
[students=NOM 3.ERG school to move.PL] = $\vec{\&}$.SS
[hwĩsôsôk ]$_2$
[learn ]
=ne [tá ro sakhre]$_3$ = **n** [kê <u>hwĩsôsôk jarẽn kandê</u> = ra aj
=&.SS [count ] =&.SS [also teacher=NOM PL
khuktxêrê]$_4$
question ]
mã.
FUT

'The students go to school $\overrightarrow{\text{and}}$ (then) study, count, and the teacher asks them questions.' i.e., 'The students go to school to study, to count, and for the teacher to ask them questions.'

(17) *Superseded judgment:* ✓ in 2012, ∗ in 2014
[ Hwĩsôsôk tá khãm <u>hwysysôm</u>=nda khêt ]$_1$ **= ne**
[ school in mosquito=NOM be.not] = &.SS [also
[kê <u>*i-khá*</u>=ra
1-shirt=NOM
thyktxi ]$_2$ =wa [s-atá-rá khêrê.]$_3$
be.dirty ] =$\vec{\&}$.DS.1.NOM [3-put-EMB be.not]
'At the school there are no mosquitoes and my shirt was dirty and (then) I did not put it on.'

In the examples above, the conjunction *=n(e)* is employed indistinctly in the symmetric coordination of clauses with identical subjects – clauses 2 and 3 in (16) – as well as in the symmetric coordination of clauses with *different* subjects – clauses 3 and 4 in (16) and clauses 1 and 2 in (17) – the conjunction is boldfaced in the latter occasions. That is to say, change or maintenance of subject is not being marked in those instances of symmetric coordination. Given the judgment, contradicted in the more recent field trip, that examples (16) and (17) are grammatical, I used to assume that switch-reference was licensed only in *asymmetric* coordination.

As explained in Section 2, in a more recent collection of judgments the examples above were considered ungrammatical. In addition, judgments were collected about eight other sets of sentences involving symmetric coordination and it became clear that switch-reference is obligatorily marked in both kinds of coordination.

I revisited my records of the elicitation sessions in which I collected the superseded judgments and noted that they were collected at the end of very long sessions. In most of them, I was trying to determine the obligatoriness or optionality of various phonologically small functional words occurring in some of these sentences, in particular the word *kê* 'also.' The mistaken finding that switch-reference was not marked in symmetric coordination was a side result of those elicitation sessions, and I did not have a chance to pursue the matter further until the following field trip, in November 2014.

In the more recent collection of judgments, I made sure to use varied contexts, which helped the consultants in keeping their focus. Since the collection was also directed towards determining the specific behavior of switch-reference in symmetric coordination, I managed to collect more complete paradigms and, as reported, could establish very clearly that the early judgments were mistaken.

## 4 Concluding Remarks: Research Questions

The judgments collected in November 2014 show very convincingly that, for *trivial switches*, switch-reference does not distinguish between symmetric and asymmetric coordination. By trivial switches I mean occasions in which the subjects under comparison are either completely identical or completely disjoint.

Besides trivial switches, there are also occasions I call *non-trivial switches* – those in which the subjects under comparison, though disjoint, still share a non-empty intersection. Many languages extend the use of same-subject morphology to some specific kinds of non-trivial switch. This phenomenon has been explored in Kĩsêdjê only in *asymmetric* coordination. It has been found that, in asymmetric coordination, if the subject of the second conjunct *includes* the subject of the first conjunct, as long as both subjects are of the same grammatical person, coordination will be marked with a same-subject conjunction, as seen in (18).

(18) Growing-subject switches (subjects of the same person): *same-subject marking*

Athe=n [ wa khikhre nh-ihwêt ] = {ne / *wa}
alone=FACT.NFUT [ **1**.NOM house LNK-build] = $\left\{\vec{\&}.\mathrm{SS} / {*}\vec{\&}.\mathrm{DS.1.NOM}\right\}$
[ aj i-hwêtri
[ PL **1**-all
∅-khãm aj i-pa. ]
3-in PL 1-move. PL ]
'I built the house by myself and all of us moved into it.'
$[S_1 \subset S_2 \text{ and } P_{S1} = P_{S2} = \mathbf{1}]$

Non-trivial switches can be classified into three types, listed in (19). The type instantiated in (18) is the *growing-subject* type. Only non-trivial switches of this type are marked as same-subject in Kĩsêdjê, and only, as I have already mentioned, if the subjects compared are of the same grammatical person. In (20), for instance, since the subject of the first clause is of a different grammatical person than the subject of the second clause, different-subject morphology is the only choice, in spite of this being an instance of growing-subject switch. Keep in mind that first person plural corresponds to exclusive 'we' – *wa* '1.NOM' + *aj* 'PL' – whereas inclusive 'we' is categorized as a different grammatical person altogether, and is not accompanied by a plural marker – *ku* '1+2.NOM' (* + aj 'PL').

(19) Subtypes of non-trivial switch

a. **Growing-Subject**: $S_1 \subset S_2$ $(S_1 = \{i\}; S_2 = \{i, j\})$

$\boxed{I_i}$ built the house by myself but $\boxed{we_i + j}$ all live in it.

b. **Shrinking-Subject**: $S_1 \supset S_2$ $(S_1 = \{i, j\}; S_2 = \{i\})$

$\boxed{We_i + j}$ built the house together but only $\boxed{I_i}$ live in it.

c. **Strictly-Intersecting-Subjects**:

$S_1 \cap S_2 \neq \varnothing, S_1 \not\subset S_2, S_1 \not\supset S_2$ $(S_1 = \{i, j\}; S_2 = \{i, k\})$

$\boxed{\text{He}_i \text{ and his father-in-law}_j}$ built the house and $\boxed{\text{he}_i \text{ and his wife}_k}$ live in it.

(20) Growing-subject switches (different-person subjects): *different-subject marking*

Akatxi khêt khãm = na [ wa a-thok ] = {ku / *ne} [(*aj)

morning in FACT.NFUT [ **1**.NOM 2-wake.up] = {$\vec{\&}$.DS.1+2.NOM / * $\vec{\&}$.SS.} [(*PL)

thẽ ] = n [ thep jariri. ]

go.SG ] = $\vec{\&}$.SS [ fish look.for ]

'In the morning I woke you up and $we_{incl.}$ went fishing.'

[$S_1 \supset S_2$ but $(P_{S1} = \mathbf{1}) \neq (P_{S2} = \mathbf{1+2})$]

Shrinking-subject switches and strictly-intersecting-subject switches are always marked in Kĩsêdjê with different-subject morphology – see (21) and (22), respectively. Other switch-reference marking languages have different rules on what kinds of non-trivial switches are marked with same-subject morphology and what kinds are marked with different-subject morphology.

(21) Shrinking-subject switches ($S_1 \supset S_2$): *different-subject marking*

Hẽn [ wa aj i-hwêtri khikhre nh-ihwêt ] = $\{$wa / *ne$\}$
FACT.NFUT [ 1.NOM PL 1-all house LNK-build] = $\left\{\vec{\&}.\text{DS}.1.\text{NOM} \big/ {*}\vec{\&}.\text{SS}.\right\}$
[ pa-rit
[ 1-only
aj ∅-khãm ∅-mbra ]
PL 3-in 3-move.SG]
'All of us build the house but only the two of us live there.'

(22) Strictly-intersecting-subject switch: *different-subject marking*
($S_1 \cap S_2 \neq \varnothing$, $S_1 \not\subset S_2$, $S_1 \not\supset S_2$)
[ Rafael me s-umbrengêt=ta khikhre nh-ihwêt ]
[ R. and 3-father.in.law=NOM house LNK-build ]
=$\{$nhy / *ne$\}$ [
=$\left\{\vec{\&}.\text{DS}.3.\text{NOM} \big/ {*}\vec{\&}.\text{SS}.\right\}$[
Rafael me ∅-hrõ wit ∅-khãm mbra. ]
R. and 3-wife only 3-in move ]
'Rafael and his father-in-law built a house and Rafael and his wife live in it.'

Table 7.1 *Languages that use same-subject marking for nonstrictly co-referent subjects*

| Language | Family | SS | | | Reference |
|---|---|---|---|---|---|
| | | $1 \subset 2$ | $1 \supset 2$ | $1 \cap 2$ | |
| Mojave | Yuman | ✓ | ✓ | | Munro (1980) |
| Huichol | Uzo-Aztecan | ✓ | ✓ | ✓ | Comrie (1983) |
| Kobon | Trans New-Guinea | p= | ✓ | p= | Comrie (1983) |
| Gokana | Niger-Congo | ✓ | * | * | Comrie (1983) |
| Lenakel | Austronesian | ✓ | * | * | Lynch (1978, 1983) |
| Washo | Hokan | ✓ | ✓ | * | Finer (1984:85) |
| Kĩsêdjê | Jê | p= | * | * | *my fieldwork data* |
| Kashaya | Pomoan | ✓ | ✓ | | Oswalt (1961) |
| Zuni | Isolate | * | ✓ | | Nichols (2000) |
| *all* | Yuman | ✓ | ✓ | | Langdon and Munro (1979) |
| Diyari | Pama–Nyungan | ✓ | * | | Finer (1984) |
| Jamul | Yuman | ✓ | * | | Miller (2001) |
| Udihe | Altaic | ✓ | ✓ | | Nikolaeva and Tolskaya (2001) |
| Mian | Ok (Trans New-Guinea) | ✓ | ✓ | | Fedden (2011) |
| Tauya | Trans New-Guinea | | ✓ | | MacDonald (1990) |
| Usan | Numugenan | p= | ✓ | | Reesnik (1983) |
| Telefol | Ok (Trans New-Guinea) | | ✓ | | Healey (1966) |
| Savosavo | Papuan | ✓ | | | Wegener (2012) |

Extending same-subject morphology to mark non-trivial switches is a very widely attested phenomenon. Table 7.1 compiles data about languages that have been documented in that respect. The symbols used in the table are: ✓, to indicate that a language allows same-subject marking in a specific situation; *, to indicate that a language disallows same-subject marking in a specific situation; and *p*=, to indicate that a language allows same-subject marking in a specific situation only in cases where the subjects under comparison are of the same grammatical person. Cells left empty indicate that no information was found in the literature about how a language behaves in a certain situation. I have not found any mention in the cited literature of whether the phenomenon was documented in only a specific kind of coordination. Note, on the other hand, that switch-reference is not restricted to coordination, and indeed in some languages it seems to only be found in clausal adjunction.[4]

The Kĩsêdjê examples from (18) to (22), with which I illustrated switch-reference marking in non-trivial switch situations, are clear instances of asymmetric coordination. As I already stated, no examples of non-trivial switches in symmetric coordination have been collected. It would be surprising to find that switch-reference marking in symmetric coordination in the intrinsically asymmetric context of non-trivial switches were marked in the same fashion described above. Notwithstanding my expectations, this is an open empirical question, with possibly interesting theoretical consequences.

[4] This discussion about non-trivial switches was adapted from Nonato (2014:66–67). See also McKenzie (2015:427), an extensive survey about switch-reference in North American indigenous languages, which includes a discussion of non-trivial switches in Section 4.2.1.

# 8 Clausal Recursion, Predicate-Raising, and Head-Finality in Tenetehára

*Fábio Bonfim Duarte*

Tenetehára is a language spoken by two indigenous groups of Brazil: the Tembé and the Guajajára.[1] The Tembé group lives on the border of the states of Maranhão and Pará, while the Guajajára group lives in the state of Maranhão, in the northern region of Brazil. The Tenetehára language belongs to the Tupí-Guaraní family, Tupí Stock.

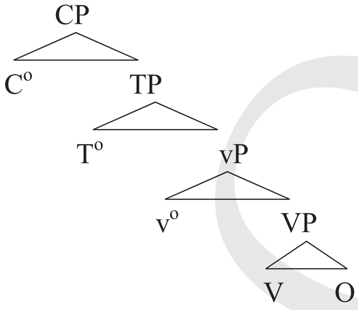
The main goal of this chapter is to present evidence in favor of the following proposals: (i) Tenetehára is a predicate-fronting language; (ii) verbs do not undergo head movement to the functional layer of the sentences, because there is a general preference for XP rather than X$^o$ movement; (iii) clausal recursion systematically involves predicate-raising to specifier positions of functional projections; (iv) the head C$^o$ is hybrid in the sense that complementizers can occur in either the head-initial or head-final position. The analysis of recursion in clausal constructions will be particularly relevant in that it integrates into the broader goals of this volume, which aims to show that recursion is a syntactic property that is pervasive across human languages (for analyses that follow these same lines of reasoning, see the chapters by Viera; Nonato; and Rodrigues, Salles, and Sandalo in this volume).

As will be demonstrated in the following sections, Tenetehára clausal recursion exhibits the [[[SOV]-C$^o$]-T$^o$] word order. In line with this assumption, the C$^o$ hybridity must be treated as a surface phenomenon and not as a phenomenon of the base. Therefore, I will assume hereafter that Tenetehára root and embedded CPs are uniformly generated to the left and that the apparent C-final order is the result of the vP-fronting. The immediate consequence of this analysis is that clausal recursion involves left-dislocation of the vP to specifier

[1] I would like to thank two anonymous reviewers, who generously offered their constructive critiques, which contributed greatly to improving this chapter. To the Tenetehára people from the Gurupí River and from the Araribóia Territory, located, respectively, in the states of Pará and Maranhão, I would like to extend my sincere thanks for their invaluable assistance with my fieldwork research in the last two decades. I take full responsibility for all possible errors in the content of this chapter. The research represented here has been funded by CAPES-Brazil (grant #1978/09-8), by FAPEMIG (grant #19901), by CNPq (grant #302674/2009-8), and by the Pró-Reitoria de Pesquisa da Universidade Federal de Minas Gerais (PRPq/UFMG).

positions of higher projections located in the functional layer of the subordinate sentences. In order to derive the hybrid nature of C, I will assume Kayne's Linear Correspondence Axiom (LCA), according to which the subject is universally projected to the left of vP. Kayne (1994) argues that the core properties of phrase structure must be determined by hierarchical relations. This theory predicts that a head will always project its specifier on the opposite side of its complement, due to the fact that specifiers asymmetrically c-command the internal arguments in phrase structure. Kayne (1994:36) posits that specifier-head-complement is the universal order to the subcomponents of a phrase so that whenever a category X asymmetrically c-commands a category Y, the words dominated by X must precede the words dominated by Y. Based on these assumptions, the main purpose of this chapter is to examine the derivation of the clauses with the VSO, SVO-Tense, VSO-Tense, and SOV-C-Tense orders. Assuming Kayne's antisymmetric theory, I will propose, hereafter, that all clauses in Tenetehára originate as SVO, as shown in the structure depicted in (1):

(1)




Another goal of the chapter is to show that Tenetehára SVO-Aux°/T° clauses present a counterexample to the Final-over-Final Constraint (FOFC). One of Biberauer, Holmberg, and Roberts' (2014) claims is that the SVO-Aux order is not attested in the world's languages. According to this view, the alleged absence of the SVO-Aux order is one piece of empirical evidence that led Biberauer, Holmberg, and Roberts to state the FOFC as follows:

(2) The Final-over-Final Constraint (FOFC)
If α is a head-initial phrase and β is a phrase immediately dominating α, then β must be head-initial. If α is a head-final phrase, and β is a phrase immediately dominating α, then β can be head-initial or head-final.

However, the Tenetehára sentences in (3) clearly indicate that a head-final T can c-select a head-initial vP, as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| (3) | *ma'e*[2] | *pe* | *Zuze* | *w-enu* | *tazahu* | *ra'e?* |
| | what | at | John | 3-hear | big pig | IPAST |

‘Where has John heard the big pig?’

| | | | | |
|---|---|---|---|---|
| (4) | *a'e ae* | *u-mu-me'u-putar* | *wa-n-emiapo-kwer* | *nehe.* |
| | he EMP | 3-CAUS-speak-want | 3PL-REL -make-PAST | FUT |

‘He will tell what they have made.’

| | | | | |
|---|---|---|---|---|
| (5) | *awa* | *w-ekar* | *tapi'ir* | *∅-iko* |
| | man | 3-look for | tapir | 3-be |

‘The man is looking for tapir.’

Notice that in the clauses above, the head-final tense particles are preceded by a head-initial vP. Thus, if one assumes that these particles project a functional category responsible for encoding the temporal and aspectual meaning of the sentence, these examples indicate that the head v° does not force its complement to move to its specifier, which clearly violates FOFC.

The methodology used in this research involved the analysis of oral and written texts, directly produced by the indigenous teachers who participated in our research activities as consultants. The aim was to help in the documentation and linguistic preservation of the Tenetehára language. In this sense, many of the examples presented in this chapter were extracted from real pragmatic contexts, based on these published materials. In addition, the analysis is also based on introspective linguistic data that were collected by means of both direct elicitation and grammatical questionnaires, during which consultants were asked to translate sentences from Portuguese into Tenetehára. Such sentences usually focus on the strategies of how tense, evidentiality, interrogation, and recursion are encoded in the language. Tests of judgments on the co-occurrence of the predicate and the tense and complementizer particles revealed that this language allows the following word order pattern: VSO, VSO/SVO-Tense and SOV-C-Tense. Furthermore, it was observed that the SV-Tense-O and SVO-C-Tense word orders are not grammatically possible.

[2] Considering the phonemic pattern of Tenetehára, this chapter adopts an orthography whose main purpose is to facilitate the reading of the data used in the analysis. The graphemes are as follows:

(i) consonants: p, t, k, ', m, n, g, gw, k, kw, z, x, h, r, w
(ii) vowels: a, e, i, o, u, y, à

The graphemes *g* and *gw* correspond, respectively, to the velar phoneme /ŋ/ and the labiovelar /ŋw/; the grapheme *z* to the occlusive alveolar /d/ and its variants [z] and [j]; the grapheme *x* to the alveolar fricative /s/ and its variant [ʧ]; and the diacritic ', to the glottal phoneme /ʔ/. Finally, the graphemes *y* and *à* correspond, respectively, to the high central vowel /ɨ/ and the middle central vowel /ə/.

This chapter is organized as follows: Section 1 aims to present some relevant data on the word order of the main constituents across clauses; Section 2 explores the derivation of the VSO clauses; Section 3 proposes that the occurrence of a tense marker in final position is a reflex of predicate-raising to Spec-TP; Section 4 aims to demonstrate that Tenetehára clausal recursion may be achieved by means of predicate-raising to the specifier position of either TP or CP. Finally, Section 5 concludes the chapter.

## 1 The Word Order of the Main Constituents

Tenetehára main and root clauses may exhibit both VSO and SVO word order, whereas embedded clauses present a rigid word order in the sense that the core arguments of the predicate must always precede both the verb and the complementizer, thereby giving rise to the SOV-C order.[3]

### *1.1 Word Order in Root and Independent Clauses*

Examples of SVO and VSO independent clauses are provided below. Notice that when an oblique phrase, such as a PP, occurs in a sentence, it must follow the direct object, resulting either in the SVO PP order or the VSO PP order, as follows:

(6) *he hy u-m-ur ma'e r-o'o-kwer ha-we.*
my mother 3-CAUSE-come thing REL-meat-PASS me-DAT
'My mother gave meat to me.'

(7) *o-'ok teko mani'ok 'y wi kury*
3-take people manioc water from now
'The people took the manioc from the water.'

(8) *w-ekar teko wakari ita r-ehe*
3-get people catfish stone REL-in
'The people get the catfish in the stone [because this fish usually hides in the stone].'

Tense markers and aspectual auxiliaries are usually placed after the core arguments of the predicate, contexts in which the SVO-Tense and VSO-Tense may occur. Notice that in such contexts, neither the subject nor the object comes after the tense markers or the auxiliaries, as follows:

[3] I refer the reader to Duarte (2005, 2007, 2012) for a detailed analysis of the agreement pattern and the word order system in Tenetehára.

**VSO-Aux**

| | | | | | |
|---|---|---|---|---|---|
| (9) | *w-ekar* | *teko* | *ka'a* | *te* | *o-ho.* |
| | 3-look for | people | bush | EMP | 3-go |

‘The people will look for bush.’

| | | | | |
|---|---|---|---|---|
| (10) | *u-zuka* | *Purutu* | *tapi'ir* | *u-(u)r* |
| | 3-kill | Purutu | tapir | 3-come |

‘Purutu came to kill the tapir.’

**SVO-Aux**

| | | | | |
|---|---|---|---|---|
| (11) | *awa* | *w-ekar* | *tapi'ir* | *∅-iko* |
| | man | 3-look for | tapir | 3-be |

‘The man is looking for tapir.’

**SVO-Tense**

| | | | | | |
|---|---|---|---|---|---|
| (12) | *a'e-ae* | *u-mu-me'u-putar* | *h-emi-apo-kwer* | *a'e* | *nehe* |
| | 3-EMP | 3-CAUS-speak-FUT | 3-NMLZ-cause-PAST | he | FUT |

‘He will tell about his doing (=that thing that was made by him).’

| | | | | | |
|---|---|---|---|---|---|
| (13) | *teko* | *w-apy* | *ko* | *kwez* | *kury.* |
| | people | 3-burn | field | IPAST | now |

‘The people have just burned the field.’

| | | | | |
|---|---|---|---|---|
| (14) | *a'e-à* | *u-'ar* | *kwez* | *tuzuk-pe* |
| | she-ARG | 3-fall | IPAST | mud-LOC |

‘She has just fallen into the mud.’

| | | | | | |
|---|---|---|---|---|---|
| (15) | *a'e-à* | *u-ur* | *kwez* | *he* | *∅-hy iruramo* |
| | he-ARG | 3-come | IPAST | my | REL-mother with |

‘He came with my mother (= by means of her).’

On the other hand, the sentence becomes grammatically disallowed if one places the object after the tense/aspectual markers. Thus, the constraint one may postulate is that the object must systematically precede auxiliary verbs and the tense markers, such as *kwez* and *iko*. This rule is evidenced by the grammatical status of the examples below.

| | | | | | |
|---|---|---|---|---|---|
| (16) | **teko* | *w-apy* | *kwez* | *ko* | *kury.* |
| | people | 3-burn | IPAST | farm | now |

[Intended: ‘The people have just burned the field.’]

| | | | | |
|---|---|---|---|---|
| (17) | **awa* | *w-ekar* | *∅-iko* | *tapi'ir* |
| | man | 3-look for | 3-be | tapir |

[Intended: ‘The man is looking for tapir.’]

Interestingly, the verb never takes the initial position in contexts where the object is dislocated to an A' position. In such contexts, the topicalized object must be indicated on the verb stem by means of the prefix {h- ~ i-}. Moreover, notice that the word order changes from VSO to OSV, as follows:

(18) *w*$_i$*-exak* *Fábio*$_i$ *Márcia*
3-see Fábio Márcia
'Fábio saw Márcia.'

(19) *upaw* *Márcia*$_i$ *Fábio* *h*$_i$*-exak-∅*
all Márcia Fábio 3-see-DISLOC
'All Márcia, Fábio saw.'
[lit.: This means that Fábio saw Márcia in every detail, and not partially.]

(20) *u*$_i$*-'u* *teko*$_i$ *pira*
3-eat people fish
'The people ate (some) fish.'

(21) *upaw* *pira*$_i$ *teko* *i*$_i$*-'u-n*
all fish people 3-eat- DISLOC
'All the fish, the people ate (some).'

In the contexts above, the object receives a contrastive focus reading so that the interpretation in (19) and (21) implies that the events of seeing Márcia and of eating fish were made in their totality, rather than partially.

Another context in which the verb cannot occur in an immediate initial position is related to interrogative sentences. In such contexts, wh-words are systematically placed in the sentence-initial position, signaling that the CP projection in the root clause is clearly head-initial, as follows:

(22) *amo* *te* *u-pyhyk* *tapy'yr* *nehe*
who C 3-hunt for tapir FUT
'Who will hunt for tapir?'

(23) *ma'e* *te* *awa* *u-zuka* *ka'a* *pe?*
what C man 3-kill forest in
'What did the man kill in the forest?'

(24) *ma'e* *mehe* *te* *u-zywyr* *wà*
what time C 3-return PL
'When did they return?'

In contrast to the above contexts, the complementizer particle *te* can be omitted without causing the sentences to be grammatically incorrect, as follows.

(25)

| | | | | |
|---|---|---|---|---|
| *amo* | *u-zuka* | *miar* | *ka'a* | *pe?* |
| who | 3-kill | animal | forest | in |

'Who killed the animal in the forest?'

(26)

| | | | | | |
|---|---|---|---|---|---|
| *amo* | *iruramo* | *awa* | *u-pyhyk-ràm* | *pira* | *o-ho* |
| who | with | man | 3-get-FUT | fish | 3-go |

'With whom will the man get (some) fish?'

(27)

| | | | | | | |
|---|---|---|---|---|---|---|
| *ma'e* | *pe* | *awa* | *u-zuka* | *miar* | *ka'a* | *pe?* |
| where | in | man | 3-kill | animal | forest | in |

'Where did the man kill the animal in the forest?'

The next section aims to present the effects of word order in the subordinated clauses. In these clauses, the word order is SOV-C, and complementizers and aspectual/tense particles are all positioned in sentence-final position.

### *1.2 Word Order in Embedded Clauses*

Subordinated clauses present a rigid SOV-C-T order so that the core arguments of the predicate must systematically precede the complementizer particles. Based on this, the VO order is prohibited in the embedded clauses below:

**sentence-final complementizers**

(28)

| | | | | |
|---|---|---|---|---|
| *a-ha* | [*ka'i* | *h-exak* | *pà*] | *kury* |
| 1-go | monkey | 3-see | COMP | then |

'(I) went to see the monkey then.'

(29)

| | | | | | |
|---|---|---|---|---|---|
| *Sérgio* | *w-exak* | [*Pedro* | *tapi'ir* | *h-aro* | *mehe*] |
| Sérgio | 3-see | Pedro | tapir | 3-wait | COMP |

'Sérgio saw Pedro waiting for the tapir.'

Furthermore, the predicate and the complementizer particles must precede the tense particles, thereby giving rise to the head-final constructions: [[[SOV[-$C^o$[-$T^o$], as follows:

(30)

| | | | | |
|---|---|---|---|---|
| *w-exak* | *awa* | [[*ure-∅-zur*] | ***mehe*]** | ***kwez*]** |
| 3-see | man | $\text{we}_{\text{exclusive}}$-REL-come | COMP | IPAST |

'The man has seen that we have just come.'

(31)

| | | | | | |
|---|---|---|---|---|---|
| *e-pyhyk* | *ne-∅-takihe* | [[*aguza* | *i-zuka* | ***pà***] | ***nehe*]]** |
| 2SG-get | your-REL-knife | rat | 3-kill | COMP | FUT |

'Get your knife in order to kill the rat.'

(32) *Purutu w-exak [[zawar*$_i$ *tapi'ir* *i*$_i$*-zuka* ***mehe***] *∅-**iko**]]*
Purutu 3-see jaguar$_i$ tapir 3$_i$-kill COMP 3-be
'Purutu saw that/when the jaguar was killing the tapir.'

The next section aims to discuss in detail the derivation of each of the clausal patterns shown in this section. The proposal that will be articulated is that the Tenetehára head-finality is a reflection of the fact that there is a general preference for movement of the vP/VP to the specifier position of either CP or TP, rather than dedicated v$^o$ movement to the heads C$^o$ and T$^o$.

## 2 VSO is the Result of VP-Remnant Movement

In root VSO clauses, it is common for a set of second position particles, such as *zekaipo*, *zekwehe*, and *kakwez*, to appear between the verb and the subject.[4] In Tenetehára, speakers usually distinguish between attested and unattested past. Compare the following examples:

**unattested distant past**

(33) *w-exak ze-kwehe zawar-uhu tapixi memyr a'e pe no*
3-see EVID-UDPAST jaguar-big rabbit son there at also
'(They say that) the big jaguar also saw the rabbit's son there.'

(34) *u*$_i$*-m-ur ze-kaipo i*$_j$*-hy*$_i$ *i*$_j$*-zupe*
3$_i$-CAUS-come EVID-UDPAST his$_j$-mother$_i$ him$_j$-to
'(They say that) his mother apparently gave (it) to him.'

**attested distant past**

(35) *u'u kakwez Pedro pira ke'e*
3-eat DPAST.ATTESTED Pedro fish grilled
'Pedro ate grilled fish [The speaker attested it in a past event].'

The particles *zekwehe and zekaipo* in the examples above are composed of three subparts: (i) the evidential clitic [*ze*]; (ii) the particle *aipo*; and (iii) the particle *kwehe*. Notice that *aipo* is only used when the speaker is not sure about whether the event has really happened.[5] This is the reason why it is often used in yes or no questions, as follows:

[4] Within generative theory, there have been different approaches as to the way in which the VSO order is derived. McCloskey (1996), Carnie, Harley, and Pyatt (2000) and Doron (2000), for example, posit that the V-initial order is achieved by means of head movement of the verb to the C/TP domain in languages such as Irish and Hebrew. However, these approaches differ from the ones that assume predicate-raising to derive the V-initial order in languages such as Chol (Coon 2010), Niuean (Massam, 2000, 2005), and Tenetehára (Duarte 2012), among others.

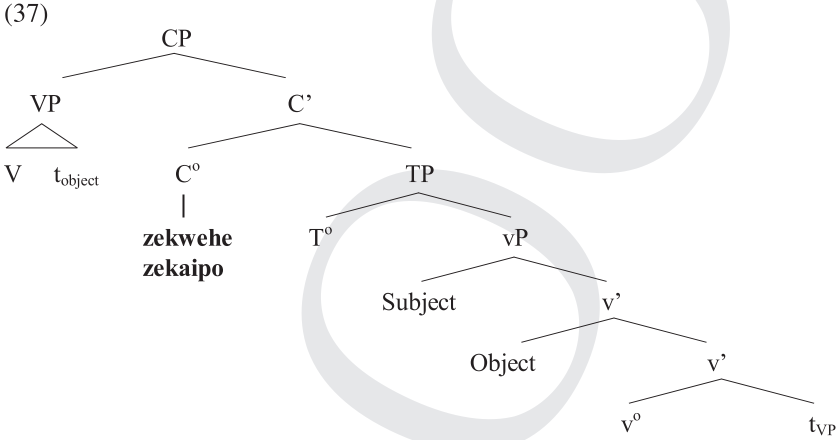
[5] For analysis of evidentiality in other indigenous Brazilian languages, see the chapters by Stenzel and Sauerland in this volume.

(36a) *aipo* *Zuze* *u-'u* *uha*?
Q John 3-eat crab
'Did John eat crab?'

(36b) *he'e,* *u-'u* *uha*
yes 3-eat crab
'Yes, he ate crab.'

Based on the empirical facts presented above, it seems reasonable to propose that these particles head a functional projection located in the CP domain, inasmuch as they encode notions such as tense, evidentiality, and inference. Pursuing this line of reasoning, I will contend that in the sentences above, VP-remnant movement takes place to Spec-CP, as shown in the derivation in (37):

(37)




Based on the structure depicted above, I will assume that *v*Ps, as well as other XPs, compete for the specifier position of CP. The immediate consequence of this generalization is that when an XP is moved to the left periphery, the VP cannot front. For this reason, the generalization that one can propose is that the verb precedes the subject only if nothing else is topicalized to the CP domain.

Under this assumption, one way to give a more theoretical account of this restriction is to postulate that the VSO clauses must involve remnant movement of the VP to Spec-CP, while the subject and the object are left behind. This proposal indicates that verbs do not undergo head movement to the higher functional layer of the sentences due to the fact that they fit a pattern of maximal projections (DP and wh-pronouns) in their ability to undergo phrasal movement to Spec-CP. Moreover, the derivation above presupposes that the object moves to a higher position before the VP is raised to Spec-CP. One way to account for this is to assume the hypothesis by Diesing (1992, 1996, 1997), according to which, when the object is definite, it raises out of the VP. In the literature, it is normally posited that this contrast has to do with the mapping from syntax to semantics, so that object shift usually depends on informational structure, in particular something like the contrast between specific and nonspecific[6]. Evidence that definite and specific objects can really move to a higher position comes from contexts where they are quantified. In such syntactic contexts, the object shift is obligatory, the word order changes from VO to OV, and the verb must agree with the quantified objects. That the object really moves to Spec-vP is evidenced by the fact that it can sit in an intermediate position between the subject and verb, a context in which it triggers the object agreement on the verb stem by means of the prefix {i-}, as follows:

(38) *upaw* *Fábio*$_i$ *pira* *i'un* *a'e*$_i$ *ra'a*
all Fábio fish 3-eat he PART
'The whole fish, he, Fábio ate.'

Evidence that the VP and XPs compete for the same syntactic position comes from the fact that when the XPs are topicalized to Spec-CP, the verb must appear after the temporal particles *zekwehe/zekaipo/kakwez*. In such contexts, the verb usually follows the subject, leading to the emergence of the [XP [**zekwehe** SVO]] order. In this sense, when the object is topicalized, the verb cannot occur in the initial position, so the word order changes from VSO to OSV, as follows:

(39) *u*$_i$*-'u* *tenetehára*$_i$ *pira*
3-eat tenetehára fish
'The Tenetehára people ate the fish (a specific one).'

(40) *upaw* *pira*$_i$ *tenetehára* *i*$_i$*-'u-n*
all fish tenetehára 3-eat-TOP
'The Tenetehára people ate all the fish.'
[lit.: This means that everything was eaten. There are no leftovers.]

Notice that if we add the temporal particles in the OSV sentence above, they must occur immediately after the topicalized object, signaling that the quantified object moves to Spec-CP, as follows:

(41) *upaw* *pira*$_i$ *ze-kwehe* *tenetehára* *i*$_i$*-'u-n*
all fish EVID-UDPAST tenetehára 3-eat-TOP
'(They say that) the Tenetehára people ate all the fish a long time ago.'
[lit.: This means that everything was eaten. There are no leftovers.]

[6] For a detailed analysis on object shift in other languages, I refer the reader to the work of Bobaljik and Thráinsson (1998) and that of Rackowski and Travis (2000:126).

## 3 Predicate-Raising and Head-Finality in Independent Clauses

Tenetehára presents a set of final particles related to the aspectual and temporal meaning of the sentence. They systematically occur after the predicate (i.e., the verb and its core arguments), thus giving rise to the [[SVO]-Tense] constructions. For example, the particles *kwez* and *ra'e* indicate that the action has just recently been completed. Interestingly, the particle *ra'e*[7] is generally employed in interrogative sentences, while the particle *kwez* appears in affirmative clauses. Based on the fact that they remain in a fixed position within the sentences, I will assume that they are phonological realizations of functional categories related to the clausal inflectional domain. For this reason, I will gloss them as IPAST, which indicates that they are particles related to the aspectual and temporal reference of the sentence, as follows:

(42)

| | | |
|---|---|---|
| *amo* | *u-màno* | ***kwez*** |
| somebody | 3-die | IPAST |

'Somebody has just died (= the death was recent).'

(43)

| | | | | |
|---|---|---|---|---|
| *teko* | *w-apy* | *ko* | ***kwez*** | *kury.* |
| people | 3-burn | farm | IPAST | now |

'The people have just burned the field.'

(44)

| | | | | | |
|---|---|---|---|---|---|
| *ma'e* | *pe* | *Zuze* | *w-enu* | *tazahu* | ***ra'e?*** |
| what | at | John | 3-hear | big pig | IPAST |

'Where has John heard the big pig?'

Additionally, two other final particles can appear to convey the temporal meaning of the sentence, such as the particle *nehe* and the auxiliary *iko*. The latter conveys the imperfective aspectual meaning, while the former encodes the future time. Both of them are systematically placed after the predicate, as follows:

(45)

| | | | |
|---|---|---|---|
| *a'e ae* | *u-mu-me'u-putar* | *wa-n-emiapo-kwer* | ***nehe***. |
| he EMP | 3-CAUS-speak-want | 3PL-REL -make-PAST | FUT |

'He will tell what they have made.'

(46)

| | | | |
|---|---|---|---|
| *awa* | *w-ekar* | *tapi'ir* | ∅-***iko*** |
| man | 3-look for | tapir | 3-be |

'The man is looking for tapir.'

[7] One of the reviewers asked whether *ra'e* and *kwez* should be located in a higher functional position than T$^{o}$, owing to the fact that they encode not only tense but also affirmative/interrogative information. Due to limitations of time and space, I will leave this discussion for future research.

One way of accounting for the occurrence of these particles in sentence-final position is to posit that they are syntactic heads that are base-generated in the head T°. In line with this view, I will argue that the [[SVO]-**Tense**] constructions are achieved by means of predicate-fronting to Spec-TP.[8] Evidence in favor of this analysis comes from the fact that the tense marker particles have a fixed position in the linear order. For example, the particle *kwez* cannot be topicalized, as in (47), nor can it occur in medial position, separating the subject from its verb, as in (48).

(47) **kwez* *teko* *w-apy* *ko* *kury.*
IPAST people 3-burn farm now
[Intended: 'The people have just burned the farm.']

(48) **teko* *kwez* *w-apy* *ko* *kury.*
people IPAST 3-burn farm now
[Intended: 'The people have just burned the farm.']

A second piece of evidence, demonstrating that what moves around T is a constituent, comes from the syntactic behavior of the particles *ra'e* and *nehe*. Both of them have the same syntactic distribution as the particle *kwez*. This hypothesis is reinforced by the fact that they cannot occur between the verb and its object, nor can they be topicalized to the left, nor can they come after the subject, as the following examples demonstrate:

(49) **ma'e* *pe* *Zuze* *w-enu* *ra'e* *tazahu*
what at John 3-hear IPAST big pig
[Intended: 'Where has John heard the big pig?']

(50) **ma'e* *pe* *Zuze* *ra'e* *w-enu* *tazahu*
what at John IPAST 3-hear big pig
[Intended: 'Where has John heard the big pig?']

(51) **a'e ae* *u-mu-me'u-putar* *nehe* *wa-n-emiapo-kwer*
he EMP 3-CAUS-speak-want FUT PL-REL-make-PAST
[Intended: 'He will tell what they have made.']

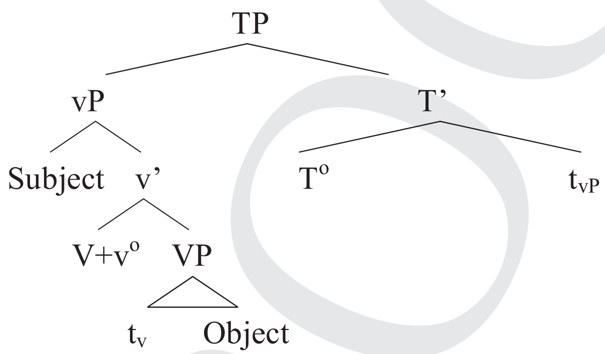
(52) **nehe* *a'e ae* *u-mu-me'u-putar* *wa-n-emiapo-kwer*
FUT he EMP 3-CAUS-speak-want PL-REL -make-PAST
[Intended: 'He will tell what they have made.']

[8] I refer the reader to Aboh's (2004) work, in which similar arguments are presented to derive sentence-final particles. According to Aboh, these particles are often the result of high elements that have lower phrases fronted around them.

(53) **a'e ae* *nehe* *u-mu-me'u-putar* *wa-n-emiapo-kwer*
he EMP FUT 3-CAUS-speak-want PL-REL-make-PAST
[Intended: 'He will tell what they have made.']

The only acceptable order in all the examples examined above, therefore, is with the tense marker particles placed after the verb and its core arguments, which in turn gives rise to the consistent SVO-**Tense** constructions. Given Kayne's antisymmetry theory, in which all movement occurs to the left, and given the internal subject hypothesis, one can postulate that the SVO-**Tense** order is derived from the basic order [**Tense** [SVO]]. Therefore, to derive the conclusion that T° is truly head-initial in these constructions, I will assume that the predicate, represented by the v-VP complex, moves to the specifier of TP. That this movement is really to Spec-TP, and not to a higher head, becomes evident due to the fact that all the particles above are directly related to the temporal and aspectual meaning of the sentence. The derivation depicted in the syntactic tree in (54) aims to demonstrate this analysis.[9]

(54)




Similar distribution also holds for the auxiliary *iko*, which can only be positioned after the predicate, and not the other way around. This constraint

[9] Notice that this derivation corroborates Holmer's (2005) typological prediction, according to which head-final particles tend to appear only in predicate-fronting languages, rather than in head-raising languages, such as Irish. Therefore, Tenetehára's head-finality characteristics lend further support to this prediction, as they allow syntactic heads to be stranded in clause-final position. Holmer (2005:186) predicts that the existence of final particles must be connected with basic order. In line with this view, he argues that one would expect final particles in VOS languages, but not in VSO languages that present head-raising. Thus, VSO languages, such as Irish, which are not predicate-raising, do not strand syntactic heads in clause-final position. To capture these facts, he proposes the following correlation:

(i)

| | | |
|---|---|---|
| Movement type | XP-raising | X°-raising |
| Basic word orders | VOS, SOV, (some) VSO | (some) VSO |
| Final particles | likely | unlikely |

explains why the auxiliary *iko* cannot occur in medial position between the subject and the verb, nor can it be topicalized to initial position. Evidence in favor of this analysis comes from the fact that the auxiliary *iko* 'be' can only be positioned after the predicate, and not vice versa. This fact explains the reason why sentences (56) and (57) are grammatically disallowed.

(55) *awa* *w-ekar* *tapi'ir* ***∅-iko***
man 3-look for tapir 3-be
'The man is looking for tapir.'

(56) **awa* *w-ekar* *∅-iko* ***tapi'ir***
man 3-look for 3-be tapir
[Intended: 'The man is looking for tapir.']

(57) **∅-iko* *awa* *w-ekar* *tapi'ir*
3-be man 3-look for tapir
[Intended: 'The man is looking for tapir.']

Thus, the only possible word order is the one in which the verb and its core arguments precede the auxiliary *iko*. Therefore, the [[SVO]-T] order shown above constitutes strong evidence that the head-initial vP predicate really does raise to Spec-TP. Given this fact, and theories such as the antisymmetry theory, in which all movement is assumed to occur to the left, one can postulate that the constructions with final auxiliary, hereafter CFA, in Tenetehára are derived from the basic [T [SVO]] order. Thus, to derive the SVO-T order, one must postulate that the vP is moved to the specifier of TP. This analysis is based on Biberauer, Holmberg, and Roberts' (2014) assumption, according to which the head-final order may, in principle, be associated with the c-selection features of a head. Thus, the vP-raising analysis in the CFA is a type of linearization-movement (L-movement). According to Biberauer, Holmberg, and Roberts (2014), hereafter BHR, L-movement is a property of Extended Projections, and may be projected up the tree through the Extended Projection of the lexical head. Based on this viewpoint, BHR (2014) argue that each occurrence of the movement trigger on a given head requires movement of the structural complement of that head into its specifier. Thus, I will argue that sentence (55) must start the derivation as in (58a) and the [[SVO]-T] word of (58b) is achieved by raising the head-initial vP to Spec-TP, due to a selection feature of the head T°.

(58) a. $[_{TP}\ [_{T}$ iko $[_{vP}$ awa $[_{v}$ wekar $[_{VP}\ t_{verb}$ tapi'ir]]]]]
b. $[_{TP}\ [_{vP}$ awa $[_{v}$ wekar $[_{VP}\ t_{verb}$ tapi'ir]]] $[_{T}$ iko $[t_{vP}]]]$

Based on the derivation in (58b), I will assume that the movement of the vP is imposed by two different formal features on T°: the uninterpretable φ-features and the c-selection feature. Suppose that the uninterpretable φ-features are checked by the subject and, as a direct consequence, the nominative case of this subject is checked off by the head T°, even though this argument remains in the specifier position of the moved vP. With regard to the c-selection feature on T°, I will argue that it corresponds to a [+PRED] feature. Then, following Massam's (2000) account, I will propose that the vP must rise to Spec-TP, due to the EPP feature on TP. Given the data shown above, one may conclude that Tenetehára exhibits disharmony at the clause-level syntax, as final auxiliaries c-select initial head vPs, giving rise to the [VO-Aux] order. This fact contradicts one of BHR's (2014) claims that the VO-Aux order is not attested in the world's languages. According to BHR (2014:5), the main aspect of the formulation of FOFC is that it rules out structures where αP is the complement of β and γP is the complement of α, as follows:

(59) *[βP [αP α γP] β]

However, the Tenetehára final auxiliary constructions do not conform to the claim that configurations instantiating the schema in (59) are not found in the world's languages. As such, Tenetehára SVO-Aux order violates the constraint in (59), since the vP, which is selected by the final auxiliary, is clearly head-initial. Hence, I will argue that the reason why Tenetehára violates (59) has to do with the fact that, while the superordinate head T° triggers movement of its complement, the complement of this same head, more precisely the head v°, does not trigger the raising of its complement. In sum, as shown here, only T° has the property of moving its complement, whereas the head v° does not, at least in the CFA, which is a pattern that signals that there is indeed violation of FOFC.

### *3.1 The Derivation of VSO-Tense Orders*

The reader might wonder how to derive the VSO predicates that co-occur with final auxiliaries and tense markers. In such contexts, the word order is VSO-Tense/Aux, and the auxiliary and the lexical verb can both control the subject agreement, as the following sentences demonstrate.

(60)

| | | | | | | |
|---|---|---|---|---|---|---|
| *u-zemumikahy* | *zekaipo* | *a'e* | *kuzà* | *∅-iko* | *a'e* | *kury* |
| 3-feel sad | EVID-UDPAST | she | woman | 3-be | she | now |

'(They said that) she, the woman, was feeling sad.'

(61)

| | | | | | |
|---|---|---|---|---|---|
| *u-haw* | *zekaipo* | *i-hy* | *amo* | *ma'eputyr* | *o-ho* |
| 3-get | EVID-UDPAST | 3-mother | a | flower | 3-go |

'(They said that) his mother went to get a flower.'

| | | | | | |
|---|---|---|---|---|---|
| (62) | *w-ekar* | *teko* | *ka'a* | *te* | *o-ho* |
| | 3-look for | people | bush[10] | true | 3-go |
| | 'The people go to look for fertile lands.' | | | | |

In order to derive the word order above, I will henceforth assume that an interaction of two different movements occurs: first, the remnant-VP moves to Spec-CP, and second, the vP fronts to Spec-AuxP/TP. This analysis is reinforced by the fact that the verb can appear before the particles *zekwehe/zekaipo*, just like any other emphasized constituent. In this view, sentence (63) must have the derivation depicted in (64):

| | | | | | | |
|---|---|---|---|---|---|---|
| (63) | *u-haw* | *zekaipo* | *i-hy* | *amo* | *ma'eputyr* | *o-ho* |
| | 3-get | EVID-UDPAST | 3-mother | a | flower | 3-go |
| | '(They said that) his mother went to get a flower.' | | | | | |

(64) $[_{CP} [_{VP} \text{uhaw}] [_{C} \text{ zekaipo } [_{TP} [_{vP} \text{ ihy } [_{v'} \text{ amo ma'eputyr } t_{VP}] [_{T} \text{ o-ho } [t_{vP}]]]]]]$

Evidence that the analysis above is really on the right track comes from the contexts in which emphasized XPs, such as interrogative pronouns, are moved to the left-peripheral position. In such syntactic environments, the VP cannot move because the interrogative pronoun *ma'e te* already occupies the specifier position of CP, as follows:

| | | | | | |
|---|---|---|---|---|---|
| (65) | *ma'e* | ***te*** | *Siba* | *u-pyhyk* | *o-ho.* |
| | What | that | Siba | 3-catch | 3-go |
| | 'What will Siba go to catch?' | | | | |

Consequently, there cannot be a situation in which both the wh-pronoun and the VP appear in Spec-CP. This is why the sentence in (66) is grammatically disallowed.

| | | | | | |
|---|---|---|---|---|---|
| (66) | **ma'e* | ***te*** | *u-pyhyk* | *Siba* | *o-ho.* |
| | What | that | 3-catch | Siba | 3-go |
| | [Intended: 'What will Siba go to catch?'] | | | | |

In the next section, I extend the same predicate-fronting analysis developed thus far to explain the reason why Tenetehára clausal recursion allows tense and complementizer particles to be stranded after the core constituents of the predicate, thereby causing the [[SOV]-C-T] order to emerge.

## 4 Clausal Recursion as a Result of Predicate-Fronting

According to the descriptive data presented thus far, one is led to assume that, in Tenetehára, subordinators are of two types: head-initial or head-final. When

[10] The word *ka'a* 'bush' here refers to those areas (= the fertile lands) that are particularly adequate for planting mani'ok and corn.

they are of the head-initial type, the word order is C°-[SVO]-Tense, with the predicate (that is, the vP) remaining between the complementizer and the tense markers, as shown in the following example.

(67) ***aze*** *zawar* ***u****-zuka* *ka'i* ***nehe***
if jaguar 3-kill monkey FUT

*Siba* *u-pyhyk-ràm* *ka'i* *o-ho* *i-zuwi*
Siba 3-take-FUT monkey 3-go 3-for
'If the jaguar kills the monkey, Siba will take the monkey for himself.'

However, if we place the subordinator ***aze*** in head-final position, the result is a grammatically incorrect construction. Hence, the impossibility of placing the predicate before the complementizer ***aze*** constitutes important evidence that this particle is truly head-initial, as follows.

(68) **zawar* *ka'i* ***u****-zuka* ***aze*** ***nehe*** (….)
jaguar monkey 3-kill if FUT
[Intended: 'If the jaguar kills the monkey (….)'.]

Moreover, the CP can also be C-initial in root-interrogative clauses, thereby exhibiting the same head-initial structure as the one shown above.

(69) *ma'e* ***te*** *awa* *u-pyhyk* *o-ho.*
What C man 3-catch 3-go
'What will Siba catch?'

(70) *ma'e* ***te*** *ze-kwehe* *Fábio$_i$* *u-'u-paw* *a'e$_i$?*
what C EVID-UDPAST Fábio 3-eat-all he
'What did they say that Fábio ate all of?'

Another piece of evidence that C can be head-initial comes from contexts in which the specifier position of CP is filled by means of the adjoined particles *na'e* and *ta'e*.[11] These particles indicate that the sentence is not subordinate, but a root one. In line with this view, my proposal is that they are syntactically merged directly into the specifier position of the CP projection, since they occur before the temporal/evidential particles *zekwehe/zekaipo*. Hence, the derivations proposed in (71b) and (72b) aim to show that neither VP-remnant nor vP-fronting occur in such sentences.

(71a) *na'e* *ze-kaipo* *miar*[12] *u-ze'eg* *i-zupe* *a'e* *wà*
then they say-DPASTU the animal$_i$ 3$_i$-speak him$_j$-to he$_i$ PL
'(They said that) then they$_i$, the animals$_i$, spoke to him$_j$.'

[11] Observe that *na'e* conveys the idea of conclusion, whereas *ta'e* expresses the cause of an event or situation.
[12] Here, *miar* refers to those animals that are chased by men when they go hunting.

(71b) $[_{CP}$ na'e $[_{C^o}$ $[_{TP}$ ze-kaipo $[_{TP}$ miar $[_{T}$ uze'eg $[_{vP}$ i-zupe [… a'e wà …]]]]]]]

(72a) *ta'e* *i-hy* *o-ho* *wa* *n-uwi* *a'e* *kury*
because of their$_j$-mother$_i$ 3$_i$-ir them$_j$ REL-away from she$_i$ now
'Because of this, she$_i$, their$_j$ mother$_i$, went away from them$_j$.'

(72b) $[_{CP}$ **ta'e** $[_{C^o}$ $[_{TP}$ ihy $[_{T}$ oho $[_{VP}$ wa nuwi […a'e … kury]]]]]]

In sum, in the latter example, the occurrence of *na'e* and *ta'e* in Spec-CP blocks the movement of the predicate to the left. This restriction becomes particularly clear in sentence (73a), in which both a topicalized and a focalized XP co-occur in the same clause. In such a context, the predicate remains in a low position, as the derivation in (73b) shows.

(73a) *se-ze* *pako$_i$* *Ana* *i$_i$-'u-n*
here-they say banana$_i$ Ana 3$_i$-eat-TOP
'They said that it was a banana that Ana ate here
(and not something else).'

(73b) $[_{TopP}$ se-ze … $[_{FocP}$ pako$_i$ … $[_{TP}$ Ana … $[_{vP}$ t$_{subject}$ i$_i$-'u-n t$_{object}$]]]]

In sharp contrast to the contexts examined above, a different clausal pattern emerges when the complementizer is of the head-final type. In such contexts, the object systematically precedes the verb and the whole predicate must appear to the left, giving rise to the word order [[SOV]-C$^o$], as follows:

(74) *w-exak* *awa* [*zawar* *ka'i* *h-aro* *mehe*]
3-see man jaguar monkey 3-wait COMP
'The man saw that/when the jaguar was waiting for the monkey.'

(75) *o-mo-no* [*mani'ok* *h-ytyk* *pà*] *kury*
3-CAUS-go manioc 3-throw COMP now
'(The people) put the manioc in the water by throwing it.'

It is also important to point out that C$^o$ can intervene between the predicate and the head-final tense particles in the embedded clauses, which provides clear evidence that the vP really does front to the specifier position of CP, as follows:

(76) *i-ma'enukwaw* *Joao* [*Quesler* *tapi'ir* *h-ekar* ***mehe*** *∅-**iko*** *ka'a* *pe*]
3-think Joao Quesler tapir 3-hunt COMP 3-be forest in
'John thinks that Quesler is hunting for a tapir in the forest.'

In conclusion, the mixed structures shown above reflect that the Tenetehára complementizer system is hybrid, in the sense that it presents both final complementizers and initial complementizers.[13] Owing to the antisymmetrical approach I am assuming in this chapter, I thus contend that the structure in (77b) must be derived from the base structure in (77a). Compare the following syntactic representations.

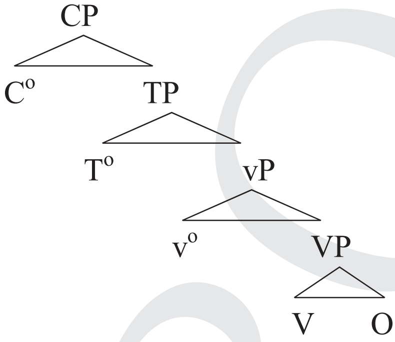
(77a) $[_{c'}\ C \ldots [_{TP} \ldots . [\ldots ._{vP\ldots .}]]]$

$\Downarrow$

(77b) $[_{c'}\ [_{vP}]\ C\ [_{TP} ..\ t_{vP\ldots}\ [_{T} \ldots\ [\ldots t_{vP}\ldots ..]]]]$

The analysis above lends further credence to Kayne's antisymmetry theory, in that the linear order of the terminal elements in a phrase marker is dependent on the antisymmetric relation of precedence. Hence, if we assume that there is an ordering such that C° always precedes both TP and vP, and that ordering is fixed as such, then we must admit that precedence will be the ordering that holds once and for all in Tenetehára. Pursuing this line of reasoning, I will claim that, since C must precede both T and v, it thus asymmetrically c-commands T and v. Assuming this theory, I will propose, hereafter, that both root and embedded clauses originate as SVO, as shown in the structure depicted in (78):

(78)




Under the assumption that asymmetric c-command goes hand in hand with linear ordering, I will claim that there are only initial complementizers in Tenetehára. The immediate consequence of this proposal is that one will have to argue that the occurrence of the final complementizers *mehe* and *pà* in Tenetehára clausal recursion is ultimately the result of predicate movement to Spec-CP. This analysis entails that final complementizers should not be seen as primitives, but rather as the result of a syntactic operation by which

[13] I refer the reader to Bayer (1999) for a different approach based on both Indo-Aryan and Dravidian languages, such as Bengali and Malayalam. According to his analysis, these languages seem to allow overt, as well as covert, movement from final-complementizer clauses. Bayer's conclusion is that these languages do not present freezing effects, thus allowing core arguments of the vP to be extracted to Spec-CP.

the predicate complement has moved leftwards. For this reason, in head-final languages like Tenetehára, final complementizers and even final auxiliaries have the property of forcing their complements to move to their specifier position. Kayne (1994:53), for instance, assumes that the derivation of the [YX] structure in such languages occurs as follows:

(79) a. X [$_{\mathbf{YP}}$…Y ZP]
↓
b. X [$_{\mathbf{YP}}$ ZP Y $t_{\mathbf{ZP}}$]
↓
c. [$_{YP}$ ZP Y $t_{ZP}$] X $t_{YP}$…

Therefore, for the derivation of the structure in (79c) to occur, the interaction of two different movements will be necessary. Firstly, ZP moves to the Spec of YP. Secondly, the YP maximal projection has to be moved to the Spec-XP. Kayne (1994:53) posits that the derivation of the [YX] order will essentially depend on:

> both Y and X having the property of forcing their complements to move to their specifier position, and since that kind of property is dominant in the so-called head-final languages, the expectation is that agglutinative YX (where Y originates below X) will primarily be found in strongly head-final languages.

### 4.1 *Pieces of Evidence*

The first piece of evidence in favor of the proposal that Tenetehára clausal recursion does involve predicate-raising to Spec-CP comes from the syntactic behavior of the tense markers *nehe*, *iko*, and *kwez*, which are always positioned after the complementizers *pà* and *mehe*. In general, these complementizer particles must intervene between the predicate and the aforementioned tense markers, as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| (80) | *e-pyhyk* | *ne-∅-takihe* | [*aguza* | *i-zuka* | ***pà***] | ***nehe*** |
| | 2SG-get | your-REL-knife | rat | 3-kill | COMP | FUT |
| | ‘Get your knife in order to kill the rat.’ | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| (81) | *Sergio* | *he-r-exak* | [*he.∅-zur* | ***mehe***] | ***kwàz*** |
| | Sergio | I-REL-see | I-REL-come | COMP | IPAST |
| | ‘Sergio saw me, when I had just come.’ | | | | |

Notice that, in the examples above, it is unclear whether or not the head C$^{o}$ and the head T$^{o}$ are both part of the same clause, due to the fact that one cannot confirm if the head T$^{o}$ is part of either the matrix clause or the embedded clause. Fortunately, there are examples where one can clearly identify that the head T$^{o}$

projects both in embedded and matrix clauses. The following examples show such contexts, in which there is a clear mismatch in the temporal interpretation of the main and embedded clauses, such that we are sure of where each head T° belongs. This proposal holds true by the fact that, in the following example, the future marker *nehe* is the final head, usually after the main predicate, whereas the tense marker of the embedded clause is morphologically realized by the tense suffix *–kwer*.

(82) *a'e ae* *u-mu-me'u-putar* [$_{CP}$ *wa-n-emi-apo-kwer*] ***nehe***.
he EMP 3-CAUS-speak-want 3PL-REL-COMP-make-PAST FUT
'He will tell what they have made.'

Another example of tense mismatch comes from an example involving the stative verb *ima'enukwaw* 'think.' If one assumes that stative verbs are not normally used in the progressive aspect, then a natural conclusion is to posit that, as in the following example, the progressive auxiliary *iko* 'be' is only within the scope of the event denoted by the embedded verb *hekar* 'hunt,' but not within the scope of the stative verb *ima'enukwaw* 'think.' Therefore, this constitutes strong evidence that the auxiliary *iko* is really part of the embedded clause. This in turn gives rise to the expected vP-C-TP order, whose syntactic derivation must proceed by means of the successive cyclic fronting of the vP, first to Spec-TP, followed by vP movement to Spec-CP.

(83) *i-ma'enukwaw* *Joao* [*Quesler* *tapi'ir* *h-ekar* ***mehe*** *∅-**iko*** *ka'a* *pe*]
3-think Joao Quesler tapir 3-hunt COMP 3-be forest in
'John thinks that Quesler is hunting for a tapir in the forest.'

A third piece of evidence comes from the sentence in (84), inasmuch as the perfective aspectual marker *kwez* is within the scope of the event denoted by the matrix verb *wexak*, whereas the aspectual auxiliary *iko* modifies the way in which the action of killing is accomplished. This clearly indicates that the two particles project tense heads in different positions within the sentence. More to the point, the tense marker *kwez* heads a TP projection in the main clause, while the progressive auxiliary *iko* realizes the embedded TP projection.

(84) *Purutu* *w-exak* [*zawar* *tapi'ir$_i$* *i$_i$-zuka* ***mehe***] *∅-**iko*** *kwez*
Purutu 3SG-see jaguar tapir$_i$ 3SG$_i$-kill COMP 3-be IPASS
'Purutu has just seen that/when the jaguar is killing the tapir.'

In conclusion, the empirical data shown above provides evidence that the head T° can, in fact, project both in the main clause and in the embedded clause. This in turn lends further support to the hypothesis that the embedded vP may be generated as a complement of the subordinate T° head. A final piece of evidence comes from what corresponds to relative clauses in Tenetehára.

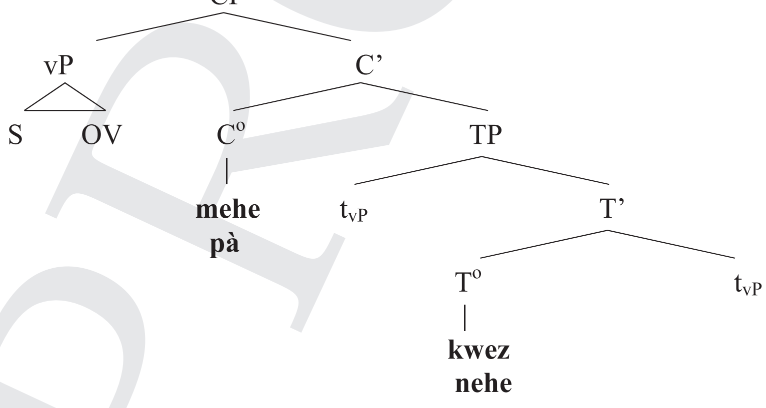
These clauses are structured by adding either the complementizer suffix *–pyr* or the complementizer prefix *emi–* to the verb stem. Notice that, when the past tense suffix {–kwer ~ –(kw)er} is attached to the verb, it must follow the verb and the complementizer affixes, generating the following affix orders: {verb+complementizer+tense}/{complementizer+verb+tense}, as follows:

(85) *a-exak* *ywyra* *i-zuhaw-pyr-(kw)er*
1SG-see wood 3-chop-REL-PASS
'I saw the wood that was chopped (by the man).'

(86) *a-exak* *ywyra* *awa* *h-emi-zuhaw-kwer*
1SG-see wood man 3-REL-chop-PAST
'I saw the wood that was chopped by the man.'

Based on these data, I will henceforth assume that the relative order of the complementizer morphemes {–pyr}/{emi–} and the tense morpheme {–kwer} mirrors the order of the syntactic derivation that occurs in the embedded clause, thereby providing further evidence in favor of the hypothesis that the complementizers may in fact intervene between the vP and TP in embedded clauses. Owing to the fact that Tenetehára has a set of clause-final subordinators followed by tense markers, I will assume that the [[SOV][C°[T°]]] order of the subordinate clauses must be derived from the basic [C°[T°[SVO]]] order. This proposal, as in Kaynian work more generally, presupposes that the surface head-final order must be derived by successive leftward movement of the vP, first to Spec-TP, then to Spec-CP. The structure proposed in (87) instantiates this syntactic derivation.

(87)




The derivation proposed above leads us to conclude that Tenetehára clausal recursion entails the existence of cyclic predicate-raising, giving rise to extremely complicated structures, in which several final particles are stranded in lower positions, such as the final complementizers *mehe/pà*[14] and the tense-final particles *kwez/nehe/ra'e/iko*.

## 5 Final Remarks

In this chapter, I assume that the derivation of the [PRED-C°-T°] order is achieved not by head movement of the verb, but rather by predicate-raising. I also propose that the landing site of the predicate can be the specifier position of either the head C° or the head T°. Either option depends, of course, on the particular grammatical construction involved in the syntax. In this respect, Tenetehára differs slightly from other predicate-fronting languages, such as Niuean and Chol, regarding the landing site of the predicate. In both of these languages, the vP movement is only up to Spec-TP, not to Spec-CP.[15] Additionally, clausal recursion becomes evident, owing to the fact that inflectional particles related to tense and the aspectual meaning of the sentence can be positioned after the head C° and the vP projection. Finally, one might question how it is possible for Tenetehára to exhibit complementizers both in initial and final positions. This puzzle might be solved if one assumes that the apparent mixed-headedness of the CP in Tenetehára can be reduced to a difference in the nature of the EPP features associated with the head C°, both in main and subordinate clauses. Following Massam's[16] (2000:111) analysis, I propose that the head-final C° carries the uninterpretable feature [*u*PRED], which in turn forces the whole predicate to rise to the left. However, the head-initial C° lacks such a feature. This explains why this head does not force the predicate to move to the left in clauses with head-initial complementizers.

In sum, a way to find a unified explanation for the reason why different word orders may appear is to set the following correlations: (i) the VSO order is the result of the VP-fronting; (ii) the SVO-T order is derived by means of the vP fronting only to Spec-TP; (iii) the VSO-T is produced by interaction of two different movements: first, the VP is raised to Spec-CP, followed by the vP fronting to Spec-TP; and (iv) the SOV-C-T order is achieved by means of a rolled-up interactive movement of the vP, first to Spec-TP and then to Spec-CP.

[14] One of the reviewers asked me to show whether the relevant subject/object extractions would be possible if the vP had not been fronted before *mehe*. However, I cannot include this discussion here because *mehe* can occur only as a final head, thereby always positioning after the vP. One cannot find this complementizer in an initial syntactic position.

[15] I refer the reader to the proposal by Chung (2005, 2006), Massam (2000, 2005) and Coon (2010), for a detailed analysis on the predicate movement in Niuean and Chol.

[16] Massam (2000:111) argues that "the Niuean head of IP has no [D] feature; thus, the specifier need not be filled by an element checking [D], but instead can be filled by the predicate checking the [PRED] feature. (…) [D] and [PRED] are thus in complementary distribution and can be seen as two reflections of a single EPP predication feature."

# 9 Recursion in Tupi-Guarani Languages: The Cases of Tupinambá and Guarani

*Marcia Maria Damaso Vieira*

Recursion has always been a central feature of grammar, both from formal and descriptive perspectives. It is good to clarify several angles at the outset in the evolution of this concept. First, there is a computer science tradition of using the term to refer to algorithms where the output of a rule is the input to the same rule. This does not make commitments to particular structural relations and fails to provide a clear mechanism for a description of pertinent phenomena, but it captures the elementary Merge operation.

Under current minimalist definitions, the operation of Merge is separated from labeling and the presence of functional categories. This means that the elementary form of recursive Merge is necessarily operative at both the syntactic phrasal level and the lexical, morphological level. It is an important unsolved question where and how much of a line between lexical morphology and syntax must exist (Baker 1988, 1996; see also: Bisetto 2010; Lander and Letuchiy 2010). In Tupinambá and Guarani, we see unmistakable instances of self-embedding recursion, where some category re-appears inside itself, but its exact formulation as based in lexical rules of morphology or syntactic rules of phrase formation remain open, as we shall see.

We can see the subtlety of the lexical/syntactic contrast in English: *drink coffee* is a VP whereas *coffee* is a DP complement, but it is only a head in the NP or adjective *coffee-drinking*. Should those examples be captured at the lexical level (with categories like N, V, A) or a syntactic level (where functional elements DP, VP, CP are involved)? One consequence of this contrast is that the exact labeling of hierarchies in morphology remains open. In Tupinambá and Mbyá Guarani, other categories involving causative, finiteness, and agreement are important features, but may or may not comprise heads in the hierarchy within morphological structure.

Beyond basic Merge, we need to recognize a long tradition of what one can call "classical recursion," which Roeper and Snyder (2004), borrowing from computer science, call Indirect Recursion. Here is where the reappearance of a structure within an identical node is critical: it always involves an intervening maximal projection. This occurs with sentences that take VPs that take sentences that take VPs, and which are currently referred to as self-embedding.

Finally, we need to recognize what lies in between: extensive use of the term in fieldwork and morphology to refer to iterative processes that involve compositional semantics as in prefixes (e.g., *re-re-reread*) or compounds (e.g., *coffee-maker-maker*). Since no maximal projections are involved, it should differ formally from syntactic self-embedding in English, but in many languages including Guarani, phrasal elements can also be incorporated.

All of these reflections of the notion of *recursion* are important and legitimate in enabling research to proceed on many levels at once. Their formal definitions undergo continuing revision that, importantly, should not block the use of this concept in descriptive work. In every science, it is virtually impossible to establish an agreed-upon taxonomy of terminology while concepts are evolving. Therefore, empirical sketches, like this one, can help orient ongoing descriptive and theoretical work to each other.

## 1 Language Overview

In this chapter, I aim to provide evidence for the existence of recursion in certain grammatical domains of two Tupi-Guarani languages: Tupinambá and Guarani (the Mbyá dialect). Tupinambá is an extinct Tupi-Guarani language, spoken on the coast of Brazil and documented by the Jesuits in the sixteenth and seventeenth centuries. The Tupinambá data presented here were extracted from Anchieta (1990) and Lemos Barbosa (1956). Mbyá Guarani is spoken nowadays in the south and southeast of Brazil. The data presented here were collected by the author of this chapter during fieldwork in 1996, 1998, 2011, and 2012.[1] The languages under investigation are interesting for the discussion of recursion due to the fact that they exhibit it at both the syntactic and the morphological levels. Such a finding supports the view that morphology is a hierarchically organized level of grammar, as suggested by proponents of Distributed Morphology, such as Marantz (1997) and Pylkkänen (2002).

The issue of whether there is recursion in morphology has been the object of much debate over decades in the linguistic literature. Recursion here refers to specific affixes and their meaning. A conservative position is that "non-recursivity is a characteristic trait of morphology" (Matthews 1991:213). According to this view, except for a few counterexamples in derivational morphology, inflectional morphology is basically non-recursive, as inflections are usually implemented in languages through a series of fixed sets of dimensions, such as temporal reference. It is in this respect that Matthews argues that "one cannot form a future stem of a Latin verb, then an imperfect from that and apply the future once more to the result" (1991:214). Booij

[1] The fieldwork took place in the Boa Vista village in Ubatuba, São Paulo, and in Faxinal do Céu, in the state of Paraná.

(2000) concurs to show that compounding, but not inflection, can be recursive. Since compounding can be reapplied to a complex word, it would be possible to form recursive compounds (e.g., *song book shop assistant salary*) where the category N can apply to itself.

Aronoff and Fuhrhop (2002), on the other hand, take a different approach, arguing that morphological recursion can be instantiated by the reapplication of an affixation process to an already affixed word (e.g., *confess* > *confession* > *confessional* > *confessionalize*).

Here beyond basic Merge, there is a morphological rule that changes category that can re-appear, in alternation, with suffixes. Therefore, it is an example of self-embedding that can continue indefinitely [*confessionalization*]: a nominal suffix (*–tion*) inside a nominal suffix (*–tion*) produces confess V+N+A+V+N. However, this lacks *immediate* self-embedding, since a non-nominal must intervene. In contrast, other parts of morphology do allow immediate self-embedding, as in prefixes: in English-like languages, as in *anti-anti-anti-missile* where *anti–* leaves the N category unchanged. The prefix itself can be recursive in forms like *re-over-mis-interpret*.

It is in this manner that morphological recursion is approached in this chapter, where recursion is argued to be found with clausal complements with or without verb incorporation, and in causative, reflexive, and possessive constructions.

This view is in line with the Distributed Morphology (DM) framework (see Halle and Marantz 1993), presupposing that syntax computation deals with abstract functional features, implemented by morpho-phonological material only late in the derivation by late insertion. Therefore, in DM, “syntax goes all the way down,” which means that word-internal structure is constructed in syntax proper, and hence we expect recursion in morphology.

The chapter is organized as follows: Section 1 provides an overview of some grammatical properties of Tupinambá and Guarani that are relevant for the understanding of the recursive data to be presented. Section 2 describes the grammatical domains in which recursion is attested in the two languages investigated, such as complement clauses and verb incorporation, causatives, reflexives, and possessive constructions. Section 3 closes the discussion and suggests other possible domains in which recursion seems to apply, but which merit further investigation.

## 2 Some Grammatical Properties of Tupinambá and Guarani

We begin by presenting an overview of nominal morphology, verbal morphology, causatives and reflexives, noun incorporation, and word order in these two languages. This background is essential for the discussion of recursion across these domains in Section 2.

## *2.1 Nominal Morphology*

In Tupinambá and Guarani, nominal morphology expresses the following grammatical categories: possession, tense, and degree. The Mbyá Guarani dialect spoken in the state of Paraná has also developed a plural marker which can be attached to any countable noun:

(1) i-kyxe-**kuery**
3-knife-PL
'His knives'

In possessive constructions, the head noun follows the possessor, where the latter can be expressed either by DPs or by personal prefixes, as in (2) and (3). A morphologically conditioned relational morpheme (*r*– or Ø) stands between them, as indicated by (4). As illustrated in the following, the relational morpheme is also used with transitive verbs and postpositions to mark a head-complement relation, as illustrated by (5).

The following data are taken from Lemos Barbosa (1956:78):

*Tupinambá*

(2a) **Paîé** kysé
Shaman knife
'The shaman's knife'

(2b) **i**-kysé
3-knife
'His knife'

*Guarani*

(3a) **Kunhã** karo
Woman glass
'The woman's glass'

(3b) **i**-karo
3-glass
'Her glass'

*Guarani*

(4a) mitã **r**-o-rã
child REL-house-fut.
'The child's future house'

(4b) mitã **Ø**-akã
child-REL-head
'The child's head'

*Tupinambá* (Lemos Barbosa 1956:74, 75, 130)

(5) a. nde **r-**ausub
2SG REL-love
'(He) loves you'

b. nde **Ø**-pysyk
1SG REL-hit
'(He) holds you'

c. Taubysy **r**-esé
Taubysy REL-with
'With Taubysy'

d. ok **Ø**-pe
house REL-in
'In the house'

As will be seen below, verbal morphology is richer and more complex than noun morphology in the languages under study here.

## *2.2 Verbal Morphology*

In main clauses, arguments are expressed in the verbal morphology through two different sets of personal markers: active and non-active. Due to the presence of personal affixes in the verbal morphology, subjects and objects can be dropped, as examples (6) and (7) show. In intransitive constructions, the subject is cross-referenced either by the active or by the non-active series, depending on the nature of the verb. In typological terms, Tupi-Guarani languages are classified as active/non-active (Leite 1990). The subjects of intransitive active verbs, (6a) and (7a), are expressed by the same set of personal affixes used for marking transitive subjects, (6b) and (7b), while the subjects of intransitive non-active verbs, (6d) and (7d), are cross-referenced by the same set of affixes which expresses transitive objects, (6c) and (7c). In transitive constructions, both subject and object are realized by affixes in the verb morphology when the latter is third person, as (6b) and (7b) show. However, when the object is non-third person, either the subject or the object will be cross-referenced on the verb. Their choice depends on their position in Silverstein's (1976) referential hierarchy, wherein 1>2>3, as in (4c) and (5c). According to Silverstein (1976), speech-act participants, i.e., first and second persons, are ranked higher in the semantically based features hierarchy than third person. The choice of agreement markers follows this hierarchy in some natural languages. These phenomena can probably be captured by complex feature matrices.

*Tupinambá* (Lemos Barbosa 1956: 52, 72, 125)

(6a) **a**-só<br>1SG-go<br>'I go'

(6b) **a-î-**pysyk<br>1SG-3-hold<br>'I held him'

(6c) **xe**-pysyk<br>1SG-hold<br>'He held me'

(6d) **xe**-marangatu<br>1SG-good<br>'I am good'

*Guarani*

(7a) **re**-nha<br>2SG-run<br>'You run'

(7b) **re-i-**kyxĩ<br>2SG-3-cut<br>'You cut him'

(7c) **ne**-kyxĩ<br>2SG-REL-cut<br>'He cut you'

(7d) **ne**-porã<br>2SG-beautiful<br>'You are beautiful'

Besides personal markers, discontinuous negation, tense (future *–ta*), desiderative mood, aspect, and adverbials can also appear as affixes on the verb, as shown in (8) and (9):

*Tupinambá* (Lemos Barbosa 1956)

(8a) **nd**-o-bebé**-I**
NEG-3-fly-NEG
'He didn't fly'

(8b) a-î-**nupãnupã**
1SG-3-hit-hit old
'I kept hitting him'

(8c) o-karu-**seî**
3-eat-DES you
'He wants to eat'

(8d) epîá'-**katu**
see-good
'To see well'

*Guarani*

(9a) Tuja **nd-**o-karu**-I**
old NEG-3-eat-NEG
'The old man didn't eat'

(9b) Tuja o-karu-**ta**
3-eat-FUT
'The old man will eat'

(9c) pende pe- karu- **xe**
You 2PL- eat- DES
'You want to eat'

(9d) nd-oro-ke-**porã-**I
NEG-1PL-sleep-well-NEG
'We didn't sleep well'

*2.2.1 Causatives and Reflexives* Tupinambá and Guarani have valence-changing morphology. The causative prefix *mo/mbo–* can be added to any kind of intransitive verb, licensing an external argument and assigning accusative case to the *causee.* The addition of *mo/mbo-* turns an intransitive into a transitive verb, as (10b) and (11b) illustrate. Transitive verbs are causativized by the suffix *–uka/ ukar*, which adds a new agent, which is introduced by a postposition, as shown in (12):

*Tupinambá* (Lemos Barbosa 1956:190)

(10a) o-ker
3-sleep
'He sleeps'

(10b) **mo-** nger
CAUS-sleep
'to make(someone) sleep'

*Guarani*

(11a) Xee a-po
I 1SG-jump
'I jumped'

(11b) Ara **xe-** **mbo**-po
Ara 1SG-CAUS-jump
'Ara made me jump'

*Guarani*

(12) a-Ø-juka-**uka ava pe** xivi
1SG-3-kill-CAUS man OBL jaguar
'I made the man kill the jaguar'

The reflexive morpheme makes a transitive verb into an intransitive one by eliminating one of its arguments, as exemplified in (13) and (14). The reflexive and the causative morphemes can co-occur in the same verbal structure. The highest morpheme attached to the verbal complex determines the transitivity of the clause. When the causative is affixed to a reflexivized verb, the construction becomes transitive again, as in (15a) and (16a). When the reflexive is attached to a causativized verb, it becomes intransitive, as shown by (15b) and (16b). The reflexive and the causative affixes are realized with the forms *nhe*– and *mo*– respectively in nasal environments.

*Tupinambá* (Lemos Barbosa 1956:219)

(13) a-**îe**-pysyk
1SG-REFL-hold
'I held myself'

*Guarani*

(14) o-**je**- juka
3-REFL-kill
'He killed himself'

*Tupinambá* (Lemos Barbosa 1956:191, 202)

(15a) a-î-**mo-îe-**îuká Itayiba
1SG-3-CAUS-REFL-kill Itajiba
'I made Itajiba kill himself'

(15b) a-**îe-mo**-akub
1SG-REFL-CAUS-heat
'I made myself hot'

*Guarani*

(16a) a-**mbo-je**-juka Ara
1SG-CAUS-REFL-kill Ara
'I made Ara kill herself'

(16b) a**-nhe-mo-**aku
1SG-REFL-CAUS-hot
'I made myself hot'

2.2.2 *Noun Incorporation* In Tupinambá, noun incorporation was a very productive operation. Internal arguments could be incorporated freely into the verb, as (17b) and (18) indicate. The possibility of modifier stranding, exemplified in the former, along with the definite nature of the incorporated noun, provide evidence for the syntactic nature of this operation. Guarani also allows noun incorporation. However, only a few nouns can be incorporated, such as those referring to body parts, and to the words "people," "thing," and "clothes":

*Tupinambá* (Lemos Barbosa 1956:202, 207)

(17a) a-s-asab **kó** **y**
1SG-3-cross this river
'I crossed this river'

(17b) a-**y-**asab **kó**
1SG-river-cross this
'I crossed this river'

(18) nd-oro-**ybak-**epîak-ukar-i nde be
NEG-1PL-sky-see-CAUS-NEG you OBL
'We didn't make you see the sky'

*Guarani*
(19). a-**poro-**juka
1SG-people-kill
'I kill people'

The contrast between the languages illustrates the fact that boundaries on productivity can be quite various. Whether productivity includes self-embedding recursion can be unclear. What still needs to be established is whether we can have constructions such as *river-crossing-hating*.

*2.2.3 Word order, subordination and verb incorporation* Tupinambá is of the SOV type, but, according to Lemos Barbosa (1956:67), it exhibited a flexible word order in main clauses, as illustrated in (20). In Guarani, both SVO and SOV orders are attested, as in (21).

*Tupinambá* (Lemos Barbosa 1956:67)
(20a) Pindobusu o-s-epîak Paraná SVO
Pindobusu 3-3-see sea

(20b) Pindobusu Paraná o-s-epîak SOV
Pindobusu sea 3-3-see

(20c) o-s-epîak Paraná Pindobusu VOS
3-3-see sea Pindobusu

(20d) Paraná Pindobusu o -s-epîak OSV
sea Pindobusu 3-3-see
'Pindobusu saw the sea'

*Guarani*
(21a) Xee uru **Ø-**pi'a a-moĩ ajaka py SOV
I chicken REL-egg 1SG-put basket in

(21b) Xee a-moĩ uru **Ø-** pi'a ajaka py SVO
I 1SG-put chicken REL-egg basket in
'I put the chicken's eggs in the basket'

Inside subordinate clauses, however, Tupinambá has a strict SOV order and the verbal arguments are realized either by DPs or by free-standing pronouns. Only intransitive subjects and objects can be expressed through the sets of personal affixes, following an ergative pattern. Non-incorporated clausal complements appear to the right of their selecting verbs, giving rise to an VO order type, as in (22):

*Tupinambá* (Lemos Barbosa 1956:131)

(22) [a-î-potar [**nde xe-r-uba r-epîak-a**]] V [SOV]
1SG-3-want you 1SG-REL-father REL-see-DEP
‘I want (that) you see my father’

Inside Guarani complement clauses, both SVO and SOV orders are allowed. The expression of arguments follows the same rules as those found in main clauses. Similar to Tupinambá, these clauses follow their selecting verbs:

*Guarani*

(23a) Ore ro-i-pota [**Vera o-japo ore-r-o- rã**] V[SVO]
We 1PL-3-want Vera 3-make 1PL-REL-house-FUT
‘We want that Vera makes our future house’

(23b) Ore ro-i-pota [**Vera ore-r-o- rã o-japo**] V[SOV]
We 1PL-3-want Vera 1PL-REL-house-FUT 3-make
‘We want that Vera makes our future house’

Although the canonical word order of these languages seems to be SOV and, this way, one should expect that complement clauses occur on the left and not on the right of the main verb, we maintain that the structures in (22) and (23) involve syntactic embedding. Evidence that complement clauses involve embedding and not juxtaposition comes from long-distance wh-interrogatives in which downstairs arguments can be questioned, as in (24) where the wh-word stands for the embedded subject:

*Guarani*

(24) **mava’ e**$_i$ tu [ndee **ne-ayu** [**t**$_i$ **o-juka** mboi]]?
Who Q you 2SG-say 3-kill snake
‘Who did you say has killed the snake?’

When main and embedded subjects are co-referential, verb incorporation can apply, giving rise to an SOV order in which the verbal complement appears to the left, as in (25) and (26). Notice that noun incorporation is also possible in contexts of verb incorporation, as (27b) indicates:

*Tupinambá* (Lemos Barbosa 1956:148)

(25a) o-**ké’-potar**
3-sleep-want
‘He wants to sleep’

(25b) a-î-**meen’-guab**
1SG-3-give-know
‘I know (how) to give it’

*Guarani*

(26a) re-**nha-pota**
2SG-run-want
'You want to run'

(26b) a-**japo-kuaa**
1SG-make-now
'I know (how) to make it'

*Tupinambá* (Lemos Barbosa 1956:149)

(27a) nd'-a-s-**epîá'-potar-i kunhã**
NEG-1SG-3-see-want-NEG woman
'I don't want to see the woman'

(27b) nd'-a-**kunhã-epîá'-potar-I**
NEG-1SG-woman-see-want-NEG
'I don't want to see the woman'

Now that the relevant grammatical aspects have been presented, we turn to the description of the domains in which recursive structures are allowed to appear.

## 3 The Domains of Recursion in Tupinambá and Guarani

According to Roeper's (2010:47) general definition, recursion is "an operation which takes its own output as an input." Roeper and Snyder (2004) distinguish between two kinds of recursion: direct and indirect. In direct recursion, a given category generates itself, as indicated by the phrase-structure representation in (28a). Through it, constructions with a conjunctive reading can be generated, such as (28b). In indirect recursion, identical categories are introduced by non-identical categories, as represented in (29a), in which a sentence does not generate another sentence directly, but only indirectly through the head of the VP that it contains. (29a) generates recursive embedding clauses such as (29b):

(28a) NP $\rightarrow$ NP (and) (NP)

(28b) John, Bill, Fred, and Susan arrived.

(29a) S $\rightarrow$ NP VP
VP $\rightarrow$ V S

(29b) John said that Mary thinks that Charles loves Sue.

Grammars vary regarding the domains in which they can generate recursion. Roeper (2010) identifies some grammatical domains in which recursion can appear in natural languages: compounds, possessives, adjuncts, prepositional phrases, and clausal complements, among others. Based on the Tupinambá and Guarani data observed, this chapter will show that recursion is found with clausal complements with or without verb incorporation, causative, reflexive, and possessive constructions.

### *3.1 Recursion at the Clause Level and Verb Incorporation*

The data available to us reveal that Guarani clausal complements can have two levels of embedding, a case of indirect recursion, as indicated by (30) and (31). As Tupinambá is an extinct language, the data available just show one level of clause embedding, as illustrated in (32):

(30) Ndee [re-**japo** [a-i-**kuaa** aguã [ajaka a-**japo** aguã]]]
You 2SG-make 1SG-3-know DEP basket 1SG-make DEP
'You [made [me learn (how)[to make baskets]]]'

(31) Poty **omombe'u [**Tupã **aipoe'i** [Ara **o-java**]]][2]
Poty 3-tell Tupã 3-say Ara 3-run away
'Poty told (that) Tupã said (that) Ara ran away'

*Tupinambá* (Lemos Barbosa 1956:149, 150)

(32a) [a-î-potar[**xe só]**]
1SG-3-want I go
'I want (that) I go'

(32b) [a-î-potar[**nde só]**]
1SG-3-want you go
'I want (that) you go'
*Guarani*

When matrix and embedded subjects are co-referential, both languages allow non-incorporated and incorporated clausal complements, as illustrated from (33) to (35). The difference between these two options is seen through the verbal agreement possibilities. In the incorporated versions, only matrix subjects and downstairs objects are expressed through personal affixes, as the use of the portmanteau prefix *oro-* in (33b) clearly shows. In the non-incorporated versions, each verb marks all of its arguments independently:

[2] *aipo e'i* is an irregular verb that does not inflect for person in the same way as the regular verbs.

*Tupinambá* (Lemos Barbosa 1956:131, 149)

(33a) a-î-**potar** [nde –r-**epîak-**a]
1SG-3-want-2SG-REL-see-DEP
'I want to see you'

(33b) oro-**epîá'-potar**
1SG/2SG-see-want
'I want to see you'

*Guarani*

(34a) ore ro-i-**kuaa** [ajaka ro-**japo**]
We 1PL-3-know basket 1PL-make
'We know (how)to make baskets'

(34b) ore ro-**japo-kuaa** ajaka
we 1PL-make-know basket
'We know (how)to make baskets'

(35a) Ore ro-i-**kwaa-xe** [ro-**japo** aguã ajaka]
We 1PL-3-know-DES 1PL-make DEP basket
'We want to learn (how) to make baskets'

(35b) Ore ro**-japo-kwaa-xe** ajaka
We 1PL-make-learn-DES basket
'We want to know (how) to make baskets'

For Lemos Barbosa (1956), Tupinambá incorporated verbs correspond to the infinitival complements of Portuguese. If we follow the author's intuition, it is possible to suggest that in the (b) examples above, there is a version of infinitival clausal complements in incorporating languages. This explains the absence of embedded subject markers. In the (a) examples, there are finite complement clauses that explain why embedded subjects are cross-referenced on the verb. According to this proposal, a better translation for (34b), for instance, would be: 'we know that we (can) make baskets.'

Tupinambá verb incorporation can show not only one level of embedding, as in (22) and (36), but also two levels of embedding, as in (37) and (38): '[want [to start [to eat]]]' and '[want [to see [(them) hit]]]'. These constitute evidence for recursion. Notice that in (38a) the embedded object is syntactically independent from the verb 'hit,' while in (38b) it appears incorporated into it; notice also, however, that the subject of the lowest verb in (38) has been left out.

*Tupinambá* (Lemos Barbosa 1956: 148, 149)

(36) o**-ker-ypy**
3-sleep-start
‘He started to sleep’

(37) nda-pe-[[[**karu]-ypy]-potar]**-i xó-é-te-pe-ne?
NEG-2PL-eat-start-want- NEG then
‘Don’t you [want[to start[to eat]]], then?’

(38a) nd’-ere-î-[[[**nupãnupã]-epîá´-]potar]-**i pe **abá**?
NEG-2SG-3-hit-see-want- NEG Q Indian
‘Don’t you [want[to see [(them) hit the Indian]]]?’

(38b) nd’-ere-[[[**abá-nupãnupã]-epiá’]-potar]-i** pe?
NEG-2SG-Indian-hit-see-want- NEG Q
‘Don’t you [want [to see[(them) hit the Indian]]]?’

Note that, as seen in Section 1, verb reduplication can express iteration. As such, a better translation for (38) would be one that involves ‘keep hitting.’

Guarani also exhibits recursion through verb incorporation constructions. (39) and (40) involve two levels of verb embedding/incorporation. If we accept Lemos Barbosa’s suggestion that the Tupinambá desiderative marker *–seî* ‘want’ is a defective (= affixal) verb, it is possible to analyze Guarani’s desiderative suffix (*–xe*) in the same way. In this case, (41) can be viewed as a recursive construction with three levels of embedding/incorporation and with the following translation: ‘I don’t want to make the effort to learn (how) to see/recognize a dog’:

*Guarani*

(39) Xe-[[[**ayvu]-kuaa]-pota]** pende ayvu
1SG-speak-know-want 2PL-language
‘I [want[to learn [(how) to speak your language]]]’

(40) Nd-a-[[[**exa]-kuaa]-regua]-**i jagua
NEG-1SG-see-know-can-NEG dog
‘I[can’t[know [(how) to see/recognize a dog]]]’

(41) Nd-a-**exa-kuaa-pota-xe**-i jagua
NEG-1SG-see-know-want-DES-NEG dog
‘I don’t want to make the effort to recognize the dog’

(Dooley 2016)

Based on the data presented thus far, we can assume that clausal recursion involves a rule like (29a) in which a verb can select a CP as its complement, which in turn contains another verb that selects a CP as its complement and so on. Verb incorporation has a derivation in which the main verb selects a non-finite complement (a defective TP, perhaps), which contains a verb that selects another non-finite complement and so on. In this case, the verbal complex has just one full-fledged TP. Notice that negation of the whole construction is provided by the functional discontinuous affix, as in (42), while negation of the embedded/incorporated verb is made by using the adverbial *–eym* suffixed to it, as the data in (43) illustrate.

*Tupinambá* (Lemos Barbosa 1956:188)

(42) **nd'**-ere-ker-aub-**i**
NEG-2SG-sleep-pretend-NEG
'You don't pretend you are sleeping'

(43) nd'-a-**só-eym-**aub-i
NEG-1SG-go-NEG-pretend-NEG
'I pretend that I am not going'

The incorporated verb can also have other types of affixes, such as adverbs. In (44), for instance, the adverb 'well' has scope over the incorporated verb 'to eat.' (43) and (44) show that verb incorporation in these languages target constituents larger than a root or a verbal head because they contain some additional structure:

*Guarani*

(44) n-a-[[nhe-mo-**ngaru-ete**]-**kuaa-ve**']-i
NEG-1SG-REFL-CAUS-eat-well-know-more-NEG
'I don't know any more (how) to feed myself well'

A non-canonical type of incorporation is observed in Tupinambá noun incorporation data as well. Notice that in (45b), it is the whole object phrase that becomes incorporated into the verbal complex:

*Tupinambá* (Lemos Barbosa 1956:149)

(45a) nd-a-s-epîa'-potar-i **soó r-esá**
NEG-1SG-3-see-want-NEG animal-REL-eyes
'I don't want to see the animal's eyes'

(45b) nd-a-**soó-r-esá-**epîá'-potar-I'
NEG-1SG-animal-REL-eyes-see-want-NEG
'I don't want to see the animal's eyes'

In addition, the verb incorporation data presented above resemble Pirahã recursive control clauses, as described by Rodrigues, Salles, and Sandalo (this volume) in that besides syntactic embedding, they display the canonical SOV order of the language.

We turn now to the presentation of double causative constructions, which can also be viewed as involving recursion in the languages under investigation.

### *3.2 Recursion in the Causative and the Reflexive Domains*

We have observed that *mo/mbo* causatives can be recursive in Tupinambá and Guarani. The co-occurrence of two causative morphemes in the same verbal complex is conditioned by the application of the reflexive operation. In (46b) and (47b), *mo/mbo* adds an external argument to the structure and assigns accusative case to the *causee*. The causativized structure serves as input to reflexivization, which deletes one of the verbal arguments, turning a transitive verb into intransitive, as in (48) and (49):

*Tupinambá* (Lemos Barbosa 1956:191)

(46a) akub
3.hot
'It is hot'

(46b) a-**mo-**akub
1SG-CAUS-hot
'I make it hot'

*Guarani*

(47a) i-porã
3-beautiful
'She is beautiful'

(47b) i-xy kunhã o-**mo-**porã
3-mother woman 3-CAUS-beautiful
'The mother makes the woman beautiful'

*Tupinambá* (Lemos Barbosa 1956:191)

(48) a-**îe-mo-**akub
1SG-REFL-CAUS-hot
'I heated myself'

*Guarani*

(49) kunhã o-**nhe-mo-**porã
woman 3-REFL-CAUS-beautiful
'The woman made herself beautiful'

I suggest here that in the reflexive construction, the agent is the suppressed argument, due to Guarani examples such as (50c) in which the reapplication of the causative operation adds another external argument. In (50a), there is a transitive verb 'to open' that becomes intransitive by the reflexive morpheme in (50b). In this case, what surfaces as the subject is the theme argument of the transitive version. As there is no external argument in (50b), the causative morpheme can license another external argument, deriving (50c):

*Guarani*

(50a) Xee a-i-**pe' a** okẽ
I 1SG-3-open door
'I opened the door'

(50b) okẽ o-**je-pe' a**
door 3-REFL-open
'The door opened itself'

(50c) a-**mbo-je-pe' a** okẽ
1SG-CAUS-REFL-open door
'I made the door open itself'

The output of the reflexive feeds the application of the causative operation, which introduces another external argument and licenses accusative case to the *causee,* as shown by (51) and (52):

*Tupinambá* (Lemos Barbosa 1956:191)
(51) a-**î-mo-îe-mo-**akub
1SG-3-CAUS-REFL-CAUS-hot
'I made him heat himself'

*Guarani*
(52) i-xy kunhã o-**mo-nhe-mo**-porã
3-mother woman 3-CAUS-REFL-CAUS-beautiful
'The mother made the woman make herself beautiful'

Recursion of causatives is mediated by the reflexive operation. This reflects indirect recursion. Anchieta (1990:49) notes that Tupinambá causative and reflexive operations are repeated indefinitely: "the active verbs become neuter in a way that later, they can become active with *mo/ro-* and then become neuter and another time[become] active again." Here, 'neuter' and 'active' mean, respectively, intransitive and transitive. The data Anchieta presents as evidence for the claim are given in (53d), in which two instances of the reflexive morpheme are attested:

*Tupinambá* (Anchieta 1990:49)
(53a) a-î- **mo.nhang**
1SG-3-CAUS-make
'I make (something)'

(53b) a-**ye-** **mo.nhang**
1SG-3-CAUS-make
'I am made/I make myself'

(53c) a-î**-** **mo-ye-mo.nhang**
1SG-3-CAUS-REFL-make
'I make him make himself'

(53d) a-**ye-** **mo-nhe-mo.nhang**
1SG-REFL-CAUS-REFL make
[No translation given in Anchieta (1990)]

These are then clear examples of recursive Merge in morphology, leaving an open challenge to how labelling and subcategorization should be represented: do they carry a V-category marker or is a syntactic vP node introduced (see Harley 2008 for relevant discussion)?

I conclude that Guarani illustrates both indirect recursion through morphological alternation and syntactic indirect recursion typical of self-embedding constructions, but with a novel twist: the role of intransitivization via reflexivization. In addition to immediate self-embedded constructions, as in nominal compounds (e.g., *school bake sale schedule*), an increasing range of embedding structures in various languages appear to enforce alternation in ways not yet fully understood. This is a promising new dimension of research that is particularly sharp in indigenous languages.

### *3.3 Recursion in the Possessive Domain*

Possessive construction is another domain in which recursion is found in the two languages. In Tupinambá, I have found just one example with two levels of possessive embedding, as (54) indicates:

*Tupinambá* (Lemos Barbosa 1956:398)

(54) Xe-r-**ayra** r-**ura**'
1SG-REL-son-REL-arrival
'The arrival of the son of mine'

In Guarani, I have observed possessive constructions with two and three levels of embedding, as in (55c) and (55d), respectively. (56) shows a more complex possessive structure with four levels of embedding:

*Guarani*

(55a) **Ara**-r-**u**
Ara-REL-father
'Ara's father'

(55b) **Ara**-r-**u-**r-**o**
Ara-REL-father-REL-house
'Ara's father' s house'

(55c) **Ara**-r-**u**-r-**amõi-**r-**o**
Ara-REL-father-REL-grandfather-REL-house
'Ara's father's grandfather' s house'

(56) Ara-**r**-u-**Ø-**irũ**-r-**a'y-**r**-o
Ara-REL-father-REL-friend-REL-son-REL-house
'Ara's father's friend's son's house'

In these cases, each relational morpheme (*r*– or Ø) marks a different possessive relation. This type of recursive structure is also indirect because each DP (the possessor) is reintroduced inside another possessive phrase. A similar type of possessive recursion at the DP level is observed in Japanese, as reported by Terunuma and Nakato (this volume), as well as in English, as the Guarani translations indicate.

These morphemes can be seen not simply as marking possession, but as marking recursion itself if we follow a recent proposal by Di Sciullo (2015). These forms of recursively linked morphology also obey locality constraints. They have to be marked in each clausal Phase in a sequence. If this perspective can be upheld via continued research, then it presents a quite different status for recursion in Universal Grammar.

## 4 Conclusion

While arguments based on indigenous languages alone may leave many potential data points unaddressed, combining these observations with cross-linguistic evidence makes them powerful forms of confirming evidence for the basic abstractions of linguistic theory.

In this chapter, I aimed to describe the grammatical domains in which recursion is attested in Tupinambá and Guarani, languages which have not yet been discussed in cross-linguistic surveys of recursive constructions. The data presented here reveal that these languages indeed exhibit indirect recursion across different domains, such as complement clauses and verb incorporation, and causative, reflexive, and possessive constructions.

Indirect recursion was attested at both the syntactic and the morphological levels. This latter level is also syntactic in nature because besides being productive, it seems to involve Merge operations to build its hierarchically organized structures, which sometimes target units with functional elements.

There is also another grammatical domain in these languages that deserves future investigation in relation to recursion. Observed in Guarani, constructions involving three verbs in the same clause, as shown in (57), resemble verb serialization:

(57) Xee ajaka **a-japo-ta a-iny a-iko-vy**
I basket 1SG-make-FUT 1SG-sit 1SG-be-SS
'I will be making a basket seated'

Evidence for the occurrence of serialization in examples like (57) comes from the following facts: (i) there can be more than two verbs co-occurring in the same clause; (ii) the verbs share the same subject; (iii) the verbs to the left of the main verb belong to a restricted class; (iv) there is object sharing when the non-initiating verbs are transitive; and (v) there is only one inflectional domain so that negation and tense markings are attached to the main verb.

Further research will be necessary so that a deeper analysis of the phenomena presented can be offered, but I believe that I have provided here ample evidence for the existence of recursive operations in the two natural languages investigated.

*Part III*

# Recursive Possession and Relative Clauses

# 10 Recursive Possessives in Child Japanese

*Akiko Terunuma and Terue Nakato*[*]

Recursive structures are attested in many constructions across languages.[1] One form of recursion is found in the possessive construction. In languages such as English and Japanese, more than one possessive phrase can be generated in the pre-nominal position. (1) and (2) are English noun phrases with two or three possessive phrases. (3) and (4) are their Japanese counterparts.

(1) Jane's father's bike

(2) Jane's father's friend's bike

(3) Jane-no otoosan-no jitensha
Jane-GEN father-GEN bike
'Jane's father's bike'

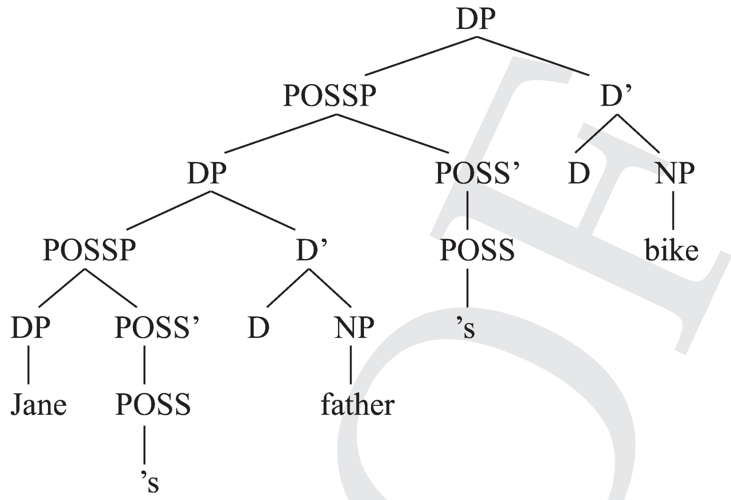
(4) Jane-no otoosan-no tomodachi-no jitensha
Jane-GEN father-GEN friend-GEN bike
'Jane's father's friend's bike'

The possessive phrases in (1)–(4) are marked by genitive markers: *'s* in English and *no* in Japanese. We assume that such phrases are POSSPs headed by genitive markers. The English noun phrase in (1), for example, has the structure in (5). The Japanese counterpart in (3) has the same structure, except that the order of the D head and its complement NP is reversed.

[*] We are grateful to Tom Roeper, Luiz Amaral, the audience at the conference *Recursion in Brazilian Languages and Beyond 2013* held at the Federal University of Rio de Janeiro, and two anonymous reviewers for their valuable comments and suggestions. We are also indebted to Gabriel Lee for statistical analyses of the experimental results.

[1] The term *recursion* is used in two different senses. In a broad sense, recursion is a result of the structure-building operation Merge (Chomsky 2007, 2008). In a narrower sense, it refers to recursive occurrences of the same type of phrase (Roeper 2011; Arsenijević and Hinzen 2012). In this chapter, we focus on the latter sense of recursion, especially what Roeper (2011) calls *indirect recursion*.

(5)




As (5) shows, DPs can have a POSSP in their Spec, and POSSPs can have a DP in their Spec. This enables recursion of possessive phrases in English and Japanese.[2]

The acquisition of recursive possessives has recently attracted considerable attention (Limbach and Adone 2010; Fujimori 2010; Roeper 2011, 2013; Pérez-Leroux et al. 2012; Amaral and Leandro 2013; Hollebrandse and Roeper 2014; Lima and Kayabi, this volume). One of the issues that has been addressed is whether there is a specific developmental path of recursive structures with possessive phrases. Previous findings suggest that there are two developmental stages in the acquisition of recursive possessives. One explanation for this is the DP substitution account (Roeper 2011; Hollebrandse and Roeper 2014). The present study attempts to shed new light on the developmental path of recursive possessives, providing data obtained through two experiments that investigate how Japanese-speaking children interpret sentences with one to four possessive phrases (1- to 4-POSS sentences). The data reveal that there are in fact three stages in the acquisition of recursive possessives. We provide two possible analyses of our data, both of which are obtained by modifying the DP substitution account. In the first analysis, the crucial step for the acquisition of an unlimited recursion of possessives lies in the substitution of DPs for

[2] It has been reported that some languages do not allow recursive possessives even though they have a morpheme similar to genitive markers in English and Japanese (Roeper and Snyder 2005; Limbach and Adone 2010). In German, for example, the morpheme *s* is used to mark pre-nominal possessive phrases, as in *Marias Auto* ‘Maria’s car.’ However, recursion of pre-nominal possessive phrases is not allowed. The question of why recursive possessives are not allowed in some languages is left open in this chapter, but see also notes 17 and 19.

NPs *within possessive phrases*. In the second analysis, what is crucial is the acquisition of a certain mechanism that licenses multiple possessive phrases, in addition to the substitution of DPs for NPs *in general*.

This chapter is organized as follows: Section 1 provides a summary of findings from previous experimental studies and reviews the DP substitution account. Sections 2 and 3 report the results of our experiments. Section 4 shows that two analyses are possible for our data if the DP substitution account is modified. Section 5 concludes the chapter.

## 1 Previous Research

In previous studies, it has been observed that 3- to 5-year-old English-speaking children have difficulty comprehending and producing 2-POSS sentences (Limbach and Adone 2010; Pérez-Leroux et al. 2012), and that Wapichana-Portuguese bilingual children's performance in the comprehension of 2-POSS Wapichana sentences is not perfectly adult-like, even at the age of 7 and 8 (Amaral and Leandro 2013). It has also been reported that Japanese-speaking children tend to start giving adult-like interpretations to 2- to 4-POSS sentences all at once at around 4 years of age (Fujimori 2010). The results of these studies suggest that although the age at which children come to understand or produce recursive possessives in an adult-like manner varies, they undergo the following two developmental stages:

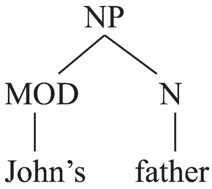
(6) Developmental stages suggested by previous studies
Stage 1: Only a single possessive phrase can be generated.
Stage 2: More than one possessive phrase can be generated.

This poses a theoretical challenge: what property must be triggered in order for children to recognize the unlimited productivity of recursive possessives?[3]

One explanation for this question is the DP substitution account (Roeper 2011; Hollebrandse and Roeper 2014). In this account, recursive possessives are possible when POSSPs are projected and DPs are substituted for NPs. Until POSSPs and DPs emerge, possessive phrases with genitive markers are considered to be modifiers of the head N as if they were lexical possessives such as *his* in *his father*. More specifically, the noun phrase with a possessive phrase has a non-recursive structure as in (7) at first.

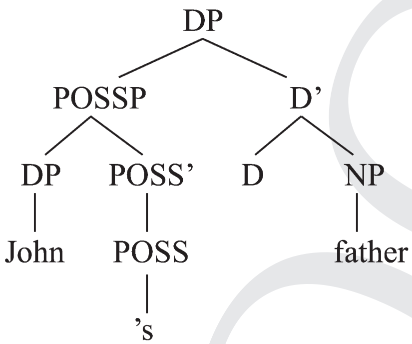
[3] It is also reported in experimental studies on relative clauses and PPs that children have difficulty with recursive structures (Amaral and Leandro, this volume; Pérez-Leroux et al., this volume). In Lima and Kayabi's (this volume) experiment, however, 4- and 5-year-old Kawaiwete-speaking children gave more adult-like responses to 3-POSS sentences than to 1-POSS and 2-POSS sentences. For possible reasons for this, see Lima and Kayabi (this volume).

(7)




In the next stage, POSSPs are projected, and NP nodes at the top of noun phrases and inside of POSSPs are replaced by DPs, as shown in (8).

(8)




Since the structure in which DPs contain another DP through POSSPs is available, recursive possessives are possible at this stage.

## 2 Experiment 1

A crucial observation that supports the developmental path in (6) above is found in the results of Fujimori's (2010) experiment. In her experiment, Japanese-speaking children who gave adult-like interpretations to 2-POSS sentences tended to give adult-like interpretations to 3-POSS and 4-POSS sentences. These results are interesting, but the number of participants of her experiment was relatively small.[4] To examine whether the children's responses reported in Fujimori (2010) truly represented a general tendency, we conducted an experiment on a larger scale using similar test sentences.

### *2.1 Participants*

The participants were thirty-six children and thirteen adults. They were all monolingual native speakers of Japanese. The children were recruited from a

[4] Only seven children participated in the experiment. For further details of Fujimori's (2010) experiment, see Roeper (2011).

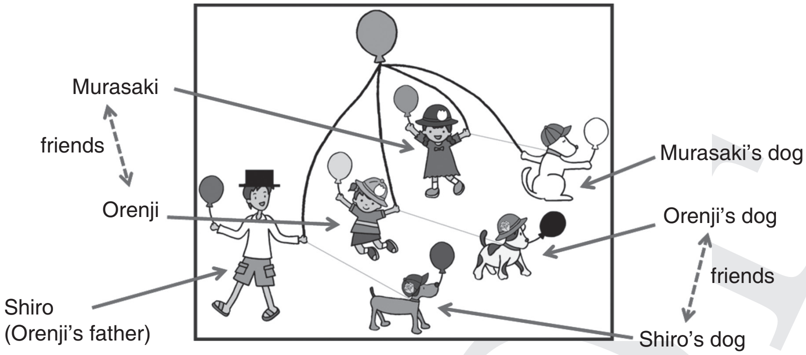



Figure 10.1 Sample picture in Experiment 1

kindergarten in Tokyo. The adults were undergraduate students at Daito Bunka University. The data from ten children were not included in our results because they were distracted halfway through the experiment. The remaining twenty-six children ranged in age from 3;4.15 to 6;1.7.

### 2.2 *Materials*

The experiment was carried out using a question-answering task methodology. Twenty-seven questions were asked while three pictures were being shown along with verbal descriptions of the characters in the pictures. Out of the twenty-seven questions, sixteen were target 1- to 4-POSS sentences and eleven were filler sentences.[5] Each picture was presented with nine questions: five target sentences and four filler sentences for two of the three pictures, and six target sentences and three filler sentences for the other picture. Shown in Figure 10.1 is one set of the materials (a sample picture (Figure 10.1), its verbal description, and the target sentences assigned).

**Verbal description (English translation):**

(9) This is Orenji. This is Orenji's father, Shiro. This is Orenji's friend, Murasaki. Orenji and Murasaki have the same flower on their hats as a sign of their friendship. This is Shiro's dog. This is Orenji's dog. This is Murasaki's dog. Shiro's dog and Orenji's dog are friends. They have the same flower on their hats as a sign of their friendship.

**Target sentences:**

(10) Shiro-san-no booshi-wa nani-iro kana? (1-POSS)
Shiro-san-GEN hat-TOP what-color Q
'What color is Shiro's hat?'

[5] The sixteen target sentences consist of three 1-POSS sentences, five 2-POSS sentences, four 3-POSS sentences, and four 4-POSS sentences.

| | | | | | | |
|---|---|---|---|---|---|---|
| (11) | Orenji-chan-no | inu-no | fuusen-wa | nani-iro | kana? | (2-POSS) |
| | Orenji-chan-GEN | dog-GEN | balloon-TOP | what-color | Q | |
| | ‘What color is Orenji’s dog’s balloon?’ | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| (12) | Orenji-chan-no | inu-no | tomodachi-no | booshi-wa | | (3-POSS) |
| | Orenji-chan-GEN | dog-GEN | friend-GEN | hat-TOP | | |
| | nani-iro | kana? | | | | |
| | what-color | Q | | | | |
| | ‘What color is Orenji’s dog’s friend’s hat?’ | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| (13) | Murasaki-chan-no | tomodachi-no | inu-no | booshi-wa | | (3-POSS) |
| | Murasaki-chan-GEN | friend-GEN | dog-GEN | hat-TOP | | |
| | nani-iro | kana? | | | | |
| | what-color | Q | | | | |
| | ‘What color is Murasaki’s friend’s dog’s hat?’ | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| (14) | Shiro-san-no | kodomo-no | tomodachi-no | inu-no | fuusen-wa | (4-POSS) |
| | Shiro-san-GEN | child-GEN | friend-GEN | dog-GEN | balloon-TOP | |
| | nani-iro | kana? | | | | |
| | what-color | Q | | | | |
| | ‘What color is Shiro’s child’s friend’s dog’s balloon?’ | | | | | |

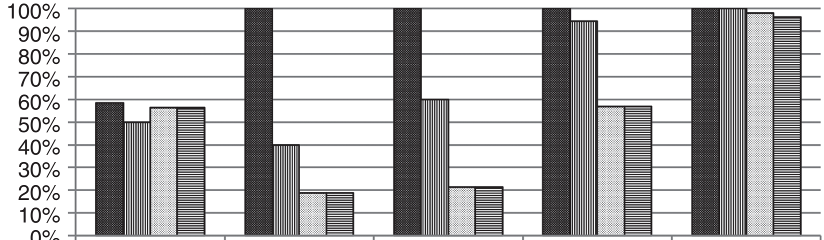
Figure 10.1 shows not only a picture but also notes about the characters’ names and their relationships. In the experiment, however, the participants were shown only a picture. A description of the characters was given verbally as in (9) above, accompanied by pointing.

The human characters in the picture were named after the colors of their clothes so that children could easily memorize their names. For example, one girl in Figure 10.1 was called *Orenji*, which means ‘orange’ in Japanese, because she wore an orange shirt.[6]

## 2.3 *Procedure*

The child participants were first shown a picture and given a verbal description of the picture. Then, they were asked to answer questions about the characters (e.g., *Whose dog is this?* [pointing at a dog in the picture in Figure 10.1]) in order to ensure that they remembered the characters’ names and their relationships. The characters’ names and their relationships were given again (repeatedly, if needed) to the children who could not answer the questions about the characters. After that, the children were asked to answer a set of target and filler questions. The three pictures were shown in a random order. The target and filler questions for each picture were also given randomly.

[6] In our pilot experiment on five children at 3 to 9 years of age, we used ordinary human names and found that children had difficulty remembering the names of the characters. In the present experiment, children memorized the names of the characters much more easily.




| | Child Group 1 (n=4) | Child Group 2 (n=4) | Child Group 3 (n=7) | Child Group 4 (n=11) | Adult Group (n=13) |
|---|---|---|---|---|---|
| 1-POSS | 58.3% | 100% | 100% | 100% | 100% |
| 2-POSS | 50% | 40% | 60% | 94.5% | 100% |
| 3-POSS | 56.3% | 18.8% | 21.4% | 56.8% | 98.1% |
| 4-POSS | 56.3% | 18.8% | 21.4% | 56.8% | 96.2% |

Figure 10.2 Results of Experiment 1 (the ratio of adult-like responses)

The adult participants were shown a picture on a big screen along with a verbal description of the picture, and were given a set of target and filler questions. They were asked to write their answers on an answer sheet.

## *2.4 Results*

As reviewed in Section 1, it has been observed that children go through the two developmental stages in (6). In order to examine whether this is a general tendency, we divided our child participants into four groups according to their responses to 1-POSS and 2-POSS sentences: children who were not fully adult-like in their responses even to 1-POSS sentences (Group 1); children who were adult-like with respect to 1-POSS sentences and gave adult-like responses to 2-POSS sentences 40 percent of the time (Group 2) or 60 percent of the time (Group 3); and children who were adult-like with respect to both 1-POSS and 2-POSS sentences (Group 4). The overall results for the four child groups and the adult group are shown in Figure 10.2.[7]

[7] In the pictures used in Experiment 1, several characters share one object. This led a few adults to make an unusual, but not wrong, response to some target sentences. (14) is one such sentence. Although adults' general answer to (14) was "white," one adult answered "white and pink." White is the color of the balloon that the dog in question has by itself. Pink is the color of the balloon that the dog shares with other characters. Of all responses from adults, eight were of this type (two for a 1-POSS sentence, four for a 2-POSS sentence and one each for 3-POSS and 4-POSS sentences). These responses were regarded as correct answers because both the object that the character has by himself/herself and the object that he/she shares with other characters could be considered his/her belongings. There was no child who showed such

What is most important to our purpose is the performance by Child Groups 2, 3, and 4. Child Groups 2 and 3, who gave adult-like responses to the 1-POSS sentences but not to the 2-POSS sentences, were not adult-like with respect to the 3-POSS and 4-POSS sentences. Even Child Group 4, who made adult-like responses to both the 1-POSS sentences and the 2-POSS sentences, was not fully adult-like with respect to the 3-POSS and 4-POSS sentences.[8] Moreover, in each of the child groups, there was no difference between the responses to the 3-POSS and 4-POSS sentences. These results suggest that Japanese-speaking children start to give adult-like interpretations to 1-POSS and 2-POSS sentences consecutively, and then come to interpret 3-POSS and 4-POSS sentences in an adult-like manner almost at the same time.

## 3 Experiment 2

In Experiment 1, the children's performance for the 3-POSS and 4-POSS sentences was not as good as that for the 2-POSS sentences. One possible reason for this is that the phrases containing *tomodachi* 'friend,' namely *N-no tomodachi* 'N's friend' and *tomodachi-no N* 'friend's N,' were included in the 3-POSS and 4-POSS sentences but not in the 2-POSS sentences. In adult Japanese, these phrases can have two interpretations depending on prosody when the N is animate. The children's poor performance for the 3-POSS and 4-POSS sentences might be because of their insensitivity to the effect of prosody on interpretation. Let us take a look at an example of a target sentence containing *N-no tomodachi* 'N's friend.' Consider (12), which is repeated here with the relevant part in bold type:

responses. Pictures of this type were used in Experiment 1 to examine whether children, unlike adults, regard recursive possessive structures as conjoined nominal structures. It is reported that such conjunction errors are observed in child English (Gentile 2003; Limbach and Adone 2010). For example, some children interpret *Jane's father's bike* as a bike that Jane and her father share. The results of Experiment 1 have shown that Japanese-speaking children seldom make conjunction errors. The children's individual results are given in Appendix 1.

8 For the results shown in Figure 10.2, the following statistical comparisons were made at $p < .05$ level of significance. One-way ANOVAs were performed to see whether or not any differences between the five groups were significant. When the one-way ANOVAs showed a significant difference, multiple post-hoc comparisons were made with Tukey's HSD to examine where the differences resided. According to the one-way ANOVAs, significant differences were found between the groups with respect to all the four types of sentences ($F(4, 34) = 63.57$, $p < .001$ for 1-POSS; $F(4, 34) = 60.15$, $p < .001$ for 2-POSS; $F(4, 34) = 22.96$, $p < .001$ for 3-POSS; $F(4, 34) = 15.50$, $p < .001$ for 4-POSS). The results of the multiple post-hoc comparisons that are relevant here are as follows: the difference between Child Group 1 and the Adult Group in their performance for the 1-POSS sentences was significant ($p < .001$). The differences between Child Groups 2 and 3 on the one hand and the Adult Group on the other in their performance for the 1-POSS sentences were not significant ($p = 1.0$ for both), but the differences between them in their performance for the 2- to 4-POSS sentences were significant ($p < .001$ for all). The differences between Child Group 4 and the Adult Group in their performance for the 1-POSS and 2-POSS sentences were not significant ($p = 1.0$ and $p = .602$, respectively), but the differences in their performance for the 3-POSS and 4-POSS sentences were significant ($p < .001$ and $p = .003$, respectively).

(12) **Orenji-chan-no inu-no tomodachi**-no booshi-wa (3-POSS)
Orenji-chan-GEN dog-GEN friend-GEN hat-TOP
nani-iro kana?
what-color Q
'What color is Orenji's dog's friend's hat?'

With normal prosody, where no particular stress falls on any morpheme and no prosodic break is made inside of the phrase, the bold part has the interpretation in (15).

(15) Orenji's dog's friend

On the other hand, with stress on the first genitive marker and a prosodic break after that, the bold part has the interpretation in (16):[9]

(16) Orenji's friend, who is a dog

In Experiment 1, all the sentences were read with normal prosody, and the adult participants assigned the interpretation in (15) to the bold part of (12). However, children who are insensitive to prosody may assign the interpretation in (16) to the bold part. In such cases, the relevant hat in (12) is understood to be not Orenji's dog's friend's hat but Orenji's dog's hat. If children interpret the bold part of (12) as in (16), it is reasonable for their responses to differ from adults'.

In a similar way, children's responses could also be different from adults' in the target sentences containing the phrase *tomodachi-no N* 'friend's N.' Consider (13), which is repeated here with the relevant part in boldface type:

(13) **Murasaki-chan-no tomodachi-no inu**-no booshi-wa (3-POSS)
Murasaki-chan-GEN friend-GEN dog-GEN hat-TOP
nani-iro kana?
what-color Q
'What color is Murasaki's friend's dog's hat?'

The bold part has the interpretation in (17) with normal prosody, while it has the interpretation in (18) if there is a stress on the second genitive marker and a prosodic break after that.[10]

[9] While the bold part of (12) has the structure [[Orenji's dog's] friend] under the interpretation in (15), it has the structure [Orenji's [dog's friend]] under the interpretation in (16). In addition, the phrase *inu-no* 'dog's' is taken not as a possessor but as a modifier which adds some information about the following noun under the interpretation in (16). See also note 12.

[10] The bold part of (13) has the following constituent structure regardless of whether its interpretation is (17) or (18): [[Murasaki's friend's] dog]. Under the interpretation in (18), however, the phrase *tomodachi-no* 'friend's' is interpreted not as a possessor but as a modifier of the following noun. See also note 12.

(17) A dog that is owned by Murasaki's friend

(18) A dog, which is a friend of Murasaki's

When the bold part has the interpretation in (17), the relevant hat in (13) is Murasaki's friend's dog's hat, which was the adult interpretation in Experiment 1. When the bold part has the interpretation in (18), the relevant hat is Murasaki's dog's hat. If children are insensitive to prosody, their responses to (13) may be different from adults'.[11]

Two out of the four 3-POSS sentences and three out of the four 4-POSS sentences used in Experiment 1 contained either the phrase *N-no tomodachi* 'N's friend' or the phrase *tomodachi-no N* 'friend's N whose interpretation could change depending on prosody.' The child participants gave a response that could be regarded as evidence for their insensitivity to prosody 23.1 percent of the time (12/52 trials) to these two 3-POSS sentences and 32.1 percent of the time (25/78 trials) to these three 4-POSS sentences. However, such responses could also be made when the children simply drop the POSSP *tomodachi-no*

[11] As suggested in notes 10 and 11, the Japanese genitive marker *no* has two interpretations: the "possessive" interpretation and the "modifier" interpretation. There are three possibilities for the derivation of these two interpretations. The first possibility is to assume two lexical items, whose syntactic categories are different: one as a head of POSSP and the other as a head of MODP. In this analysis, the structures behind the two interpretations differ in the label for the phrase with *no*. The phrase is labeled as POSSP when it has the "possessive" interpretation and as MODP when it has the "modifier" interpretation, as in (i) and (ii).

(i) $[_{DP} [_{POSSP}$ DP-no$]$ $[_{NP}$ N$]]$
(ii) $[_{DP} [_{MODP}$ DP-no$]$ $[_{NP}$ N$]]$

From this analysis, children who gave the "modifier" interpretation to *no* could be said to have made a labeling error. The second possibility is to assume only one lexical item, whose meaning is underspecified, and to derive the two interpretations via semantic rules (such as coercion or type-shifting). Nishiguchi (2006, 2009) takes this position, although she does not discuss in detail the interpretations in question. In this analysis, the two interpretations share the structure in (i) above and *no* has the semantic information in (iii). The interpretive difference depends on which of the two relations in (iv) rewrites the R in (iii):

(iii) $\|no\| = \lambda x.\ \lambda y.\ R(y)(x)$
(iv) a. possession: $R = \{< x, y > \mid x \text{ owns } y\}$
b. property: $R = \{< x, y > \mid x \text{ is dominant characteristic of } y\}$

From this analysis, we could say that the children who gave the "modifier" interpretation to *no* do have a structure of recursive possessives, but they differ from adults in the way they rewrite R in the semantic/pragmatic component. The third possibility, which we think is less tenable than the other two, is to attribute the ambiguity with respect to the interpretation to a "true" structural ambiguity. For example, we could say that the "modifier" interpretation derives from the underlying structure, which is similar to English relative clauses. The issue of which of these alternatives should be taken goes beyond the scope of this chapter. We would like to leave the issue open.

'friend's' in those sentences.[12] It is not clear from the results of Experiment 1 whether the children's poor performance for the 3-POSS and 4-POSS sentences was a result of their insensitivity to prosody or a result of their inability to generate structures with three or four possessive phrases. Therefore, we conducted a further experiment in which the phrases in question were not used.

### *3.1 Participants*

Thirty-two children were recruited from a kindergarten in Saitama. They were all monolingual native speakers of Japanese. The children were classified into three age groups in accord with classes in the kindergarten: the Junior Group (those who turned 4 years old during the academic year), the Middle Group (those who turned 5 years old during the academic year), and the Senior Group (those who turned 6 years old during the academic year). Data from three children were not included in the results because they failed to give an adult-like response to more than one filler. The results shown below are for the other twenty-nine children: eight in the Junior Group (4;1.11–4;8.30), ten in the Middle Group (4;11.20–5;9.17), and eleven in the Senior Group (5;10.5–6;9.1).

### *3.2 Materials*

The method was the same as for Experiment 1: the question-answering task methodology. Twenty-one questions were asked while three pictures were shown along with verbal descriptions. For each picture, seven questions were presented. Four were target 1- to 4-POSS sentences, and the other three were filler sentences. The target sentences were different from those in Experiment 1 in that they did not contain the phrases *N-no tomodachi* 'N's friend' or *tomodachi-no N* 'friend's N.' Figure 10.3 shows an example of a set of the materials:

**Verbal description (English translation):**

(19) This is Midori, and this is Midori's father. This is Orenji, and this is Orenji's father. This is Midori's dog, and this is his father's dog. This is Orenji's dog, and this is her father's dog. They are all wearing a hat, and the hats have a flower on them.

**Target sentences:**

| | | | | | |
|---|---|---|---|---|---|
| (20) | Midori-kun-no | booshi-wa | nani-iro | kana? | (1-POSS) |
| | Midori-kun-GEN | hat-TOP | what-color | Q | |

'What color is Midori's hat?'

[12] It has been observed that English-speaking children sometimes drop one of the POSSPs in their comprehension of 2-POSS sentences (Limbach and Adone 2010).

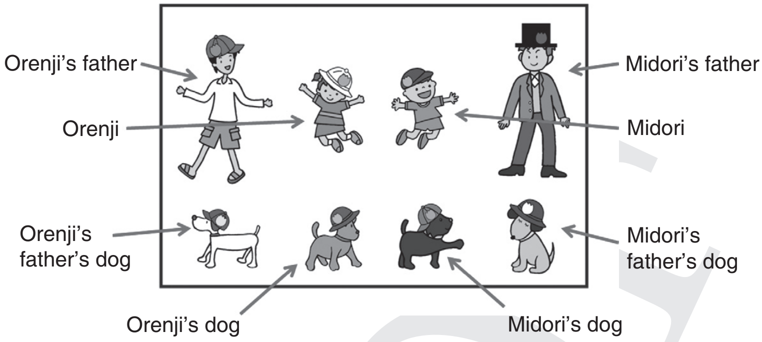



Figure 10.3 Sample picture in Experiment 2

(21) Orenji-chan-no booshi-no hana-wa nani-iro kana? (2-POSS)
Orenji-chan-GEN hat-GEN flower-TOP what-color Q
'What color is Orenji's hat's flower?'

(22) Midori-kun-no otoosan-no inu-no booshi-wa nani-iro kana? (3-POSS)
Midori-kun-GEN father-GEN dog-GEN hat-TOP what-color Q
'What color is Midori's father's dog's hat?'

(23) Orenji-chan-no otoosan-no inu-no booshi-no hana-wa (4-POSS)
Orenji-chan-GEN father-GEN dog-GEN hat-GEN flower-TOP
nani-iro kana?
what-color Q
'What color is Orenji's father's dog's hat's flower?'

The other two sets of materials have a similar design.

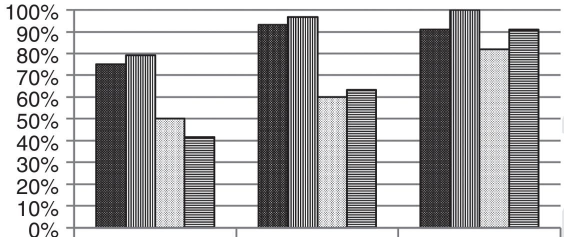
### *3.3 Procedure*

After being shown a picture along with a verbal description, the children were asked to answer a set of target and filler questions. The three pictures were given in a random order. The target and filler questions for each picture were also presented randomly.

### *3.4 Results*

Figure 10.4 shows the overall results of Experiment 2.[13]
Experiment 2 was not conducted on adults. However, it is expected that adult responses would be over 90 percent for each type of target sentence in

[13] The children's individual results are given in Appendix 2.




| | Junior Group (n = 8, mean age: 4; 5.19) | Middle Group (n = 10, mean age: 5; 6.17) | Senior Group (n = 11, mean age: 6; 4.28) |
|---|---|---|---|
| 1-POSS | 75% | 93.3% | 90.9% |
| 2-POSS | 79.2% | 96.7% | 100% |
| 3-POSS | 50% | 60% | 81.8% |
| 4-POSS | 41.7% | 63.3% | 90.9% |

1-POSS 2-POSS 3-POSS 4-POSS

Figure 10.4 Results of Experiment 2 (the ratio of adult-like responses)

Experiment 2, considering the results of Experiment 1 above. Thus, the results shown in Figure 10.4 could be interpreted as follows: The Junior Group was not (fully) adult-like in their responses to all the four types of sentences; the Middle Group was adult-like with respect to the 1-POSS and 2-POSS sentences but not fully adult-like with respect to the 3-POSS and 4-POSS sentences; and the Senior Group was almost adult-like with respect to all the four types of sentences.

The results of Experiment 2 as well as those of Experiment 1 show that there is a stage where children's performance for 3-POSS and 4-POSS sentences is not good compared to 2-POSS sentences. Since the 3-POSS and 4-POSS sentences used in Experiment 2 did not contain the phrases *N-no tomodachi* 'N's friend' or *tomodachi-no N* 'friend's N,' it could be said that the ambiguity of these phrases was not a main reason for the children's poor performance for the 3-POSS and 4-POSS sentences.

## 4 Discussion

Main findings in our experiments can be summarized as follows:

(24) Children's responses to 1-POSS and 2-POSS sentences become adult-like in turn.

(25) Even when children's responses to 2-POSS sentences become adult-like, their responses to 3-POSS and 4-POSS sentences are still different from adults'.

(26) Children come to give adult-like responses to 3-POSS and 4-POSS sentences almost at the same time.

Our data suggest that there are three developmental stages in the acquisition of recursive possessives, as shown in (27).

(27) Developmental stages suggested by our data
Stage 1: Only a single possessive phrase can be generated.
Stage 2: Two possessive phrases can be generated.
Stage 3: More than two possessive phrases can be generated.

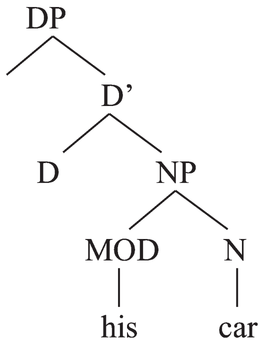
The developmental path in (27) cannot be fully attributed to incremental parsing difficulties. Under the incremental parsing hypothesis, children's performance for sentences with recursive possessives is expected to become worse as the number of possessive phrases increases. As our data indicate, however, the children showed no greater difficulty with the 4-POSS sentences than with the 3-POSS sentences.

The results of our experiments cannot be explained directly by the DP substitution account, either. Under the DP substitution account, it is predicted that any number of possessives can be generated once POSSPs are projected and DPs are substituted for NPs, and so the difference between the second and the third stages in (27) remains to be explained. However, if we take into consideration three types of possessives available in UG and modify the DP substitution account, two analyses are possible. After illustrating the three types of possessives in Section 4.1, we provide two analyses in Sections 4.2 and 4.3. We also briefly discuss the transition between the developmental stages in Section 4.4.

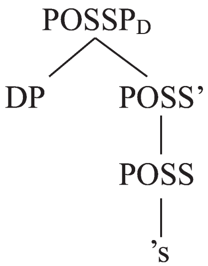
### *4.1 Three Types of Possessives*

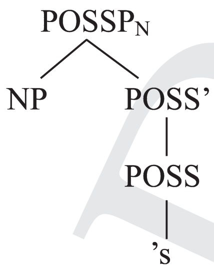
It has been observed that there are three types of possessives: lexical possessives, DP-possessives and NP-possessives (Munn 1995; van Hout et al. 2013; Hollebrandse and Roeper 2014). We assume that these three types of possessives are available in UG.[14] Lexical possessives such as *his* in *his car* are considered to be modifiers of the head N, as (28) shows.

[14] We would like to thank Tom Roeper (personal communication) for this point.

(28)


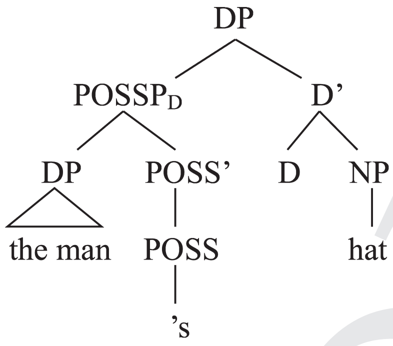

DP-possessives and NP-possessives are POSSPs with a DP projection and an NP projection, respectively, in their Spec, as shown in (29) and (30).

(29)


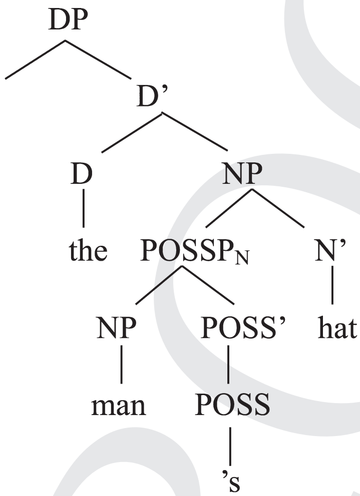

(30)



The evidence of these two types of non-lexical possessives comes from the ambiguity of the phrase *the man's hat*. This phrase has two interpretations: 'the hat owned by the man' and 'the hat for men.' The first interpretation derives from the structure in (31a), where the DP *the man* is combined with a genitive marker to make a DP-possessive. The second derives from the structure in (31b), where the NP *man* makes an NP-possessive together with a genitive marker.

(31) a.



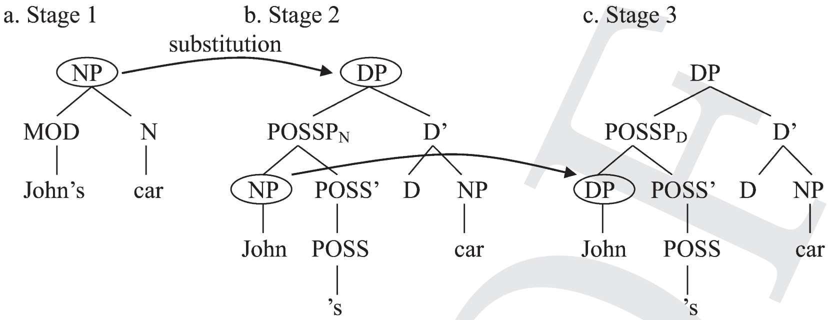
b.



### *4.2 Analysis 1*

Given the three types of possessives, the DP substitution account can be modified in two ways to explain the developmental path in (27) above. One analysis is obtainable if we assume that the DP substitution inside of POSSPs is delayed compared to the DP substitution at the top of noun phrases. In this analysis, a structure with one non-lexical possessive phrase develops, as in (32):

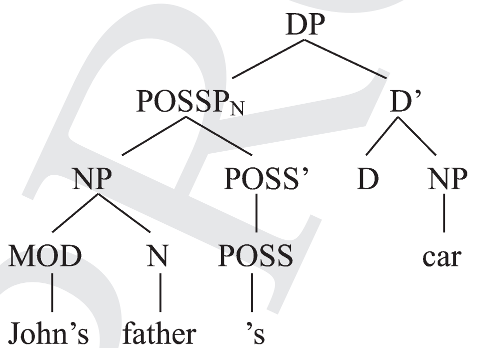
(32)




In the first stage, the structure for lexical possessives is the only option available for possessive phrases, because DPs and POSSPs have not yet been projected. In this stage, possessive phrases with genitive markers are taken to be noun modifiers. In the next stage, POSSPs are projected, and the DP substitution takes place only at the top node of noun phrases. In the third stage, NP nodes within POSSPs are also replaced by DPs. Differing from the original DP substitution account, this analysis expects children to go through a stage where the structure in (32b) is generated.[15]

In this analysis, only a single possessive phrase is possible in the form of a noun modifier in the first stage. In the second stage, children can generate not only 1-POSS structures such as (32b) above but also non-recursive 2-POSS structures such as (33), which contain an NP-possessive and a possessive phrase as a noun modifier.

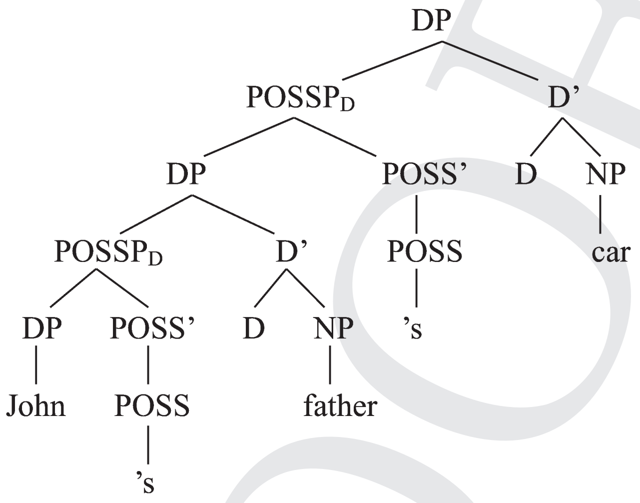
(33)




[15] It is assumed in this analysis that at some stages, children (could) consider NPs such as *John* and *John's car* to be NPs. In this chapter, we do not go into the problem concerning mapping between meaning and syntactic structure in child grammar.

In the final stage, the DP substitution within POSSPs triggers recursive structures in which a DP contains another DP through a DP-possessive, such as (32c) above. Once this structure is acquired, children can generate adult-like recursive 2-POSS structures, such as (34), by using multiple DP-possessives.

(34)




Children also have no difficulty generating adult-like structures with more than two possessive phrases at this stage.[16]

### 4.3 *Analysis 2*

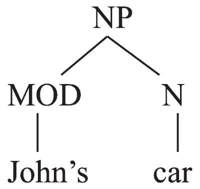
An alternative analysis for the developmental path in (27) above is obtainable even if we maintain the original assumption of the DP substitution account that NPs are replaced by DPs all at once. In this analysis, it is assumed that multiple occurrences of the same type of POSSP need to be licensed by a certain mechanism, which is acquired late.[17] Let us assume here that a mechanism similar to the one which licenses multiple Negative Polarity Items or WH-operators is at work in adult grammar: The POSS head is an operator-like element, and needs to be licensed by the topmost POSS in the structure.

In this analysis, children's initial grammar is the same as the one assumed in the original DP substitution account and Analysis 1: possessive phrases with a genitive marker are considered to be a noun modifier at the first stage of acquisition. In this stage, only 1-POSS structures, such as (35), can be generated in child grammar.

[16] As mentioned in note 2, German does not allow recursion of pre-nominal possessive phrases. In Analysis 1, it would be possible to argue that possessive phrases in German are lexical possessives even though they are marked by a morpheme similar to genitive markers in English and Japanese.

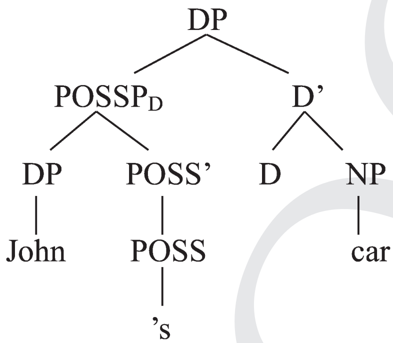
[17] We would like to thank Tom Roeper (personal communication) for his suggestion.

(35)



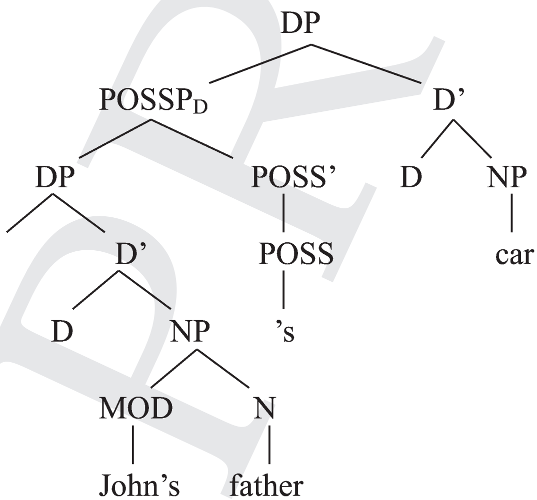

In the second stage, 1-POSS structures containing a DP-possessive, such as (36), can be generated because POSSPs are projected and the DP substitution takes place both at the top node of noun phrases and inside of POSSPs.

(36)



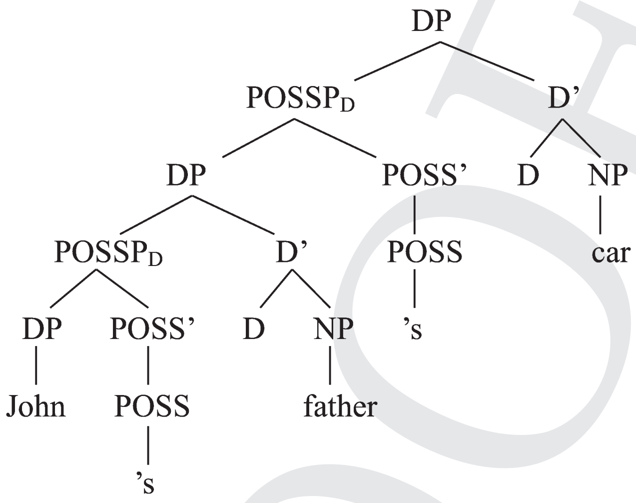

Children at this stage can also generate non-recursive 2-POSS structures, such as (37), by using a DP-possessive and a possessive phrase as a noun modifier.

(37)



However, they cannot generate recursive 2-POSS structures, such as (38), which contain two DP-possessives, because the mechanism that licenses multiple DP-possessives has not yet been acquired.

(38)




Children at this stage are also unable to generate structures with more than two possessive phrases.

In the final stage, the licensing mechanism is acquired which allows several POSSPs of the same type to occur in one noun phrase, and adult-like 2-POSS structures, such as (38), can be generated. Recursive structures with more than two possessive phrases are also available.[18]

### *4.4 Transition between Developmental Stages*

The results of our experiments show that in the acquisition of recursive possessives, children go through three stages in (27). However, one thing should be noted with respect to their moderate performance observed in our experiments: to a certain extent, children in one developmental stage give the response that is expected to be observed in the next stage.[19] For example,

[18] In Analysis 2, there are two possible explanations of why recursive pre-nominal possessives are not allowed in German. One explanation, which is the same as the one provided in Analysis 1, is that possessive phrases in German are lexical possessives even when they are marked by a genitive marker. The other is that although possessive phrases with a genitive marker project POSSPs, the mechanism that licenses multiple POSSPs is not implemented in German.

[19] We would like to thank the audience at *Recursion in Brazilian Languages and Beyond 2013* for pointing this out.

the responses of Child Group 4 in Experiment 1 and the Middle Group in Experiment 2 were (significantly) different from the adults with respect to the 3-POSS and 4-POSS sentences, while they were adult-like with respect to the 2-POSS sentences. This suggests that they were at the second stage in (27), where they were not expected to generate structures with more than two possessive phrases. However, the rate at which they gave adult-like responses to the 3-POSS and 4-POSS sentences was around 60 percent, which seems to indicate that this was not by chance. In almost all the trials in both experiments, children were asked to answer questions about the color of an object in a situation where there were six to eight objects of the same kind. In one item in Experiment 1, for instance, six hats and seven balloons were depicted in the picture (see Figure 10.1), and the target questions were focused on the color of one of these hats or balloons (see (10)–(14)). Considering that there were more than five choices, the performance of around 60 percent could not be just guesses. We could say that children in the second developmental stage may sometimes reach the third stage. That is, children may go back and forth between two consecutive developmental stages on their way to adult grammar. The results of our experiments are not conclusive with respect to this matter. The problem of how we should interpret children's moderate performance in our experiments needs further consideration.

## 5 Concluding Remarks

In this chapter, we have reported the results of two experiments on Japanese-speaking children, and demonstrated that there are three developmental stages in the acquisition of recursive possessives. We have also shown that two analyses are possible for our findings if we modify the DP substitution account.

The two analyses make different predictions on the acquisition of recursive possessives in relation to other constructions. In Analysis 2, a correlation is expected between the acquisition of recursive possessives and that of multiple Negative Polarity Items or WH-operators. These constructions all involve some licensing mechanism. It would be no surprise that they are acquired almost at the same developmental stage. For Analysis 1, in contrast, such a correlation is not expected.

The two analyses also make different predictions about the children's response to particular noun phrases that contain two possessive phrases.[20] From Analysis 1, it is plausible to speculate that children in the second developmental stage have more difficulty comprehending phrases such as *the boy's father's car* than

[20] We would like to thank the audience in *Recursion in Brazilian Languages and Beyond 2013* for this point.

phrases such as *John's father's car*, because the 2-POSS structure in (33) above, which is the only structure obtainable for noun phrases with two possessive phrases in the second stage for Analysis 1, does not have a position for the definite determiner in phrases like *the boy's father's car*. In Analysis 2, in contrast, the 2-POSS structure in (37) above is available in the second stage. In such a structure, the definite determiner could occur in the position for the lower D head. Therefore, it is not necessarily the case that children in the second stage have more difficulty with phrases such as *the boy's father's car* than with phrases such as *John's father's car*.

Further acquisition research is necessary to conclude which of our two analyses is tenable. We would like to examine this issue in future research.

# Appendix 1

Table 10A.1 *Children's individual results in Experiment 1*

| | | 1-POSS | 2-POSS | 3-POSS | 4-POSS |
|---|---|---|---|---|---|
| Group 1 | Child 1 (3;4.15) | 2/3 (66.7%) | 3/5 (60%) | 2/4 (50%) | 0/4 (0%) |
| | Child 12 (4;10.21) | 2/3 (66.7%) | 2/5 (40%) | 2/4 (50%) | 4/4 (100%) |
| | Child 18 (5;4.3) | 1/3 (33.3%) | 1/5 (20%) | 2/4 (50%) | 1/4 (25%) |
| | Child 22 (5;7.26) | 2/3 (66.7%) | 4/5 (80%) | 3/4 (75%) | 4/4 (100%) |
| Group 2 | Child 3 (3;6.24) | 3/3 (100%) | 2/5 (40%) | 1/4 (25%) | 0/4 (0%) |
| | Child 4 (3;8.9) | 3/3 (100%) | 2/5 (40%) | 0/4 (0%) | 0/4 (0%) |
| | Child 8 (4;2.21) | 3/3 (100%) | 2/5 (40%) | 2/4 (50%) | 1/4 (25%) |
| | Child 23 (6;0.7) | 3/3 (100%) | 2/5 (40%) | 0/4 (0%) | 2/4 (50%) |
| Group 3 | Child 2 (3;6.4) | 3/3 (100%) | 3/5 (60%) | 0/4 (0%) | 0/4 (0%) |
| | Child 5 (3;9.11) | 3/3 (100%) | 3/5 (60%) | 1/4 (25%) | 0/4 (0%) |
| | Child 6 (3;11.10) | 3/3 (100%) | 3/5 (60%) | 2/4 (50%) | 1/4 (25%) |
| | Child 10 (4;6.3) | 3/3 (100%) | 3/5 (60%) | 1/4 (25%) | 2/4 (50%) |
| | Child 11 (4;9.5) | 3/3 (100%) | 3/5 (60%) | 0/4 (0%) | 1/4 (25%) |
| | Child 15 (5;0.6) | 3/3 (100%) | 3/5 (60%) | 2/4 (50%) | 1/4 (25%) |
| | Child 16 (5;3.4) | 3/3 (100%) | 3/5 (60%) | 0/4 (0%) | 1/4 (25%) |
| Group 4 | Child 7 (4;2.0) | 3/3 (100%) | 5/5 (100%) | 2/4 (50%) | 2/4 (50%) |
| | Child 9 (4;5.15) | 3/3 (100%) | 5/5 (100%) | 1/4 (25%) | 2/4 (50%) |
| | Child 13 (4;11.12) | 3/3 (100%) | 5/5 (100%) | 2/4 (50%) | 0/4 (0%) |
| | Child 14 (4;11.17) | 3/3 (100%) | 4/5 (80%) | 1/4 (25%) | 2/4 (50%) |
| | Child 17 (5;3.11) | 3/3 (100%) | 4/5 (80%) | 3/4 (75%) | 3/4 (75%) |
| | Child 19 (5;5.17) | 3/3 (100%) | 5/5 (100%) | 2/4 (50%) | 2/4 (50%) |
| | Child 20 (5;6.16) | 3/3 (100%) | 5/5 (100%) | 2/4 (50%) | 3/4 (75%) |
| | Child 21 (5;7.6) | 3/3 (100%) | 5/5 (100%) | 3/4 (75%) | 1/4 (25%) |
| | Child 24 (6;0.26) | 3/3 (100%) | 5/5 (100%) | 4/4 (100%) | 4/4 (100%) |
| | Child 25 (6;0.27) | 3/3 (100%) | 5/5 (100%) | 1/4 (25%) | 3/4 (75%) |
| | Child 26 (6;1.7) | 3/3 (100%) | 4/5 (80%) | 4/4 (100%) | 3/4 (75%) |

# Appendix 2

Table 10A.2 *Children's individual results in Experiment 2*

| | | 1-POSS | 2-POSS | 3-POSS | 4-POSS |
|---|---|---|---|---|---|
| Junior Group | Child 1 (4;1.11) | 2/3 (67%) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) |
| | Child 2 (4;3.7) | 3/3 (100%) | 3/3 (100%) | 1/3 (33%) | 1/3 (33%) |
| | Child 3 (4;4.2) | 3/3 (100%) | 2/3 (67%) | 2/3 (67%) | 0/3 (0%) |
| | Child 4 (4;5.27) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) | 0/3 (0%) |
| | Child 5 (4;6.14) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) |
| | Child 6 (4;7.8) | 0/3 (0%) | 3/3/ (100%) | 0/3 (0%) | 3/3 (100%) |
| | Child 7 (4;7.24) | 2/3 (67%) | 1/3 (33%) | 0/3 (0%) | 0/3 (0%) |
| | Child 8 (4;8.30) | 2/3 (67%) | 1/3 (33%) | 0/3 (0%) | 0/3 (0%) |
| Middle Group | Child 9 (4;11.20) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) |
| | Child 10 (5;1.4) | 3/3 (100%) | 3/3 (100%) | 1/3 (33%) | 1/3 (33%) |
| | Child 11 (5;4.20) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) | 2/3 (67%) |
| | Child 12 (5;7.0) | 3/3 (100%) | 3/3 (100%) | 1/3 (33%) | 1/3 (33%) |
| | Child 13 (5;7.18) | 3/3 (100%) | 3/3 (100%) | 2/3 (67%) | 2/3 (67%) |
| | Child 14 (5;8.21) | 2/3 (67%) | 2/3 (67%) | 1/3 (33%) | 1/3 (33%) |
| | Child 15 (5;8.27) | 3/3 (100%) | 3/3 (100%) | 1/3 (33%) | 2/3 (67%) |
| | Child 16 (5;9.0) | 3/3 (100%) | 3/3 (100%) | 2/3 (67%) | 2/3 (67%) |
| | Child 17 (5;9.13) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) |
| | Child 18 (5;9.17) | 2/3 (67%) | 3/3 (100%) | 1/3 (33%) | 2/3 (67%) |
| Senior Group | Child 19 (5;10.5) | 0/3 (0%) | 3/3 (100%) | 0/3 (0%) | 3/3 (100%) |
| | Child 20 (5;11.13) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) |
| | Child 21 (6;2.11) | 3/3 (100%) | 3/3 (100%) | 2/3 (67%) | 3/3 (100%) |
| | Child 22 (6;3.30) | 3/3 (100%) | 3/3 (100%) | 2/3 (67%) | 3/3 (100%) |
| | Child 23 (6;5.5) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) |
| | Child 24 (6;5.17) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) |
| | Child 25 (6;6.3) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) |
| | Child 26 (6;7.22) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) |
| | Child 27 (6;7.28) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) |
| | Child 28 (6;9.0) | 3/3 (100%) | 3/3 (100%) | 2/3 (67%) | 2/3 (67%) |
| | Child 29 (6;9.1) | 3/3 (100%) | 3/3 (100%) | 3/3 (100%) | 1/3 (33%) |

# 11 Recursion of Possessives and Locative Phrases in Kawaiwete

*Suzi Lima and Pikuruk Kayabi*

This chapter presents a description of two cases of embedding in the Kawaiwete language, also known as Kaiabi, a Tupi-Guarani language spoken in Brazil.[1] The first type of embedding that will be discussed is attested in possessive phrases with full NP possessors. The second type is attested in locative phrases. This chapter has two goals. First, based on comprehension tasks, we argue that 4-year-old Kawaiwete children comprehend complex possessive phrases such as "What color is Maria's brother's friend's bowl?" Second, we propose an account of word order variation in possessive and locative phrases with multiple levels of embedding. This chapter aims to contribute to the theoretical discussion on complex embedding in Brazilian indigenous languages and also to studies on the language development aspects of embedding in possessive and locative phrases.

## 1 The Kawaiwete Language

The Kawaiwete language is part of the Tupi-Guarani family, within the Tupi stock (Rodrigues 1986). The Tupi-Guarani family is divided into eight subgroups. The Kawaiwete language belongs to subgroup 5; the languages Asuriní do Xingu and Araweté are also part of this subgroup.

The Kawaiwete consist of approximately 2242 people.[2] In 2014, most of the Kawaiwete people lived in the Xingu Indigenous Territory, divided among approximately thirty-four villages. A smaller part of the population lives in other indigenous territories outside Xingu (Mato Grosso).

As described by Souza (2004) and as confirmed by a sociolinguistic evaluation of the Kawaiwete villages located in the Xingu Indigenous Territory (Lima and Santos 2008), the Kawaiwete people are mostly bilingual, speaking Kawaiwete and Brazilian Portuguese. Due to marriages across language groups,

[1] We would like to thank ProDocLin/Museu do Índio and the Kawaiwete communities from the Xingu Indigenous Territory.

[2] https://pib.socioambiental.org/en/povo/kawaiwete

some Kawaiwete also speak a third language, usually another indigenous language spoken in the Xingu territory. The Kawaiwete themselves argue that the only territory where most of the population speaks the Kawaiwete language is the Xingu Indigenous Territory, where this research took place. The first material that described the Kawaiwete language was a word list collected by Schmidt (1942). The Villas Boas brothers also elicited a list of words (Villas Boas and Villas Boas 1989). Missionaries have described the phonology and morphosyntax of this language (Dobson 1980, 1988, 1997, 2005) and produced a dictionary (Weiss 1998), as well as compilations of mythological narratives (Dobson 1990). Academic linguists have investigated the phonology, the pronominal system (Souza 2004), free word order, and second position clitics (Faria 2004; Gomes 2002, 2007).

The contributions of this chapter are threefold: first, it furthers our understanding of recursive structures in Tupi-Guarani languages, alongside the contributions of Duarte; Vieira; and Thomas in this volume. Second, it contributes to a better understanding of the acquisition path of recursive structures (see also Pérez-Leroux et al. in this volume). Finally, it dialogues with the studies of recursive possessive and postpositional phrases of Terunuma and Nakato, Sandalo et al. and Maia et al. in this volume.

## 2 Complex Embedding 1: Possessives

The first type of embedding we will discuss in this chapter is the type we found in possessive phrases. Possessive relations in Kawaiwete can be expressed either by possessive prefixes or by juxtaposition of NPs. The possessive prefixes are derived from pronominal forms:

Table 11.1 *Possessive prefixes*

| **Person (singular)** | | **Person (plural)** | | |
|---|---|---|---|---|
| 1S | jeakãng<br>je-akãng<br>'My head' | 1PL | janeakãng<br>jane-akãng<br>'Our heads' | oreakãng<br>ore-akãng |
| 2S | eneakãng<br>ene-akãng<br>'Your head' | 2PL | pẽakãng<br>pẽ-akãng<br>'Your heads (pl)' | |
| 3S | ngaakãng<br>nga-akãng<br>'His head' | 3PL | ngãakãng<br>ngã-akãng<br>'Their heads' | |

In the second case, no possessive prefix is used and the possessive relation is usually expressed by pronouncing the possessor (e.g., 'João' in (1)) after the possessed NP (e.g. *kasuru* 'dog' in (1)). The fact that possessive prefixes are not attested with full NP possessors suggests that they ought to be analyzed as pronominal clitics rather than as agreement morphemes:

(1) Je aesak **kasuru João** ma'e[3]
1SG see dog João thing
'I saw João's dog'

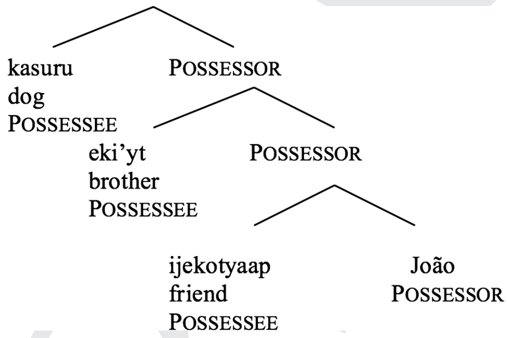
In this chapter, we are interested in possessive phrases with full NP possessors, as illustrated in (1). We will discuss the properties of possessive phrases with multiple degrees of possession. Such constructions involve stacking of NPs in the order possessee < possessor. For example, the possessee in examples (1–3) is *kasuru* 'dog' and the possessor can be simple (1) or complex (2–3):

(2) Je aesak **kasuru ijekotyaap João** ma'e
1SG see dog friend João thing
'I saw João's friend's dog'

(3) Je aesak **kasuru eki'yt ijekotyaap João** ma'e
1SG see dog brother friend João thing
'I saw João's friend's brother's dog'

The construction of complex possessive phrases clearly involves semantic embedding, as illustrated in (4):

(4)




In view of this syntactic and semantic complexity, we conducted a comprehension study to assess when Kawaiwete children start to understand complex possessive constructions with embedded relations between possessors and possessees.

[3] We currently do not have an explanation for the occurrence of the morpheme *ma'e* 'thing' in possessive phrases in Kawaiwete.

## 3 Study: Comprehension Task

### *3.1 Previous Studies on Recursive Possessives*

Studies on syntactic recursion suggest that children have difficulty with this kind of construction in comprehension and production tasks (see Roeper 2011; Pérez-Leroux et al. 2012). Corpus research on the CHILDES database (Roeper and Snyder 2005) has shown that children have difficulties comprehending multi-level possessive phrases in interactions with adults ((5) and (6)) even when the context supports their answer (6):

(5) Mother: What's Daddy's Daddy's name?
Sarah: uh?
Mother: What's Daddy's Daddy's name?
Sarah: uh?

(Roeper 2011:10)

(6) 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?

(Roeper 2011:10)

Experimental studies support this claim. Previous studies, such as the one conducted by Fujimori (2010), have compared different levels of complexity in non-pronominal possessive constructions. Seven children from 2 to 6 years of age were provided with questions that included four different levels of complexity, as follows:

(7) What color is Mika's ball? (First level)
(8) What color is Mika's dog's ball? (Second level)
(9) What color is Mika's friend's dog's ball? (Third level)

(10) What color is Mika's brother's friend's dog's ball? (Fourth level)

The results suggest that children progressively understand recursive possessive phrases. While younger children (2;5, 3;2 and 4;3 years of age) did not correctly answer questions that include possessive phrases like (9) and (10), older children succeeded in this task. Based on these results, Roeper (2011) claimed that the acquisition of recursion in possessive phrases is not immediate, but once a child can process possessive phrases of level 3, they can also process level 4 possessives.

One of the crucial findings in previous studies is that children favor a non-recursive interpretation of possessive phrases when these phrases are at the third or fourth level of complexity (such as in (9) and (10)) and they do not entertain a recursive interpretation of these phrases. Roeper (2011) illustrated this finding by showing that when asked a question such as "What color is Sho's friend's dog's ball?", children point to three different balls: the ball that belongs to Sho, the ball that belongs to Sho's friend, and the ball that belongs to the dog. That is, they do not interpret possessive markers as referring to a single 'complex' possessor.

In Kawaiwete, as we saw above, when the possessive relations are established by juxtaposition of nouns, there are no additional possessive morphemes. In the following we reproduce a task similar to Fujimori (2010) in order to test when Kawaiwete children are able to interpret complex possessive phrases and what interpretation they associate with these constructions.

### *3.2 Materials and Methods*

This study is based on the comprehension task designed by Roeper (personal communication) and reproduced by other researchers such as Fujimori (2010) for Japanese in which children answered questions based on visual stimuli. The participants consisted of ten children: four children not yet in school (4 and 5 years old) and six children in school (6 to 10 years of age). Pikuruk Kaiabi, who is a local teacher well known by the children and their parents, was present at all of the data collection sessions. The study took place in the local school in the Diauarum village. The instructions and the study itself were fully conducted in Kawaiwete. The study was divided into a pre-test phase and the actual test phase.

*3.2.1 Warm-Up and Pre-Test Phase* First, all children were introduced to six characters in two different scenarios:

**‘Bowl’ Scenario**

“This is Maria; she has a bowl. This is Carla, a friend of Maria. She also has a bowl. This is João, he is Carla’s brother. He also has a bowl.”


Maria


Carla


João

**‘Basket’ Scenario**


Pedro


João


Paulo

“This is Pedro. He has a basket. This is João, a friend of Pedro. He also has a basket. This is Paulo, he is João’s brother. He also has a basket.”

In the pre-test phase, we checked whether the children knew the names of the colors used in the materials by asking the color of the bowls and baskets presented in both scenarios. When the children did not know the name for a color, the experimenter introduced the name of the color in Kawaiwete. The results of the pre-test phase are presented in Table 11.2.

In this phase, most of the 6-to-10-year-old children knew the words for colors (✔). Some answered in Brazilian Portuguese (BP). In the 4-to-5-year-old group, children were less familiar with the names for the colors. Two of them expressed hesitation (–) and one answered the questions incorrectly (✖). In those cases, Pikuruk introduced the name for the color in the Kawaiwete language.

This test phase was critical because it is reported in the literature that the acquisition of color words is slower in comparison to other adjectives such as *big* and *little* (see Carey 1982; Landau and Gleitman 1985; Backscheider and Shatz 1993). Sandhofer and Smith (1999) reported a longitudinal study in which they observed the following pattern: by 27 months, children are able to group color terms such as *red*, *yellow*, and *blue*; that is, at this age they are able to identify that these words belong to the same “lexical class,” but do not

Table 11.2 *Results of pre-test phase*

| Target questions | Expected answer | Age | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 4 | 4 | 4 | 5 | 6 | 7 | 7 | 9 | 10 | 10 |
| What is the color of the bowl? | Black | – | ✓ | – | ✓ | ✓ | ✓ | ✓ | – | ✓ | ✓ |
| | Green | ✓ | ✓ | – | ✓ | ✓ | ✓ | ✓ | – | ✓ | ✖ |
| | Red | ✓ | ✓ | ✓ | ✖ | ✓ | ✓ | ✓ (BP) | – | ✓ | ✓ |
| What is the color of the basket? | Green | ✓ | ✓ | – | ✖ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ (BP) |
| | Blue | – | ✓ | – | ✖ | ✓ | ✖ | ✓ | ✓ | ✓ | ✓ (BP) |
| | Yellow | – | ✓ | – | ✖ | ✓ (BP) | ✓ | ✓ | ✓ | ✓ (BP) | ✓ (BP) |

know the specific meaning of these words. That is, in tasks where children had to answer questions about the color of an object, children often chose the wrong color (but did not choose a word from a different lexical class, showing that they distinguish color terms from other categories). A few months later (between 28 and 29 months), children start demonstrating a better performance in comprehension tasks where they have to identify objects based on their colors. Approximately at 30.5 months, children start to use color to match objects in nonlinguistic tasks. For comparison, by 27 months children are successful in comprehension tasks with size adjectives.

The slow process of language acquisition of color words is attested in other lexical domains, such as number words (see Mix, Sandhofer, and Baroody 2005:337). The literature reports that despite the fact that young children are able to recite number words at around two years of age (see Wynn 1990), their ability to match number words to the amounts that they correspond to emerges quite late (Le Corre and Carey 2007; Sarnecka et al. 2007; Condry and Spelke 2008; Huang, Spelke, and Snedeker 2010). Before four years of age, children know some small number words but do not master the interpretation of larger numbers. For example, 2.5 year olds are ‘two-knowers’: they correctly associate the numeral “two” to quantities of two objects, but fail with higher numerals; a few months later it is reported that they become ‘three knowers’ (Huang, Spelke, and Snedeker 2013).

*3.2.2 Test Phase (Critical Items)* After the pre-test phase, children participated in comprehension tasks in which we asked the name of colors in possessive constructions with increasing degrees of semantic embedding. Note that the pictures were still visible after the experimenter’s question. We tested three levels of semantic embedding:

**'Bowl' Scenario**

Level 1

| | | | | | |
|---|---|---|---|---|---|
| (11) | Man | **ipit** | **y'a** | **Maria** | ma'e |
| | What | color | bowl | Maria | thing |

'What color is Maria's bowl?'

Maria (black)

Level 2

| | | | | | | |
|---|---|---|---|---|---|---|
| (12) | Man | **ipit** | **y'a** | **ijekoty'aawa** | **Maria** | ma'e |
| | What | color | bowl | friend | Maria | thing |

'What color is Maria's friend's bowl?'

Carla (green)

Level 3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (13) | Man | **ipit** | **y'a** | **eki'yt** | **ijekoty'aawa** | **Maria** | ma'ea[4] |
| | What | color | bowl | brother | friend | Maria | thing |

'What color is Maria's friend's brother's bowl?'

João (red)

[4] Currently we do not have an explanation for the variation between *ma'e* and *mae'a*. It is attested that in Kawaiwete, noun phrases are followed by the morpheme *–a*, which seems to be unmarked for number, gender and definiteness (i) (see Lima et al. in press). Alternatively, nouns can be followed by a third person pronoun (as illustrated in ii). The morpheme *–a* and the third person pronouns cannot co-occur (iii):

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| i | kasuru-a | ujãn | ii. | Kasuru | 'nga | ujãn | iii. | * Kasuru-**a** | **'nga** | ujãn |
| | dog-A | ran | | dog | 3SG | ran | | dog-A | 3SG | run |

'(A/the/some) dog(s) ran' '(A/the) dog ran'

The morpheme *–a* is also found in other Tupi-Guarani languages (see Vieira 1995:704), such as Assuriní do Trocará. In this language, the morpheme *–a* can be suffixed to nominal roots and it is unmarked for number, gender and definiteness:

Assuriní do Trocará

| | | | | | |
|---|---|---|---|---|---|
| (5a) | h-aty-a | (5b) | se-memyr-a | (5c) | manako-a |
| | 3-wife-NOM | | 1POS-son-NOM | | basket-NOM |
| | 'He has a wife' | | 'My son/He is my son' | | 'A/the basket(s)' |

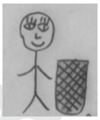
(Vieira 1995)

Vieira analyzes this morpheme as a functional head of category *n* in Assuriní do Trocará. When this morpheme is combined with a root, it results in a constituent of category N (Vieira 1995:704). Following Lemos Barbosa (1956, cited in Vieira 1995), Vieira argues that the distinction between nouns and verbs in Tupi Guarani languages such as Tupinambá, but also Assurini do Trocará and Kawaiwete, is made by the use of affixes. The same root can be turned into a verb or a noun in different sentences depending on the affix that appears with the root. In Kawaiwete, this morpheme also seems to be associated with the formation of noun phrases, but this is yet to be fully understood.

**'Basket' Scenario**

Level 1

(14) Man **ipit** **tamakari** **Pedro** ma'ea
What color basket Pedro thing
'What color is Pedro's basket?'



Pedro (yellow)

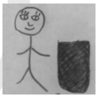
Level 2

(15) Man **ipit** **tamakari** **eki'yt** **Pedro** ma'e
What color basket brother Pedro thing
'What color is Pedro's brother's basket?'

João (green)

Level 3

(16) Man **ipit** **tamakari eki'yt ijekoty'aawa Pedro** ma'ea
What color basket brother friend Pedro thing
'What color is Pedro's friend's brother's basket?'



Paulo (blue)

### *3.2.3 Results*

Pre-School Group

The results for pre-school children (four children) are presented in Table 11.3. Each child answered two questions per level of embedding (one associated with the 'bowl' scenario and another associated with the 'basket' scenario).

The results suggest that the level of semantic embedding of possessive constructions did not impact children's answers negatively. That is, children's performance in this task seems to have actually improved as the experimenter moved to a more syntactically and semantically complex sentence. Their low

Table 11.3 *Percentage of correct answers per level of complexity (pre-school children)*

| Level | Result |
|---|---|
| Level 1 | 25% |
| Level 2 | 37% |
| Level 3 | 62% |

Table 11.4 *Percentage of correct answers per level of complexity (school-age children)*

| Level | Result |
|---|---|
| Level 1 | 92% |
| Level 2 | 100% |
| Level 3 | 92% |

performance in levels 1 and 2 could be an effect of being unsure about the name of the color for a particular object (as observed in the pre-test phase). This could also be an effect of the order of presentation of the critical items: as children got more comfortable with the task, their performance at each level improved.

Crucially, these results provide evidence that 4-year-old children can already manage complex possessive sentences, as observed in the results for level 3 where the possessor was composed of three nouns ('What color is **Pedro's friend's brother's** basket?').

### School-Age Group

In the 6-to-10-year-old group (children that are already in school), the performance of the participants at all levels was similar. Overall, children in this age group know the words for colors and know how to correctly interpret questions that involve multiple possessives. This is presented as follows:

The results clearly do not suggest an effect of level of complexity given that children's performance in those tasks was consistently high in all trials. One side note about this group is the existence of one child that answered the questions correctly, but answered them in BP. Nonetheless, this does not disconfirm that this child was able to understand what was being asked to her in Kawaiwete, as she provided the correct answers.[5]

In sum, these results suggest that Kawaiwete children master complex possessive structures given their high performance in level 3 possessive phrases ('What is **Pedro's friend's brother's** basket's color?'). These results are particularly interesting for two reasons. First, word order is free in Kawaiwete – including in possessive constructions – as we will discuss in the next section.

[5] All children who volunteered were allowed to participate (as long as their parents authorized them). Given the wide age range in the children's test group, we were not able to perform a statistical analysis that explored the age effects.

Second, previous studies on syntactic recursion suggest that children have difficulties with this kind of construction in comprehension and production tasks (Roeper and Snyder 2005; Roeper 2011; Pérez-Leroux et al. 2012), as discussed in Section 4.1.

It is also important to note that the incorrect responses of children in this task are relevant to our discussion about the interpretation of complex possessive phrases. None of the children tested provided an answer that was compatible with a non-recursive/distributive interpretation for the question they were asked; that is, none of the children that participated in this study interpreted level 3 possessive phrases ('What is the color of Pedro's friend's brother's basket?') as if we were asking about the color of three different baskets (Pedro's basket, the basket of Pedro's friend, or the basket of the brother of Pedro's friend) as some children did in other languages, as reported by Roeper (2011). As such, Kawaiwete children are interpreting these constructions as recursive constructions where just one basket (possessee) is owned by a 'complex' possessor.

In our study, when the Kawaiwete children did not answer a question correctly it could very well be because they were unsure about the name of the color for that object (as shown in the pre-test phase, Table 11.2) rather than a difficulty with complex possessive phrases. That would explain why the preschool group performed better in level 3 tasks in comparison to levels 1 and 2. As discussed in Section 2, previous studies have reported that the acquisition of dimensional adjectives (*big*, *little*) occurs earlier than the acquisition of color terms. In view of this, in future tasks, we will include a different variable instead of color (size or form, for example) in order to check whether it was the variable 'color' that affected children's answers in this task.

## 4 Word Order Inside Possessive Phrases

The literature on the Kawaiwete language has shown that its word order is free (see Dobson 1980, 1988; Gomes 2002, 2007; Faria 2004). It seems that the most basic order is an SOV order, while the orders SVO and VSO are also productive:

| | | | | | |
|---|---|---|---|---|---|
| (17) | SOV | kuima'e | nga | pira-a | a'u |
| | | man | 3SG | fish-a | eat |
| | | '(The) man ate the fish' | | | |

| | | | | | |
|---|---|---|---|---|---|
| (18) | SVO | kuima'e | nga | a'u | pira-a |
| | | man | 3SG | eat | fish-a |
| | | '(The) man ate fish' | | | |

| | | | | |
|---|---|---|---|---|
| (19) | VSO | a'u | kuima'e-a | pira-a |
| | | eat | man-a | fish-a |
| | | 'The man ate fish' | | |

In possessive constructions, the order of the possessor and possessee is also apparently free: the possessor may precede or follow the possessee:

| | | | | | |
|---|---|---|---|---|---|
| (20) | Maran te | **Maria** | **y'a** | **ipit** | |
| | What | Maria | bowl | color | |
| | 'What is Maria's bowl's color?' | | | | **[Maria bowl color]** |

| | | | | | | |
|---|---|---|---|---|---|---|
| (21a) | Man | **ipit** | **y'a** | **Maria** | ma'e | |
| | What | color | bowl | Maria | thing | |
| | 'What is Maria's bowl's color?' | | | | | **[color bowl Maria]** |

Furthermore, not only does the order between the possessee and possessor vary (compare 20 and 21a), but the possessee and possessor can be discontinuous (21b, 22b, and 23b). When discontinuous, the possessee precedes the possessor:

| | | | | | | |
|---|---|---|---|---|---|---|
| (21b) | Man te | **y'a** | **ipit** | **Maria** | ma'ea | |
| | What | bowl | color | Maria | thing | |
| | 'What is Maria's bowl's color?' | | | | | **[bowl** color **Maria]** |

| | | | | | | |
|---|---|---|---|---|---|---|
| (22a) | Man | **ipit** | **tamakari** | **Pedro** | ma'ea | |
| | What | color | basket | Pedro | thing | |
| | 'What is Pedro's basket's color?' | | | | | [color **basket Pedro**] |

| | | | | | | |
|---|---|---|---|---|---|---|
| (22b) | Man te | **tamakari** | **ipit** | **Pedro** | ma'ea | |
| | What | basket | color | Pedro | thing | |
| | 'What is Pedro's basket's color?' | | | | | [**basket** color **Pedro**] |

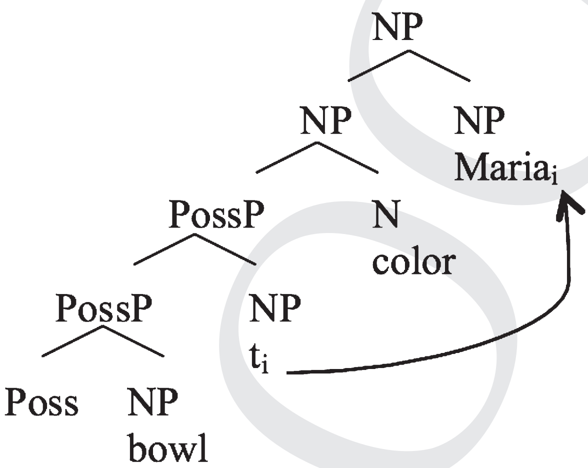
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (23a) | Man | **ipit** | **y'a** | **ijekoty'aawa** | **Maria** | ma'e | |
| | What | color | bowl | friend | Maria | thing | |
| | 'What is Maria's friend's bowl's color?' | | | | | | [color **bowl friend Maria**] |

| (23b) | Man te | **y'a** | **ipit** | **Maria** | **ijekoty'aawa** | ma'ea |
|---|---|---|---|---|---|---|
| | What | bowl | color | Maria | friend | thing |

'What is Maria's friend's bowl's color?' [**bowl** color **Maria friend**]

We propose that possessive phrases are headed by a functional head (POSS) that is phonologically null. POSS selects a possessee complement, and the possessor is located in the specifier position of the phrase. Assuming a default head-complement order, this analysis derives the basic word order that was observed in preceding examples (possessee < possessor). However, the specifier can be extraposed to the right periphery of the NP, which derives another attested word order in possessive phrases:

(24)




## 5 Complex Embedding 2: Locative Phrases in Kawaiwete

As presented in the introduction, locative phrases can also be used to study recursion in Kawaiwete. Complex semantic embedding is also attested with locative phrases in this language, which are postpositional phrases:

| (25a) | Eira | je | ujan | **arafa** | **pype** |
|---|---|---|---|---|---|
| | honey | 1SG | put | bottle | POSP |

'I put honey in the bottle'

| (25b) | * Eira | je | ujan | **pype** | **arafa** |
|---|---|---|---|---|---|
| | honey | 1SG | put | POSP | bottle |

In an elicitation session with two adult Kawaiwete speakers, the consultants saw a drawing that described one of two scenarios. In the first kind of scenario, several portions of a substance were distributed in several containers, which we will refer to as the conjunctive/distributive reading (see Roeper and Snyder 2005; Roeper 2010). In the second kind of scenario, a single portion of a substance was located in a single container, which was itself recursively located in a series of other containers, which we will refer to as the recursive/'*matryoshka* doll' reading:

(26a)

Distributive/conjunctive reading

(26b)

Recursive '*matryoshka* doll'

The consultants were presented with a total of six items (three items per scenario). The scenarios were not accompanied by any verbal or written description. The participants saw only pictures (similar to the pictures in 26a and 26b) and had to provide their best description of what they were seeing. The sentences produced by the speakers are provided in the following, preceded by a verbal description of these scenarios in English:

Scenario 1 (conjunctive/distributive reading): someone put a flower inside a cup, and inside a bowl, and inside a pan and these three different containers are above a chair:

| | | | | | | |
|---|---|---|---|---|---|---|
| (27a) | Ywotyra | je | omongy | | y'a | pype, |
| | flower | 1SG | put.PL | | bowl | inside (POSP) |
| | kanekũ | pype | japepo | pype, kanawa | 'arimũ | |
| | cup | POSP | pan | POSP chair | POSP | |

Scenario 2 ('*matryoshka* doll' – recursive): someone put a flower inside a cup, and this cup is inside a bowl, and this bowl is inside a pan and this pan is above a chair:

| | | | | | |
|---|---|---|---|---|---|
| (27b) | Ywotyra | je | amyĩ | kanekũ | pype, |
| | flower | 1SG | put | cup | inside (POSP) |
| | y'a pype, | japepo | pype, | kanawa 'arimũ | |
| | bowl POSP | pan | POSP | chair above | |

Scenario 3 (conjunctive/distributive reading): someone put honey inside a bottle, which was put inside a bowl, which was put inside a box.

Scenario 4 ('*matryoshka* doll' – recursive): someone put honey inside a bottle, and this bottle is inside a bowl, and this bowl is inside a pan and this pan is inside a box:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (28) | Eira | je | ujan | arafa | pype, | y'a | pype, |
| | Honey | 1SG | put | bottle | POSP | bowl | inside (POSP) |
| | japepo pype | ka'aaranatã | | pype | | | |
| | pan POSP | box | | POSP | | | |

In the examples above, we present two pairs of scenarios: in the first pair, we manipulated an object (*ywotyra* 'flower') and in the second pair we manipulated a substance (*eira* 'honey'). One relevant question was whether speakers would provide different descriptions of the locative relation in distributive and recursive scenarios. Another relevant question was whether the nature of the content of the container (object versus substance) would affect their answers.

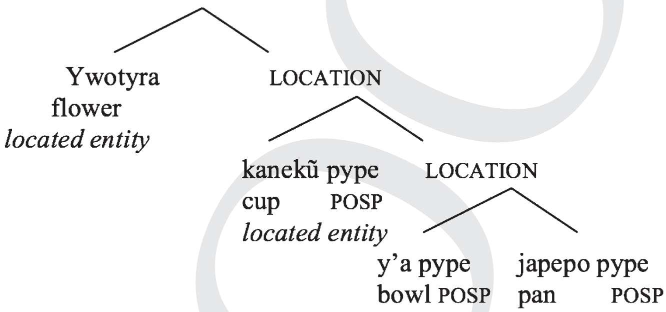
Examples (27a) and (27b) show that speakers differentiate distributive and non-distributive scenarios by using different verb forms. The verb 'put' in Kawaiwete has two forms: one that is associated with multiple events *omongy* 'put (pl)' (27a) and one – *amyĩ* 'put' – that does not specify whether the event was distributive or not. As such, the latter form is compatible with non-distributive/recursive scenarios as in (27b).

In (27a), three containers were lined up and each one contained a flower (distributive interpretation). A successful description of this scenario would consist of mentioning the three containers each containing a flower, but it would not require mentioning the containers in a particular order. In (27b), however, the order of the containers matters, as we are talking about containers contained in one another in a particular fashion (recursively). The contrast illustrated in (27a) and (27b) shows that the consultants were sensitive to the distinction between the recursive and the distributive scenarios as they provided different descriptions for each of them.

In scenarios 3 and 4, a substance was manipulated – *eira* 'honey.' Here, the consultants provided the same description for the recursive and distributive scenarios (28). Crucially, the order of presentation of the containers in the visual scenario was respected (which is a requirement for the description of a scenario such as 4 and optional for the description of a scenario such as 3). Note that the verb utilized in the scenarios that involved a substance *ujan* 'put' was different from the verbs utilized in the scenarios that involved an object *ywotyra* 'flower'. For objects, the verb form depended on whether we were manipulating a plurality of objects or not (e.g., *omongy* 'put' is used only when a plurality of objects is manipulated and *amyĩ* 'put' is used when a single object is manipulated).

The sentences produced by the Kawaiwete speakers show that semantic recursion of locatives is attested in Kawaiwete as observed for complex possessive phrases. In locative phrases, the located entity (*ywotyra* 'flower' or *eira* 'honey') precedes the location and the location can be simple (if an object or substance is inside a single container, as exemplified in (25a) or complex (as in (27) and (28)):

(29)




Assuming that adpositions are head-final and that PPs are right-adjoined to the phrases they modify, the expected word order for the sentence in (29) would be:

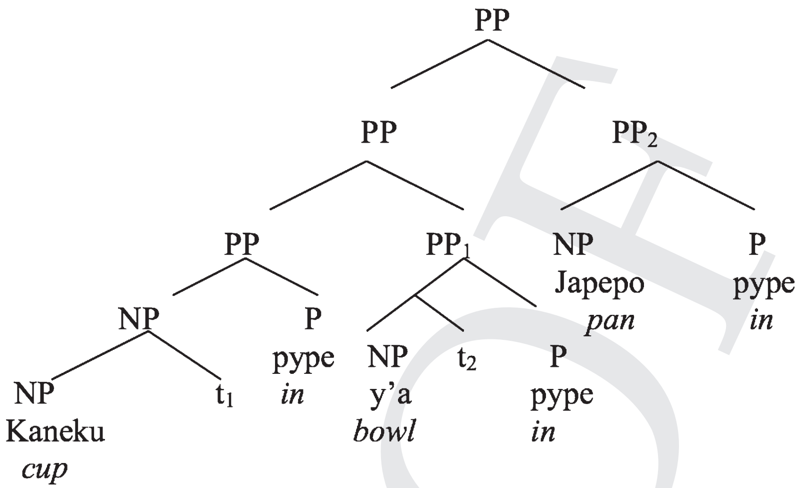
(30) [[cup [[bowl [pan in] $_{PP}$] in] $_{PP}$] in] $_{PP}$

On the other hand, assuming left adjunction of PPs, the expected word order would be:

(31) [[[[[pan in] $_{PP}$ bowl] $_{NP}$ in] $_{PP}$ cup] $_{NP}$ in] $_{PP}$

None of these word orders correspond to the sentences that were spontaneously produced by the Kawaiwete consultants. However, if PPs are right-adjoined, recursive embedding of locative PPs results in center-embedding. A ban on center-embedding may then trigger the successive extraposition of PPs, which generates the attested word order:

(32)




## 6 Conclusions

In this chapter, we have shown that semantic recursion is attested both with possessive phrases and with locative phrases in Kawaiwete. In the first part of this chapter we saw that preliminary data suggest that children as young as four interpret recursive embedding of possessive phrases correctly and that they do not try to interpret multi-level possessive phrases as conjunctive/distributive. In future studies, we intend to manipulate conjunctive/distributive interpretations of complex embedding possessive and locative phrases in comprehension and production tasks. Production tasks will be pursued in the future in order to know whether children's ability to comprehend this kind of structure (as discussed in Section 4) precedes their ability to produce them.

In addition, we have seen that the relation between word order and hierarchical structure is not transparent with locative phrases. However, we can maintain a recursive analysis of locatives assuming right adjunction and multiple extraposition.

# Appendix

Where:

- **–**: when a child said that she did not know the name for a color;
- ✓: when a child provided the expected answer;
- ✖: when a child did not provide the expected answer;
- **BP**: when a child answered the name of the color in Brazilian Portuguese.

Table 11A.1 *Results for the study on possessives in Kawaiwete*

| | | | Age | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Expected answer | 4 | 4 | 4 | 5 | 6 | 7 | 7 | 9 | 10 | 10 |
| Pre-test/ warm-up phrase | What is the color of the bowl? | Black | – | ✓ | – | ✓ | ✓ | ✓ | ✓ | – | ✓ | ✓ |
| | | Green | ✓ | ✓ | – | ✓ | ✓ | ✓ | ✓ | – | ✓ | ✖ |
| | | Red | ✓ | ✓ | ✓ | ✖ | ✓ | ✓ | ✓ (BP) | – | ✓ | ✓ |
| | What is the color of the basket? | Green | ✓ | ✓ | – | ✖ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ (BP) |
| | | Blue | – | ✓ | – | ✖ | ✓ | ✖ | ✓ | ✓ | ✓ | ✓ (BP) |
| | | Yellow | – | ✓ | – | ✖ | ✓ (BP) | ✓ | ✓ | ✓ | ✓ (BP) | ✓ (BP) |
| Critical (level 1) | What is Maria's bowl's color? | Black | ✓ | ✓ | – | ✖ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ (BP) |
| | What is Pedro's basket's color? | Yellow | ✖ | ✖ | – | ✖ | ✓ (BP) | ✓ | ✓ | ✓ | ✖ | ✓ (BP) |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Critical (level 2) | What is Maria's friend's bowl's color? | Green | ✓ | ✓ | – | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ (BP) |
| | What is Pedro's brother's basket's color? | Blue | ✗ | ✓ | – | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ (BP) |
| Critical (level 3) | What is Maria's friend's brother's bowl's color? | Red | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ (BP) | ✓ (BP) |
| | What is Pedro's friend's brother's basket's color? | Green | ✓ | ✓ | – | ✗ | ✓ | ✓ | ✓ | – | ✓ | ✓ (BP) |

# 12 Relative Clauses in Wapichana and the Interpretation of Multiple-Embedded "uraz" Constructions

*Luiz Amaral and Wendy Leandro*

## 1 Introduction

In the last decade the debate about the role of recursion in human languages (e.g., Hauser et al. 2002; Everett 2005) also inspired research on the acquisition of recursive constructions (Roeper and Snyder 2004; Hollebrandse et al. 2008; Limbach and Adone 2010; Pérez-Leroux et al. 2012). Initially, prepositional phrases and genitive constructions received more immediate attention from researchers, since they seemed like good candidates to study the acquisition and processing of self-embedding (see Chapters 6, 7, 11, 13, and 14 in this volume). This chapter presents data on a different type of construction: self-embedded relative clauses in Wapichana, an Arawak language spoken in Roraima (Brazil) and in the southwest region of Guyana. In this volume, relative clauses are discussed both here and in Storto et al. (Chapter 13), who present data on Katiriana, a Tupi language. With two different language families represented, it is already possible to see that relative embedding varies considerably among Brazilian languages. These are just the first steps in understanding the multiple ways in which recursion can manifest itself in these less studied languages.

The Wapichana group in Brazil is estimated to consist of around 6500 people with roughly 40 percent of the population still speaking the language. The younger generations have direct contact with Portuguese, which is in most cases the dominant language. Some of the Wapichana speakers in Brazil also speak English and have strong ties to Guyana. Most communities in the Serra da Lua region, where the data collection took place, use both Wapichana and Portuguese in their daily lives. Similarly to the situation of other native American languages, there are very few monolingual speakers of Wapichana, who are mostly elderly members of the community. In the younger generation studied in this project, we could not find a single monolingual speaker.

This study looks at the interpretation of multiple-embedded relative constructions in Wapichana by speakers from different age groups, ranging from 8 to 64 years of age. Although all participants in our study showed some degree of bilingualism, the adults had more extensive contact with monolingual speakers and lived in communities that until 10 to 15 years ago did not have electricity or extensive exposure to TV and radio in the national language. Because the language contact situation is evolving very rapidly in Wapichana communities, studies that contrast adult grammars with the grammar of younger speakers can help shed some light on how the indigenous language could be changing given current contact situations.

As we show in Section 2, relative clauses in Wapichana differ from their counterparts in English and Portuguese because they lack a relative pronoun and show a different internal structure of constituents (see Section 2 for details). Wapichana presents an interesting case in which relative constructions can be headed by at least three different parts of speech (verbs, postpositions, and adjectives), which allows us to test attachment preferences based on the lexical properties of such heads. As far as we know, there are no studies that have looked into the interpretation of sequences of relative clauses, especially regarding the attachment preferences of the second clause.

This chapter has two distinct goals. The first one is to test the interpretation of multiple embedded relative clauses in a language that allows for different parts of speech to serve as phrasal heads for relative constructions. The second goal is to test a potential variability of interpretation patterns by speakers of different age groups to see if there are any potential changes in progress regarding such patterns, given the language contact situation described above. After this brief introduction, Section 2 presents the description of relative clauses in Wapichana with a proposed treatment using head-driven phrase structure grammar (HPSG) (Pollard and Sag 1994). In Section 3, we look at some recent studies on the acquisition of recursion and highlight some related studies done by other authors in this volume. Section 4 presents the study and its findings.

## 2 Relative Constructions in Wapichana

### *2.1 '–uraz' as a Morpheme*

Wapichana uses a morphosyntactic element ('uraz') to license relative constructions like in (2). By comparing matrix clauses, such as in (1), with relativized ones, we can see that '–uraz' appears right after the head of the construction and changes its syntactic behavior in two distinct ways. The verb can no longer be the head of a finite matrix clause, and becomes the head of a relative clause that modifies its preceding noun, as shown in example (3).

(1) Zyn kaiwada-pa-n kuwam.
Girl wear-PROG-IN hat.
'The girl is wearing a hat.'

(2) Daunaiur tyka-pa-n zyn kaiwada-pa-**uraz** kuwam.
Guy see-PROG-IN girl wear-PROG-REL hat.
'The guy is seeing the girl that is wearing a hat.'

(3) Zyn kaiwada-pa-**uraz** kuwam.
Girl wear-PROG-REL hat.
'The girl that is wearing a hat.'

Because Wapichana does not have copula verbs, other parts of speech can function as the heads of matrix clauses, such as adjectives (4) and postpositions (5). These lexical items can also be followed by '–uraz' licensing embedded relative constructions that are not headed by verbs, such as in (6) and (7). Notice that '–uraz' can appear right after the head of VPs, PPs. or AdjPs to form relative constructions without affecting the word order of the rest of the constituents.

(4) Karich barakau.
Book white.
'The book is white.'

(5) Karichinhau miisa pa'auwa.
Books table on.
'The books are on the table.'

(6) Un=tykap-nii karich barakau-uraz.
1SG=see-NPRES book white-REL.
'I saw the book that was white.'

(7) Un=tykap-nii karichinhau miisa pa'auwa-uraz.
1SG=see-NPRES books table on-REL.
'I saw the books that were on the table.'

We propose an HPSG (Pollard and Sag 1994) analysis that treats 'uraz' as a morpheme introduced by a *post-inflectional lexical rule* (Sag et al. 2003).

This rule changes the subcategorization frame of lexical items that could function as heads to matrix clauses, forcing them to behave as nominal modifiers.[1] One advantage of such a morphological analysis is that it avoids problems with potential discontinuous constituents that could emerge in a syntactic analysis of 'uraz' as a relative pronoun.

[1] Other native Brazilian languages have similar morphemes that change the morphosyntactic properties of the entire construction, such as nominalization processes in Tupi languages.

(8) Post-inflectional lexical rule for '–uraz'.

$$\begin{bmatrix} \textit{uraz}-\textit{lexical}-\textit{rule} & \\ \text{INPUT} & \begin{bmatrix} \text{PHON } \boxed{1} \\ \text{SS|CAT}\Big[\text{VAL}\Big[\text{SUBJ } \boxed{2}\big[\text{HEAD } \textit{noun}\big]\Big]\Big] \end{bmatrix} \\ \text{OUTPUT} & \begin{bmatrix} \text{PHON} & f_{uraz}\ (\boxed{1}) = \boxed{1} - \textit{uraz} \\ \text{SS|CAT|VAL} & \begin{bmatrix} \text{SUBJ} \langle\ \rangle \\ \text{MOD } \boxed{2} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

There are some important characteristics of this rule that must be highlighted. First, it only applies to parts of speech that have a non-empty value for SUBJ, which means that in Wapichana they are potential heads for matrix clauses. Even in the case of postpositions, where they can vary in terms of the subcategorization patterns of SUBJ, only those that require some nominal element as SUBJ's value can serve as the input to this rule. Second, by changing the value of VAL, mapping the value of SUBJ into the value of MOD, we disallow the lexical item to function as the head of a matrix clause. It now becomes a nominal modifier, which means that it has to be embedded in a construction with a noun.

There could be a potential problem with this rule if the noun that was being modified were to be the object of a verb in the relative clause instead of the subject, such as in example (9) for English. In this case, our lexical rule would not allow for such constructions to be licensed. However, in Wapichana '–uraz' is restricted to cases where in English the relative pronoun would function as the subject of the relative clause. In object cases, Wapichana uses a combination of topicalization with demonstratives to express the same meaning, as we can see in (10), and does not allow for the use of '–uraz' in the embedded construction, as in (11).

(9) The girl likes the guy that I saw.

(10) Zyn naydap wyryy daunaiur un=tykap-nii .
Girl like this$_{DEIC}$ boy 1ps=see-NPRES
'The girl likes the guy that I saw.'

(11) *Zyn naydap (wyryy) daunaiur un=tykap-nii-uraz .
Girl like (this$_{DEIC}$) boy 1ps=see-NPRES-REL
'The girl likes the guy that I saw.'

## *2.2 Embedding and Ambiguity*

In Wapichana, '–uraz' can be used in multiple-embedded relative constructions. For example, the sentence in (2) can itself function as a relative clause embedded in a sentence like (12).

(12) Un=parada daunaiur at tyka-pa-**uraz** zyn kaiwada-pa-**uraz** kuwam.
1SG=speak guy to see-PROG-REL girl wear-PROG-REL hat.
'I spoke to the guy that was seeing the girl that was wearing a hat.'

It is important to notice that examples like (12) are in principle ambiguous, where either the girl or the guy could be wearing the hat. These two distinct readings will depend on whether the speaker interprets the lower clause ('that was wearing a hat') as modifying the adjacent noun in the embedded clause preceding it ('the girl'), or modifying the noun in the matrix clause ('the guy'). From now on, we will call the first interpretation (where *the guy saw the girl and the girl was wearing a hat*) "the embedded reading," and the second one (where *the guy both saw the girl and was wearing a hat*) "the conjunctive reading."

Based on preliminary findings during elicitation sessions[2] that suggested different interpretation preferences by our informants, we decided that for the purpose of this study we were going to explore four different combinations of sequences for relative constructions. The first one is illustrated in (12), where both relative clauses are headed by verbs (V+V). The other ones have the following combinations of embedded heads: (13) verb followed by adjective (V+Adj); (14) verb followed by postposition (V+P); and (15) postposition followed by postposition (P+P).

(13) Py=aida un=ati kyty'uzu niki-pe-**uraz** kwazaz ko'oriu-**uraz**.
2SG=show 1ps=to bird eat-PROG-REL snake green-REL.
'Show me the bird that is eating the snake that is green.'

[2] During these sessions we asked speakers to translate sentences and to explain their meaning to us. In case where there were perceived ambiguities, we asked them how those sentences would be interpreted in some possible scenarios that we created.

(14) Py=aida un=ati kiberu niki-pe-**uraz** tarabaru tabaii
2SG=show 1ps=to frog eat-PROG-REL fly table
pa'uwa-**uraz**.
on-REL.
'Show me the frog that is eating the fly that is on the table.'

(15) Py=aida un=ati arimeraka chakui dazba-**uraz** dazuan dia'a-**uraz**.
2SG=show 1ps=to dog toucan next to-REL basket in-REL.
'Show me the dog that is next to the toucan that is in the basket.'

Notice that the ambiguity exists in all examples. In (13) either the bird or the snake can be green, in (14) either the frog or the fly can be on the table, and in (15) either the dog or the toucan could be in the basket.

Out of the four conditions we explore in this chapter, only two (P+P and V+V) would be classified as instances of recursion if we follow the definitions presented by Roeper (2011), since the same category needs to appear in both relative clauses to obey Roeper's criteria. For those two conditions, what we are calling the "conjunctive reading," Roeper would classify as "direct recursion," and what we are describing as "embedded reading," he would call "indirect recursion."[3] Although the other two conditions (V+P and V+Adj) might not represent instances of recursion according to Roeper's criteria, their ambiguity also points to the issue of attachment preference on the part of the speaker, i.e., if the second relative clause modifies its adjacent noun or if it forms a coordinated construction with the first relative clause where both of them modify the same noun, as described in the examples above.

## 3 Some Studies in Acquisition

To the best of our knowledge, there are no studies on either processing or acquisition that have looked into the interpretation patterns for the attachment of the lower clause when two relative clauses are presented in a row. This prevents us from directly comparing our results with previous findings. The acquisition of relative clauses by children has been studied before in different languages (e.g., Corrêa 1995; Hamburger and Crain 1982; Adani 2011; Sevcenco and Avram 2012, among others). However, as far as we know, there are no studies that looked into the interpretation of multiple embedded

[3] See pages 60–63 in Roeper (2011) for details.

<u>Context story example for screen setting:</u>

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 this father Paul has a silver bike.
**Which picture shows Jane’s father’s bike?**

| | |
|---|---|
| Jane’s father’s bike | Correct |
| Jane’s bike | Drop of middle DP |
| Sam’s father’s bike | Drop of first DP |
| Sam’s bike | Unrelated, not mentioned |
| Jane and father’s bike | Conjunctive reading |

Figure 12.1 Limbach and Adone scenario

relative clauses, such as the ones in this chapter. In this section we review some previous studies that have looked into the acquisition of other constructions that show recursive properties, and we highlight some studies presented by other authors of this volume.

Limbach and Adone (2010) studied the acquisition of recursive possessive phrases in English and showed that children as early as 3 years old already show instances of adult-like interpretations, though not with the same consistency in performance as adult speakers. In their experiment they used stories where the characters represented by little dolls had different objects. Their scenarios allowed for five different types of answers, as illustrated in Figure 12.1 taken from Limbach and Adone (2010, p.5).

Their results also showed that 3 year olds have a tendency to drop one of the DPs, while 4 and 5 year olds provide a high number of conjunctive interpretations. Another interesting finding is that non-native speakers’ recursive interpretations are significantly below native ones, with only 63 percent of recursive responses.

Terunuma and Nakato (this volume) also looked into the acquisition of recursive genitives by Japanese children. They designed two experiments that consisted of participants answering questions based on pictures with multiple characters. Their target questions were about the color of the items using sentences that varied from one to four genitives, such as in Terunuma and Nakato (this volume).[4]

[4] See Chapter 10 in this volume for complete details.

(16) Shiro-san-no kodomo-no tomodachi-no inu-no fuusen-wa
Shiro-GEN child-GEN friend-GEN dog-GEN balloon-TOP
nani-iro kana?
what-color Q?
'What color is Shiro's child's friend's dog's balloon?'

Their results suggest the existence of three developmental stages in the acquisition of genitive constructions in Japanese. In stage 1 only single possessives would be allowed. In stage 2 two possessives are interpreted correctly, and finally in stage 3 more than two possessive phrases are accepted.

Leandro and Amaral (2014) describe the structure of multiple embedded genitives in Wapichana, and provide the results of two experiments with children and adults, both in Brazil and in Guyana. Their second experiment was done with monolingual (English) and bilingual (English and Wapichana) speakers in Guyana and used a similar methodology as the one presented above for Terunuma and Nakato (this volume). Participants had to look at a picture with multiple characters and their objects, while hearing a brief story describing the characters. They then had to answer questions that contained up to four genitives about the objects' colors, as in (17).

(17) Xa'apauran Cedrick dadukuu minahyda'y yza bala-**n**
What Cedrick sister friend domestic animal ball-GEN
tan?
color?
'What color is Cedrick's sister's friend's dog's ball?'

Their results showed that adult speakers of Wapichana interpret multiple embedded genitives the same way as adult English speakers do, and that bilingual children (Wapichana – English) outperformed monolingual English-speaking children in the interpretation of recursive genitives, as bilinguals more easily understand constructions with more than two embedded genitives.

Pérez-Leroux et al. (this volume) studied the acquisition of PP modification in DPs by looking at two different types of constructions: the recursive PP modification, as in (18), where the alligator is in the water, and the double modification of a single noun, as in (19), where the plate is under the table. According to them, by comparing double and simple embedding, it can be determined: "whether children's structural representations of complex DPs are continuous to adults' and whether children have a bias towards less embedded representations" (p.287).

(18) [The bird [on the alligator [in the water]]]

(19) [The plate [with oranges] [under the table]]

Their results show that both children and adults produce target descriptions to their test items twice as often to non-recursive modified NPs when compared to the recursive ones. They argue that recursion directly contributes to complexity "beyond the referential demands of double modification."

## 4 Current Study

As we mentioned in Section 2, all sentences with double relative embedding can be ambiguous depending on the attachment of the lower clause. Given the four possible combinations presented in examples (12), (13), (14) and (15), our research questions are:

1. Will different types of embedded heads yield different interpretation patterns by adult speakers? In other words, is there a specific sequence of relative clauses (based on their lexical heads) that will favor multiple embedding? Our initial hypothesis is that there will be no difference in patterns of interpretation for ambiguous relative clause attachment.
2. In case there is a pattern in the adult grammar that favors the recursive reading, will this pattern be found in the grammar of younger speakers who have been exposed to Portuguese earlier on in life?

In order to test the preferred interpretation of the four different kinds of clauses presented in Section 2, we used a picture matching test. Participants saw three pictures while hearing a sentence that described one of the scenes in them. They then had to choose the picture that was best described by the sentence. There were twelve situations (test items) in total with three items per condition, i.e., per type of sequence of embedded clauses as presented above. The experiment was programmed in PsychoPy (Peirce 2007), and run with sixty-six speakers between the ages of 8 and 62. The twelve items and the fillers were randomly presented to participants. Figure 12.2 and the sentence in (20) show an example of one of the test items for the V+V condition.

All pictures had three possible scenarios. The first one reflected the interpretation consistent with the embedded reading (low attachment), as illustrated by picture 2 in Figure 12.2, where the girl is wearing the hat. The second one depicted the interpretation consistent with the conjunctive reading, such as in picture 1 (Figure 12.2), where the guy is wearing a hat. The third one depicted a situation where the scenario described by one of the relative clauses was not true. In the following example, the situation described by the lower relative clause would be true (*the girl was wearing a hat*), but the first part of the utterance was not true (*the guy was not seeing the girl*).

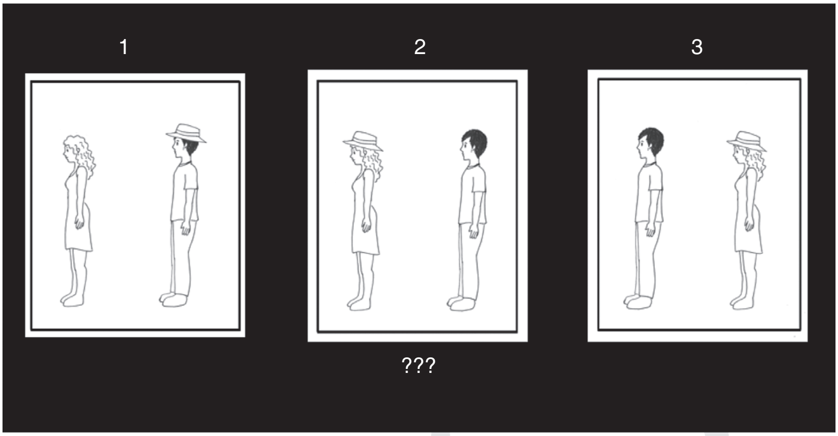



Figure 12.2 Example of test item (V+V)

(20) Py=aida un=ati daunaiur tyka-pa-**uraz** zyn kaiwada-pa-**uraz**
2SG=show 1SG=to guy see-PROG-REL girl wear-PROG-REL
kuwam.
hat.
'Show me the guy that is seeing the girl that is wearing a hat.'

(21) Py=aida un=ati daunaiur zyn dazba-**uraz** ky'ba paawa'a-**uraz**.
2SG=show 1SG=to guy girl next to-REL rock on-REL.
'Show me the guy that is next to the girl that is on the rock.'

Figure 12.3 shows an example of a test item for another condition (P+P), where both relative clauses are headed by postpositions. Again, we see three possible scenarios. Picture 1 requires the embedded reading, picture 2 illustrates the conjunctive reading, and picture 3 is a distractor. The sentence that was used as the stimulus is presented in example (21).

### *4.1 Results*

As Figure 12.4 shows, there was a clear preference for the embedded reading in cases where both relative clauses were headed by verbs. For this condition, 87 percent of the participants chose the interpretation in which the lower clause modified the immediately preceding noun. Our results also show that the other two conditions where the verb was the head of the first relative clause favored the embedded interpretation. The only condition where there was no

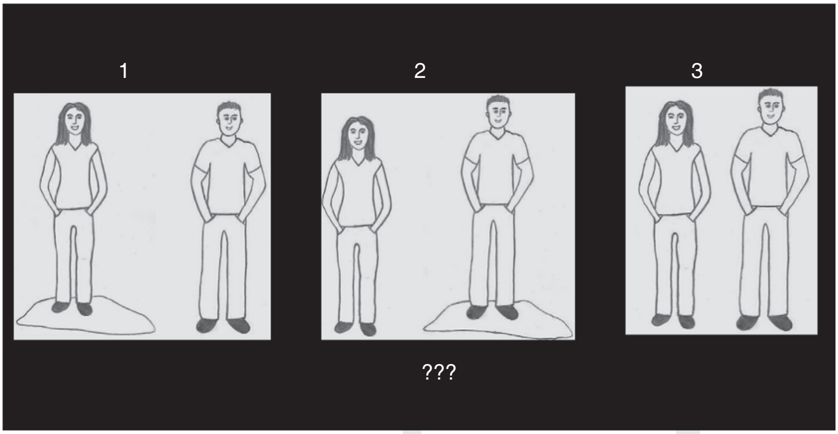



Figure 12.3 Example of test item (P+P)

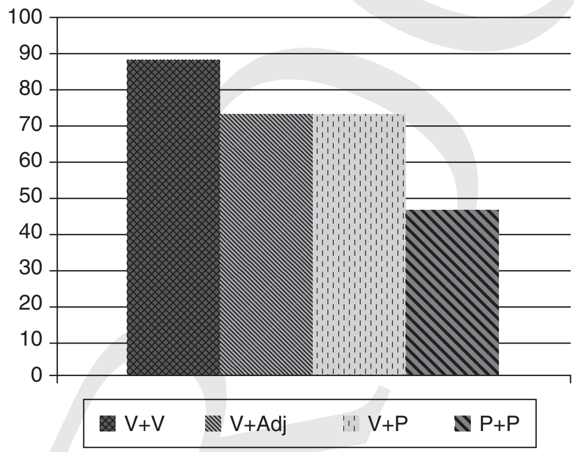



Figure 12.4 Percentage of embedded readings for 14 year olds and over

clear preference for the embedded interpretation was the one with verbless relative constructions. Participants older than 14 years old chose the embedded reading 73 percent of the time for conditions V+Adj and V+P, while condition P+P only accounted for 45 percent of embedded interpretations.

We ran a Kruskal-Wallis one-way analysis of variance with the scores for the four conditions, and the overall results showed that the differences are statistically significant (H=20.733, 3 d.f., $p<0.001$). When we check the paired-group comparisons to look at the normal ranges of the rank differences

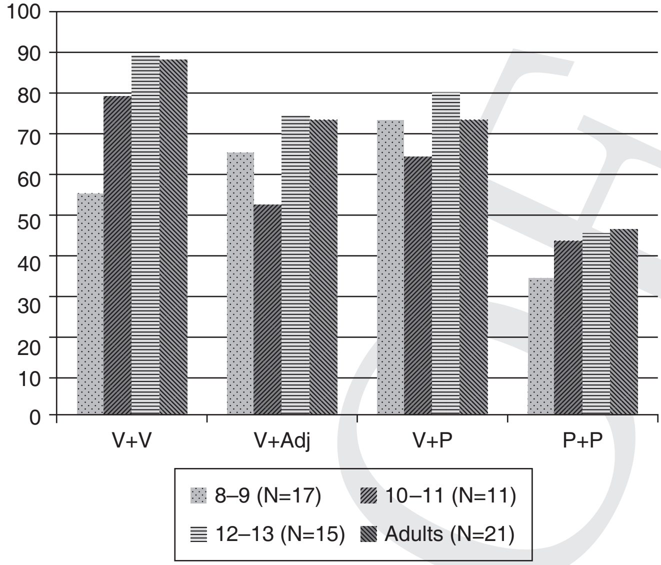



Figure 12.5 Percentage of embedded readings per condition for all groups

between conditions, we see that V+V and P+P differ significantly from all other conditions, and the only difference that is not significant is between V+Adj and V+P.

We now turn to the results by younger speakers. We grouped younger participants within three groups: (i) 8 and 9 year olds (N=17), (ii) 10 and 11 year olds (N=11), (iii) 12 and 13 year olds (N=15). The decision to include all participants at the age of 14 and above in the "adult group" was based on the analysis of the data that showed that after the age of 14 there were no statistically significant differences in participants' responses.

Our results indicate that out of the four conditions we included in the experiment, only the one where both relative clauses were headed by verbs showed any significant difference in the interpretation patterns among groups.

We ran a Kruskal-Wallis one-way analysis of variance on the results by individual group within each condition. The differences in interpretation among the four groups for condition P+P was not statistically significant (H=3.361, 3 d.f., p=0.3392), with the 8–9-year-old group giving the embedded readings 34 percent of the time, the 10–11 year olds 43 percent and the 12–13 year olds 47 percent. The differences for the V+P readings were even smaller and also not statistically significant (H=1.637, 3 d.f., p=0.65101), with adults giving the embedded interpretation 73 percent of the time, 8–9 year olds 72 percent, 10–11 year olds 64 percent and 12–13 year olds 80 percent. Similar results are found for the V+Adj condition with adults providing an embedded reading in 73 percent of their responses, 8–9 year olds in 65 percent, 10–11 year olds in 52 percent and 12–13 year olds in 74 percent, where again the differences among the results are not statistically significant (H=3.536, 3 d.f., p=0.31608).

The V+V condition is the only one where we can find a statistically significant difference in the interpretation patterns among the four groups (H=20.868, 3 d.f., p<0.001). When paired-groups comparisons are analyzed, we find that the only group whose results vary from all others is that of the 8–9 year olds. It is an interesting fact that what seems to be the construction that triggers the largest numbers of non-ambiguous readings (favoring embedding) in the adult grammar does not have the same status in the grammar of 8 and 9 year olds. Although we do not have enough data from younger speakers to make such claims, these results seem to agree with the hypothesis presented by Roeper (2011) and Terunuma and Nakato (this volume) about a possible two-step (or three-step) development in the acquisition of recursive constructions from more conjunctive interpretations to more recursive ones.

## 5 Conclusion

In this chapter we presented the structure of relative clauses in Wapichana that are formed by the morpheme '–uraz' in multiple embedded relative constructions. Relative clauses in Wapichana can be headed by different lexical categories (verbs, adjectives and postpositions), and when more than one relative clause is used in the same sentence, there could be potential ambiguities regarding the noun that is being modified by the second clause, as shown in Section 2.2.

We also provided the results of a comprehension experiment we used to test attachment preferences in sentences with more than one relative clause. The experiment used required participants to select a picture that depicted situations in which the second relative clause could be modifying one of the two available preceding nouns. Our results showed that whenever the first relative clause is headed by a verb, there is an overall preference on the part of speakers to interpret the second relative clause as modifying the embedded noun adjacent to it (what we called the "embedded reading"). In cases where there are two verbless relative constructions (P+P), participants did not provide any consistent preference for attachment patterns.

As far as we know, this is the first time that the interpretation of sentences with two relative clauses has been tested. Therefore, we could not compare the results for Wapichana with those of other languages. For future work, it would be interesting to run similar experiments in Indo-European languages with relative pronouns to see if any attachment preferences exist in those languages.

# 13 Multiple Embedding of Relative Clauses in Karitiana

*Luciana Storto, Karin Vivanco, and Ivan Rocha*

In this chapter, we aim to describe embedding and multiple embedding involving relative clauses in Karitiana, a Tupian language of the Arikém branch spoken by approximately 400 speakers in the state of Rondônia, Brazil.[1] Specifically, we will show some examples of relative clauses with two levels of embedding. Discussing this data in light of new data gathered in a comprehension task, we claim that they are true cases of subordination instead of simple conjoined clauses.

A brief summary of constituent order and the structure of Karitiana clauses is presented in Section 2. Since this chapter focuses on relative clause embedding, Vivanco's (2014) thesis on the internal structure of relative clauses in Karitiana is reviewed in Section 2.1. As the reader will see in the following sections, the oblique morpheme ***{–ty}*** is extremely important for the analysis undertaken here. Because of that, Karitiana's argument structure and the status of this morpheme will be discussed in Section 2.2, with special attention given to the cases involving relative clauses. Section 3 presents interpretations and judgments given by native speakers to multiple-embedded clauses collected in an experimental task. Section 4 concludes the chapter.

## 1 Properties of Relative Clauses in Karitiana

Karitiana has been described as an ergative language (Landin 1984). Ergativity is unmarked in arguments, but is evident in verb morphology – the intransitive subject and the direct object agree with the verb in main clauses – and in wh-extraction strategies, which are different from ergative and absolutive arguments (Storto 1999). Storto (1999) described Karitiana as a language in which transitive main clauses are verb-initial (VOS and VSO) or verb-second (SVO or OVS) and the verb is inflected with agreement, tense, or mood affixes, whereas embedded clauses are verb-final (SOV and OSV) and have bare verbs,

[1] This research was supported by FAPESP Grants 2011/15927-7, 2012/02769-7, 2014/15141-1, 2014/14044-2, and 2016/07643-2 and by CAPES (Programa de Pós-Graduação em Linguística da Universidade de São Paulo).

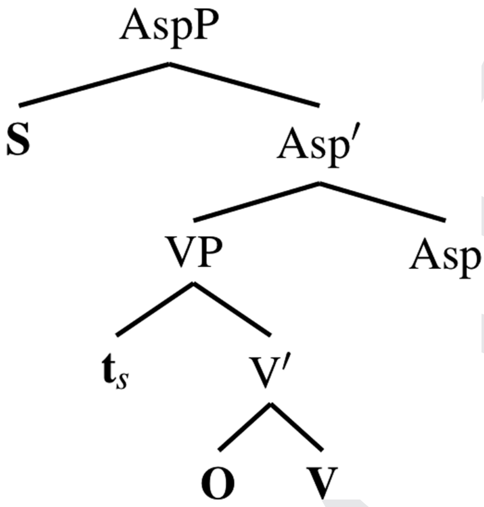



Figure 13.1 Subject relative clause

without person agreement, tense, or mood morphology.[2] There are no overt nominalizers in embedded clauses in general, except in clauses that serve as complements of the copula in copular and cleft sentences.[3] There are no relative pronouns or complementizers in Karitiana relatives.

Since aspect is the only functional head that may project above the verb phrase in embedded clauses, Storto (1999) considers them to be aspectual phrases (AspPs). The structure of a subject relative clause is given in Figure 13.1.

Karitiana relative clauses have typological characteristics of both externally headed and internally headed clauses (Culy 1990; de Vries 2002). The former is true because the head of a relative clause in natural production in the language is always fronted (Storto 1999), which is not common in languages with head-internal relatives. When a transitive relative clause has a subject as its head, the order is SOV (as in (3) and in Figure 13.1), and when the head is the object, the order is OSV (as in (4) and in Figure 13.2). In the latter, the verb is prefixed by the object focus (OFC) morpheme ***{ti–}***, obligatory in object relatives as well as in focus and wh-extraction of objects (Storto 1999).

According to Storto (1999), the behavior of internally headed relatives can be seen when case-marking on the head is related to the embedded verb instead

[2] For a recent discussion of constituent order and information structure in Karitiana, we refer the reader to Storto (2014).
[3] There is a poorly understood suffix {–p} that is present in some embedded clauses translated in Portuguese as infinitives that could perhaps be analyzed as a nominalizer (as some gerunds are in languages of the world).

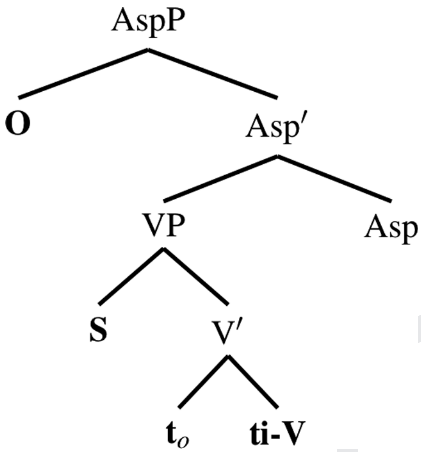



Figure 13.2 Object relative clause

of the main verb. Indeed, we know from the literature that in some languages, case-marking on the head is a main piece of evidence to distinguish between head-internal and head-external relatives. This can be illustrated by the following data from Ancash Quechua. This language has both internally and externally headed relatives and, when the head is external, the case-marking on the head is related to the main verb. In internally headed relatives, as in (2), the head is marked with the case morphology demanded by the embedded verb:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (1) | [[nuna | $Ø_i$ | ranti-shqa-n] | **bestya**$_i$] | alli | bestya- m | ka-rqo-n |
| | man | | buy-PERF-3 | horse.NOM | good | horse-EVID | be-PAST-3 |

‘The horse that the man bought was a good horse.’

| | | | | | | |
|---|---|---|---|---|---|---|
| (2) | [nuna | **bestya-ta** | ranti-shqa-n] | alli | bestya-m | ka-rqo-n |
| | man | horse-ACC | buy-PERF-3 | good | horse-EVID | be-PAST-3 |

‘The horse that the man bought was a good horse.’

(Cole, 1987:279)

If sentences (3) or (4) were head-external relatives, they could have the external head ***taso*** marked with the oblique case ***{–ty}*** required by the main verb ***so’oot*** ‘to see’ when it is used with an object,[4] but this is not what we find. Instead, the oblique suffix applies to the whole clause:

[4] The structure we propose for these types of oblique objects is one in which the oblique argument is added to the argument structure of the intransitive verb ‘to see’ through a postposition that takes the head-internal relative (AspP) as its complement, as in Figure 13.3.

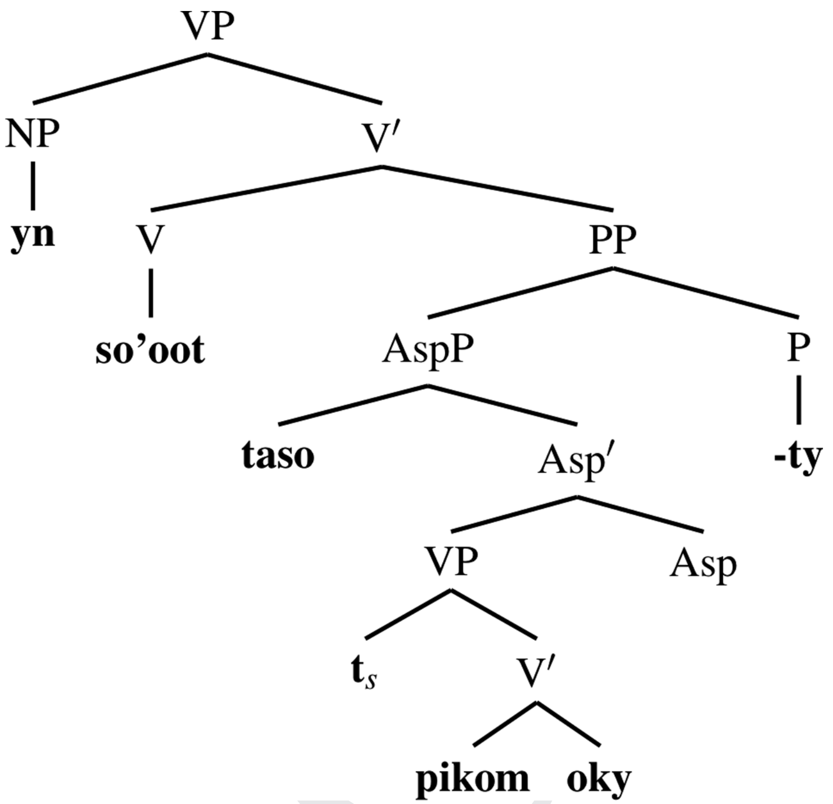



Figure 13.3 Simplified tree (without tense, agreement, and mood) of (3)[5]

(3) Y-py-so´oot-yn    yn    [**taso** pikom oky]-ty
1-ASSERT-see-NFUT    I    [**man** monkey kill]-OBL
'I saw **the man** who killed the monkey.'

(4) Y-py-so´oot-yn    yn    [**taso** ombaky ti-oky]-ty
1-ASSERT-see-NFUT    I    [**man** jaguar OFC-kill]-OBL
'I saw the **the man** who the jaguar killed.'

[5] Storto (1999) posits obligatory V to C movement in Karitiana main clauses, associated with the acquisition of tense, mood, and agreement morphology. This movement is not shown in this simplified tree. When it moves, the verb carries negation, aspect, and evidentials with it (Storto 1999, 2013), so this is not a case of predicate raising as Duarte (this volume) assumes for Tenetehára. Stenzel (this volume) has a similar analysis of evidentials forming a unit with the verb and auxiliaries in Kotiria (Tukanoan).

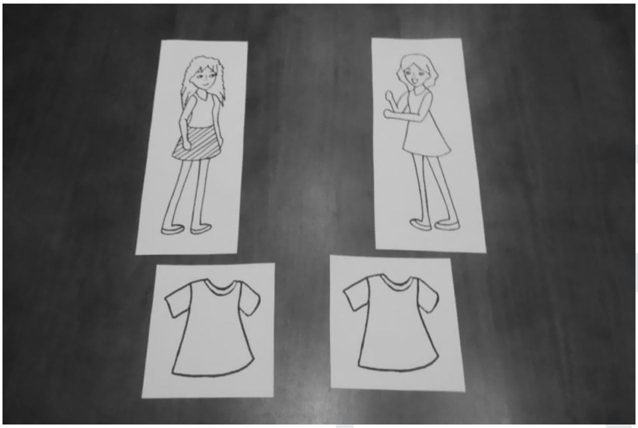


Figure 13.4 Context for an object relative

We are aware that this argument is not conclusive, since languages do not necessarily mark the head of an external relative with case. Also, oblique marking is not structurally case assigned by the main verb. Nonetheless, the verb has an oblique argument and this argument is the whole clause, which is compatible with a head-internal analysis.

Fronting of the head in relatives is used by speakers in their production, possibly to avoid ambiguity between subject and object relatives, but we have recently discovered, through experimental means, that it is possible for speakers to produce non-fronted heads as well (Vivanco 2014). We conclude that, since externally headed relatives cannot have non-fronted heads, Karitiana relatives should be analyzed as internally headed.

In Section 1.1 we show in greater detail the results of the experiments that corroborate the head-internal analysis of relative clauses.

### *1.1 Vivanco (2014)*

In a task inspired by Labelle's (1990) experiment, Vivanco's (2014) fourteen Karitiana subjects had to choose one of two pictures presented to them, and then they had to tell the researcher, using a Karitiana sentence, which of the pictures they had chosen. These pictures depicted two identical characters or objects that could only be differentiated through the action of another element in the scene:

(5) Researcher: Here we have two T-shirts. Ana sewed this one over here [point to the one on the left] and Luciana sewed this one over there [point to the one on the right]. Pick one of the T-shirts and tell me which one you chose.
Subject: [intended production] 'I chose the T-shirt that Ana/Luciana sewed'.

Altogether, there were twenty contexts suited for the production of relative clauses (ten for subject and ten for object relatives).

The results show that, although there is a strong preference for having the head of the relative at the beginning of the clause, it is also possible to have non-fronted heads. In subject relatives, the majority of the data obtained consist of SOV relatives, but OSV subject relatives were also produced. Examples of each structure are presented in (6) and (7):

(6) Subject relative with SOV word order[6]

| | | | | | |
|---|---|---|---|---|---|
| Yn | Ø-na-aka-t | i-pyting-Ø | [taso | him | by-hip]-i-ty |
| I | 3-DECL-COP-NFUT | NMLZ-want-ABS.AGR | [man | meat | CAUS-cook]-EP-OBL |

'I want the man who cooked the meat.'

(7) Subject relative with OSV word order

| | | | | | |
|---|---|---|---|---|---|
| Yn | Ø-na-aka-t | i-pyting-Ø | [opi | jõ nso | by-'it]-i-ty. |
| I | 3-DECL-COP-NFUT | NMLZ-want-ABS.AGR | [earring | woman | CAUS-do]-EP-OBL |

'I want the woman who made the earring.'

The word order variation observed in the experiment as a whole was even greater in object relatives. The formerly reported OSti-V word order was the preferred structure, but other possibilities were also produced: a non-initial head (SOti-V), a verb without the OFC morpheme (OSV), and the latter two conjugated (SOV). In the following are examples of these four sentential types produced by speakers:

(8) OSti-V object relative

| | | | | | |
|---|---|---|---|---|---|
| Yn | Ø-na-aka-t | i-pyting-Ø | [gijo | Luciana | ti-tak]-a-ty |
| I | 3-DECL-COP-NFUT | NMLZ-want-ABS.AGR | [corn | Luciana | OFC-grind]-EP-OBL |

'I want the corn that Luciana ground.'

(9) SOti-V object relative

| | | | | | |
|---|---|---|---|---|---|
| Yn | Ø-na-aka-t | i-pyting-Ø | [Ana | pykyp | ti-pipãrama]-ty |
| I | 3-DECL-COP-NFUT | NMLZ-want-ABS.AGR | [Ana | clothes | OFC-sew]- OBL |

'I want the clothes that Ana sewed.'

[6] In this experiment, the verb ***pyting*** 'to want' was used in all situations in which speakers were choosing one picture over another. This verb is syntactically intransitive, so if it has an object, it is an oblique argument suffixed by ***{–ty}.*** Also, speakers preferred to use a copular sentence followed by a small clause complement headed by the verb ***pyting***. This is always a possible alternative to using an intransitive main verb inflected in the declarative or assertative mood (Storto 2010).

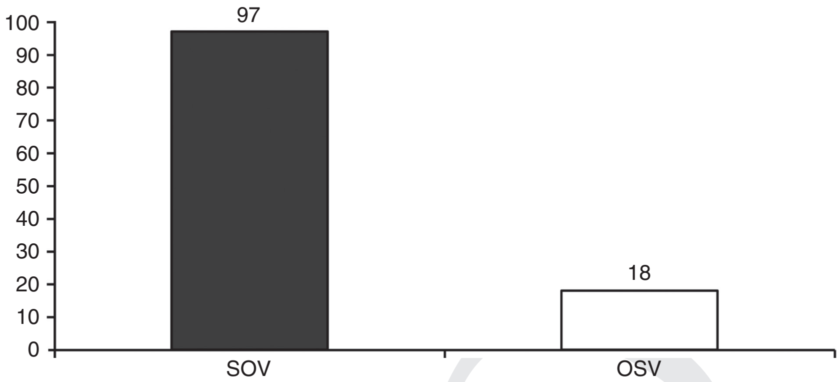



Figure 13.5 Word order distribution in subject relatives (n = 115)

(10) SOV object relative

| | | | | | |
|---|---|---|---|---|---|
| Yn | Ø-na-aka-t | i-pyting-Ø | [Ana | gok | amangã]-ty |
| I | 3-DECL-COP-NFUT | NMLZ-want-ABS.AGR | [Ana | manioc | plant]-OBL |

'I want the manioc that Ana planted.'

(11) OSV object relative

| | | | | | |
|---|---|---|---|---|---|
| Yn | Ø-na-aka-t | i-pyting-Ø | [ambi | taso | by-'a]-ty |
| I | 3-DECL-COP-NFUT | NMLZ- want-ABS.AGR | [house | man | CAUS-do]-OBL |

'I want the house that the man built.'

Vivanco concludes that, since externally headed relative clauses cross-linguistically cannot have their heads in other positions besides the left or right periphery of the clause, it makes sense to classify Karitiana relative clauses as internally headed. Head frontalization in Karitiana seems to be similar to that described in Yuman languages (Gorbet 1976; Basilico 1996) in that it is not an essential operation for relative clause formation, but is employed in relative clauses that are ambiguous, in order to make them more explicit.

Note that in this chapter we work solely with the clauses that speakers use in natural production, i.e., SOV for subject relatives and OSti-V for object relatives. We choose to do so because we are not certain of the reasons why other word orders arose in Vivanco's experiments. One of the sources of concern is that all of Vivanco's subjects were animate and her objects were inanimate, which unambiguously identifies each argument in her relatives. We would like to know, for instance, whether the variation in word order would also occur if both subjects and objects were proper names of humans,

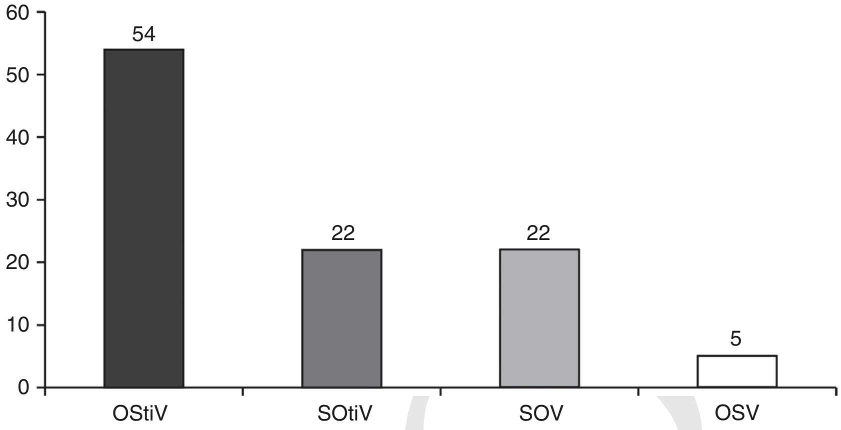



Figure 13.6 Word order distribution in object relatives (n = 103)

a condition in which ambiguity arises. Until the conditions for the variation found by Vivanco are better understood, we prefer to work with the orders that are naturally produced.

## 2 Constituent Order and Clause Structure in Kotiria

### *2.1 Relative Clauses as Oblique Objects of the Main Verb*

In this section, we review the arguments that support the analysis of some verbs in Karitiana being intransitive and taking optional oblique arguments. This analysis is crucial to us, because the strategy of multiple embedding used in our data involves a main verb of this type that takes a relative as its oblique object. We also show at the end of the section that relatives marked by the oblique suffix ***{–ty}*** are not adjunct adverbial clauses, but rather complements of an oblique postposition.

Storto and Rocha (2014) have shown that the Karitiana language may be analyzed as having three kinds of verbs: intransitive verbs, consisting of two subtypes: (i) simple intransitive verbs and (ii) intransitive verbs with experiencer subjects and optional oblique objects; transitive verbs; and ditransitive verbs.

(12) Simple intransitive
∅-pyr- otam-y-n João
3-ASSERT-arrive-EP-NFUT João
'João arrived.'

(13) Intransitive verbs with experiencer subject and oblique object

| | | |
|---|---|---|
| y-py-so´oot-y-n | yn | (pikom-ty) |
| 1-ASSERT-see-EP-NFUT | I | (monkey-OBL) |
| | | ‘I saw (the monkey).’ |

(14) Transitive verb

| | | |
|---|---|---|
| ∅-pyry´y-dn | yn | asyryty |
| 3-ASSERT-eat-NFUT | I | banana |

‘I ate the banana.’

(15) Ditransitive verb with an oblique theme

| | |
|---|---|
| y-pyry-hit-y-n | taso (boet-e-ty) |
| 1-ASSERT-give-EP-NFUT | man (necklace-EP-OBL) |

‘The man gave me a necklace.’

In order to define the behavior of verbs in each of these classes, the authors tested them in causative, passive, and copular constructions. It has been observed that only intransitive verbs (such as (12) and (13)) may be causativized by the morpheme ***{m–}*** (as (16) and (17)), and only they may occur as the head of the copular complement, which is a nominalized small clause, as exemplified in (18) and (19). Examples (20) and (21) show that neither transitive nor ditransitive verbs are grammatical in such constructions:

(16)

| | | |
|---|---|---|
| y-pyry-mb-otam-y-n | yn | John |
| 1-ASSERT-CAUS-arrive-EP-NFUT | I | John |

‘John made me arrive.’

(17)

| | |
|---|---|
| y-py-m-so’oot-y-n | õwã (pikom-ty) |
| 1-ASSERT-CAUS-see-EP-NFUT | child monkey-OBL |

‘The child made me see the monkey.’ / ‘The child showed me the monkey.’

(18)

| | |
|---|---|
| John ∅-na-aka-t | i-otam-∅ |
| John 3-DECL-COP-NFUT | NMLZ-arrive-ABS.AGR. |

‘John arrived.’

(19)

| | | |
|---|---|---|
| õwã ∅-na-aka-t | i-so’oot-∅ | (pikom-ty) |
| child 3-DECL-COP-NFUT | NMLZ-see-ABS.AGR. | monkey-OBL |

‘The child saw the monkey.’

(20)

| | |
|---|---|
| *∅-pyry-m-’y-n | ti’y taso |
| 3-ASSERT-CAUS-eat-NFUT | food man |

(21)

| | |
|---|---|
| *ti’y ∅-na-aka-t | i-’y-t |
| food 3-DECL-COP-NFUT | NMLZ-eat-ABS.AGR. |

Furthermore, transitive or ditransitive verbs may always be passivized by the addition of the prefix ***{a–}*** undergoing a decrease of valence, as in (22). The passive prefix is ungrammatical with intransitive verbs, such as in (23) and (24):

| | | |
|---|---|---|
| (22) | ∅-pyr-a-'y-dn | asyryty |
| | 3-ASSERT-PASS-EAT-NFUT | banana |
| | 'The banana was eaten' | |
| (23) | *∅-pyr-a-otam-y-n | João |
| | 3-ASSERT-PASS-arrive-EP-NFUT | João |
| (24) | *∅-pyr-a-so'oot-y-n | õwã (boet-e-ty) |
| | 3-ASSERT-PASS-see-EP-NFUT | child (necklace-EP-OBL) |

In the following examples, we can see that relative clauses (inside square brackets) are embedded under two types of main verbs in Karitiana:

| | | | | | |
|---|---|---|---|---|---|
| (25) | Yn | Ø-naka-´y-t | [kinda 'o | Maria | ti-amangã] |
| | I | 3-DECL-eat-NFUT | [fruit | Maria | OFC-plant] |
| | 'I ate the fruit that Maria planted.' | | | | |

| | | | | |
|---|---|---|---|---|
| (26) | Y-py-so' oot-y-n yn | [kinda 'o | Maria | ti-amangã]-ty |
| | 1-ASS-see-EP-NFUTI | [fruit | Maria | OFC-plant]-OBL |
| | 'I saw the fruit that Maria planted.' | | | |

In (25) we know for sure that the relative clause is the complement of the transitive main verb because it corresponds to its direct object, but clauses suffixed by oblique case such as in (26) are not in complement position, because the main verb ***so'oot*** 'to see' is intransitive by all valence diagnostics mentioned in this section (Rocha 2011; Storto and Rocha 2014) and requires that any optional object be marked as oblique.[7]

When a relative clause occurs as an oblique object, it is neither a direct object nor an adjunct. The syntactic status of an oblique argument clause is not the same as that of an adjunct clause because adjunct adverbial clauses do not occur in argument position, whereas relative clauses do (Storto 2012). Furthermore, adjunct clauses and relatives differ in that the former require that the adverbializer suffix ***{–t/–Ø}*** and the latter are ungrammatical with that suffix (Rocha 2013). Whatever the syntactic analysis given to oblique relative clauses may be, it must be the same that is given to

[7] Agreement in such clauses is subject and not object agreement; these verbs may occur as heads of small clauses taken as complements of copular verbs (adjectives, nouns and intransitive verbs are the only heads allowed in such configurations), and they can be causativized but not passivized.

indirect objects of ditransitive verbs (Storto 2012), because valence diagnostics treat ditransitive verbs as transitive whose optional indirect object (the theme) is marked with the same oblique suffix ***{–ty}*** (Storto and Rocha 2014). In this chapter, we consider oblique arguments to be introduced by a postpositional head. The postposition, being external to the VP, adds an optional indirect object to the argument structure of an intransitive or transitive verb in such cases.

In the remainder of this section, we present some of the evidence presented by Rocha (2013) to confirm that adverbial clauses in Karitiana (29–30) must receive an adverbializer suffix ***{–t/–Ø}***, whereas relative clauses (27–28) are ungrammatical with such morphology:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (27) | Yn | ∅-na-otet-∅ | [ip | õwã | ti-´y | pasagngã | tyka] |
| | I | 3-DECL-cook-NFUT | [fish | child | OFC-eat | POSTERIOR | MOT.IMPF] |
| | ‘I cooked the fish that the child is going to eat.’ | | | | | | |
| (28) | *Yn | ∅-na-otet-∅ | [ip | õwã | ti-´y | pasagngã | tyka-t] |
| | I | 3-DECL-cook-NFUT | [fish | child | OFC-eat | POSTERIOR | MOT.IMPF-ADVZ] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (29) | [gok | jõnso | amangã | tyki’oo-t] | Ø-na-oky-t | him | taso |
| | [manioc | woman | plant | PROG.IMPF-ADVZ] | 3-DECL-kill-NFUT | hunt | man |
| | ‘While the woman was planting manioc, the man killed the hunt.’ | | | | | | |
| (30) | *[gok | jõnso | amangã | tyki’oo] | Ø-na-oky-t | him | taso |
| | [manioc | woman | plant | PROG.IMPF] | 3-DECL-KILL-NFUT | hunt | man |

This analysis is further confirmed by Sanchez-Mendes’ (2013, 2014) morphemic analysis of adverbs in Karitiana as taking a suffix ***{–t}***:

| | | | | | |
|---|---|---|---|---|---|
| (31) | jõnso | Ø-naka-ot-Ø | ese | kanda-t | SVOAdv |
| | women | 3-DECL-bring- NFUT | water | a lot-ADVZ | |
| | ‘Women brought a lot of water (many times).’ | | | | |
| (32) | Maria | ∅-naka-kydn-∅ | pita-t | | SVAdv |
| | Maria | 3-DECL-wait- NFUT | a lot-ADVZ | | |
| | ‘Maria waited a lot’ | | | | |

Sanchez-Mendes’ examples did not show the zero allomorph of the adverbializing morpheme because in her dissertation all of the roots suffixed by it ended in vowels, and the zero allomorph is conditioned by consonant-final roots. Furthermore, this adverbializing suffix ***{–t/–ø}*** displays a different morphophonological behavior when compared with the oblique suffix ***{–ty}***: the latter triggers vowel epenthesis when it occurs after a non-nasal consonant-final root, whereas the former triggers the zero allomorph in that same environment. These phonological facts are important because they show that the oblique suffix is not partially formed by the adverbializing morpheme ***{–t}*** plus a putative suffix ***{–y}***.

Independent of the status of the relative clause – direct or oblique argument of the main verb – its internal structure apparently seems to be the same: one in which the head moves to the left edge of the clause. In the following section, we examine some sentences in which relative clauses marked with an oblique postposition may differ from non-oblique relatives. All sentences presented in the next section were collected through direct elicitation: we gave our informants a single or multiple-embedded sentence in Portuguese, which they had to translate into corresponding Karitiana sentences. These sentences were later manipulated in order to see if some morphemes could be added or omitted and if the positions of the embedded clauses were interchangeable.

## 2.2 *Oblique Heads of Oblique Relatives*

Note that sentences with oblique relative clauses such as (33) may alternatively be realized with an oblique suffix on the head of the relative co-occurring with the oblique suffix at the end of the clause:

| | | | | | |
|---|---|---|---|---|---|
| (33) | Y-py-so' oot-y-n | yn | [kinda 'o]-ty | [Maria | ti-amangã]-ty |
| | 1-ASSERT-see-EP-NFUT | I | [fruit]-OBL | [Maria | OFC-plant]-OBL |
| | 'I saw the fruit that Maria planted' | | | | |

One might think that this case is a juxtaposition or conjunction between a phrasal oblique argument ***kinda 'o*** and a clausal oblique argument (***Maria tiamangã***) with a null object. This would be a plausible analysis because we know independently that null heads are allowed in free relatives with an indefinite reading (as in (34)):

| | | | | |
|---|---|---|---|---|
| (34) | Y-py-so' oot-y-n | yn | [Maria | ti-amangã]-ty |
| | 1-ASSERT-see-EP-NFUT | I | [Maria | OFC-plant]-OBL |
| | 'I saw what Maria planted' | | | |

However, if the juxtaposition or conjunction analysis were correct, the order between the two oblique noun phrases could be exchanged, and this is not the case as a comparison between (33) and (35) clearly shows:

(35) *Y-py-so' oot-y-n yn [Maria ti-amangã]-ty [kinda 'o] ty 1-
ASSERT-see-EP-NFUT I [Maria OFC-plant]- OBL [fruit]-OBL
'I saw the fruit that Maria planted'

If the structure is not a juxtaposition or conjunction, it is reasonable to analyze it as a regular case of extraction of the head to the left edge of the relative clause. The fact that the object focus prefix is present in other cases of extraction to the left periphery of the clause (object focus and wh-movement) gives support to this analysis. In intransitive verbs, the analysis is confirmed by other examples:[8]

(36) Y-py-so' oot-y-n yn [Francisco ga-p erery hoop]-o-ty
1-ASSERT-see-EP-NFUT I [Francisco field-in cotton grow]-EP-OBL
'I saw the cotton that grew in Francisco's field.'

(37) Y-py-so' oot-y-n yn [erery]-ty [Francisco ga-p hoop]-o-ty
1-ASSERT-see-EP-NFUT I cotton-OBL Francisco field-in grow-EP-OBL
'I saw the cotton that grew in Franscisco's field.'

The adjunct PP ***Francisco gap*** is interpreted inside the relative and the moved head occurs before this adjunct, at the left edge of the relative (in Spec, AspP).

At this point, there is an issue that needs further clarification. Given our discussion about the status of Karitiana relative clauses as internally headed, one could wonder whether the clause in (33) could be analyzed as an externally headed relative clause because of the oblique marking on the head. However, relative clauses with the corresponding template of (38) are ungrammatical, indicating that the oblique marking in the whole clause is a requirement of the main verb:

(38) *Yn Ø-na-aka-t i-so'oo-t ombaky-ty taso ti-oky
I 3-DECL-COP-NFUT NMLZ-see-ABS.AGR. jaguar-OBL man OFC-kill

We conclude that cases like (33) are not externally headed relative clauses but internally headed relatives whose heads are redundantly marked as oblique.[9] Head-external relatives do not seem to exist in Karitiana at all,

[8] The postposition 'in' is attached to the NP *Francisco ga*, which means 'Francisco's field.'

[9] To date, no semantic difference has been detected between relative clauses with or without oblique marking. We refer the reader to the experimental task carried out in Section 3 to control for eventual semantic differences, which were not found.

given Vivanco's (2014) findings about the possibility that heads may occur internally to the relative clause, which does not occur in externally headed languages. Possibly, this redundant case-marking is a strategy to identify the head: since internally headed relative clauses usually have all their elements *in situ*, some languages employ mechanisms to make their heads more explicit. One common strategy reported in the literature is the frontalization of the head, but other operations such as intermediate movement (Gorbet 1976; Basilico 1996) and head duplication (Kendall 1974; Moore 2006) have also been identified.

To conclude this section, we present cases of multiple embedding in which the same extraction of the head of the relative occurs:

(39) Y-py-so' oot-y-n yn erery-ty Maria pytagngãm-ty João sondyp-y-ty
1-ASSERT-see-EP-NFUT I cotton- OBL Maria steal-OBL João know-EP-OBL
'I saw the cotton that João knows that Maria stole.'

In all such cases of multiple embedding, the oblique head of the oblique relative clause must be at the left periphery, whereas each clause marked as oblique may occur in any order:

(40) Y-py-so' oot-y-n yn [erery]-ty [João sondyp]-y-ty [Maria pytagngãm]-ty
1-ASSERT-see-EP-NFUT I cotton-OBL João know-EP-OBL Maria steal-OBL
'I saw the cotton that João knows that Maria stole.'

In the case of (39) and (40), this must follow from the fact that both the verb ***sondyp*** and ***pytagngãm*** are intransitive and thus require oblique clausal arguments, as in (41):

Furthermore, some oblique markers can be dropped as in (42) and (43):

(41) Y-py-so' oot-y-n yn [erery]-ty [Maria pytagngãm]-ty [João iip]-i-ty
1-ASSERT-see-EP-NFUT I cotton-OBL Maria steal-OBL João say -EP-OBL
'I saw the cotton that João said that Maria stole.'

(42) Y-py-so' oot-y-n yn erery-ty Maria pytagngãm-ty João iip
1-ASSERT-see-EP-NFUT I cotton-OBL Maria steal-OBL João say
'I saw the cotton that João said that Maria stole.'

(43) Y-py-so' oot-y-n yn erery Maria pytagngãm-ty João iip
1-ASSERT-see-EP-NFUT I cotton Maria steal-OBL João say
'I saw the cotton that João said that Maria stole.'

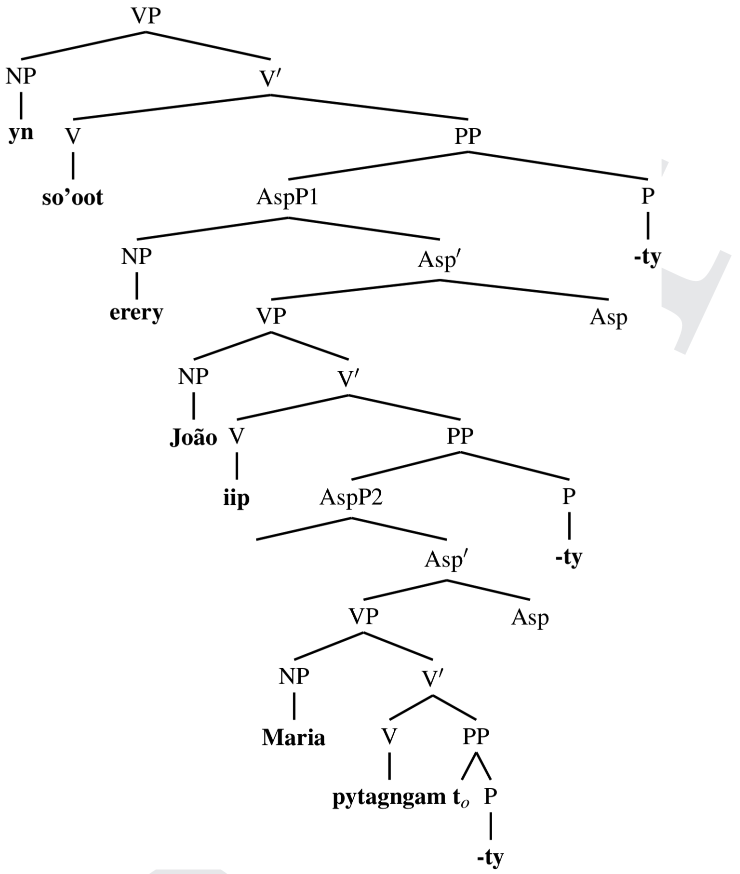



Figure 13.7 Simplified structure (without tense, agreement, and mood) of (41)

It is not clear whether there are subtle differences in meaning related to these variations of the same sentence. In order to certify that all the variants have the same meaning, an experimental task was carried out with three speakers.

## 3 Experimental Task with an Oblique Relative

In this task, a story illustrated by four drawings was presented to the speaker, one drawing after the other on a computer screen. By the end of the story, the speaker would see all four drawings at once. When a drawing was being displayed, the researcher described in Portuguese the situation depicted (the sentences used in each context are included below, translated into English).

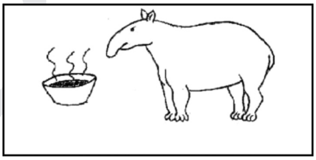
Next, the researcher would read a multiple-embedded sentence in Karitiana from the computer screen and ask the speaker if the sentence was appropriate to describe that particular context. If the sentence was not appropriate, the speaker could correct the sentence. The whole task was recorded either in audio or in video. In the following, we show one of the contexts used:

(44) Researcher: "In this story, Luciana cooked porridge."

"Thiago saw Luciana cooking the porridge."

"They put the porridge outside to cool it."

"Then a tapir ate the porridge"



After this step, the speaker was presented with a Karitiana sentence on a computer screen. The multiple-embedded sentence displayed on the screen for this particular context is transcribed in (46); it is ungrammatical:

(45) Researcher:
[reads the sentence aloud]
"Can you say that in this context?"

'Irip naka'yt syke Thiago so'oot Luciana tim'a

(46) *'Irip Ø-naka-'y-t syke Thiago so'oot Luciana ti-m-'a
tapir 3-DECL-eat-NFUT porridge Thiago see Luciana OFC-CAUS-do
'The tapir ate the porridge that Thiago saw Luciana making.'

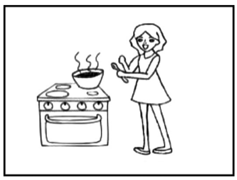
In this example, the main verb is transitive, so we do not expect an oblique argument at the end of the complex relative clause, but the verb 'to see' requires an oblique object. Therefore, we would expect speakers to correct this sentence in that respect. Three native speakers were tested and their judgments were collected and compared. Sentence (46) was corrected by speakers so as to include a type of infinitive suffix ***{–p}*** at the end of the clause, translated as 'the porridge that Thiago saw':

(47) 'Irip Ø-naka-'y-t [syke Thiago so'oot]-o-p Luciana ti-m-'a
tapir 3-DECL-eat-NFUT porridge Thiago see-EP-INF Luciana OFC-CAUS-do
'The tapir ate the porridge that Thiago saw Luciana making.'

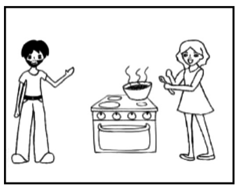
This is not what was expected by the authors, but it was consistent for the three speakers. To be able to compare these results with those of the other two experiments, researchers changed all multiple-embedded clauses presented so as to include that same suffix. Speakers only differed in the order in which they preferred each embedded clause to be pronounced. The head of the relative was always given at the left edge. No oblique suffixes were allowed.

In the second context, we had the following procedure:

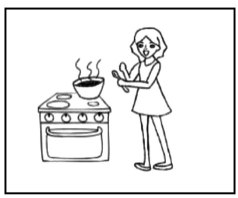
(48) Researcher: "In this story, Luciana cooked porridge."



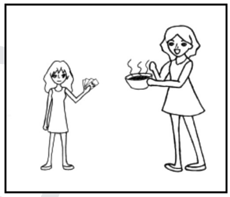
"Thiago saw Luciana cooking the porridge."



"They let the porridge finish cooking."



"Then a child bought Luciana's porridge."



The sentence given to speakers in this case was (49), in which the main verb ***amy*** 'to buy' is intransitive and may have an oblique object.

(49)

| | | |
|---|---|---|
| Õwã | ∅-na-aka-t | i-amy-t |
| child | 3-DECL-COP-NFUT | NMLZ-buy-ABS.AGR |

| | | | | |
|---|---|---|---|---|
| syke | Thiago | so'oot-o-p | Luciana | ti-m-'a-ty |
| porridge | Thiago | see-EP-INF | Luciana | OFC-CAUS-do-OBL |

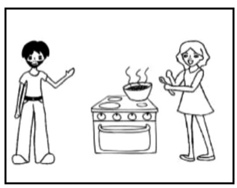
'The child bought the porridge that Thiago saw Luciana making.'

The results showed that the oblique suffix may appear only once, at the end of the complex relative as in (49), or twice, at the end of each clause. The head of the relative was only produced at the left edge of the complex relative clause, with (two speakers) or without the oblique suffix (all speakers). If the oblique head was allowed at all at the end of the clause (by one speaker), it was clearly pronounced as an afterthought (after a pause). In this experiment, we have confirmed that the oblique suffix required by the main verb is being repeated at the end of each clause and after the relative's head as an alternative to the same meaning.

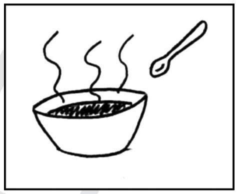
In the third context, the procedure was the following:

(50) Researcher: "In this story, Luciana cooked porridge."

"Thiago saw Luciana cooking the porridge."



"They put the porridge outside to cool it."



"Then a child ate Luciana's porridge and liked it."

The sentence given in the third experiment was (51):

(51) Õwã ∅-na-aka-t i-so'oot hãraj̃-∅ syke
child 3-DECL-COP-NFUT NMLZ-like-ABS.AGR porridge

Thiago so'oot-o-p-o-ty Luciana ti-m-'a-ty
Thiago see-EP-INF-EP-OBL Luciana OFC-CAUS-do-obl
'The child liked the porridge that Thiago saw Luciana making.'

In this sentence, the main verb is intransitive and its oblique object occurs at the end of the sentence. Results were consistent with what was found in sentence (49), which has the same structure.

The experiment was able to confirm the facts observed in the data presented in this chapter: that when one oblique relative clause is the object of an intransitive verb, the head at the left edge of the relative may be marked as oblique, as well as any intermediate clauses without a change in meaning. Even though in this particular task speakers used a different type of relative clause with a poorly understood infinitival suffix on the first embedded verb, the behavior of such clauses with respect to the oblique suffix was exactly the same as that observed in the other examples. Because of this, we consider that such clauses have the same structure as the others, given in Figure 13.8.

## 4 Final Discussion

Our analysis of embedding in the cases under consideration is that the oblique suffix that appears at the end of the relative is required by the main verb when

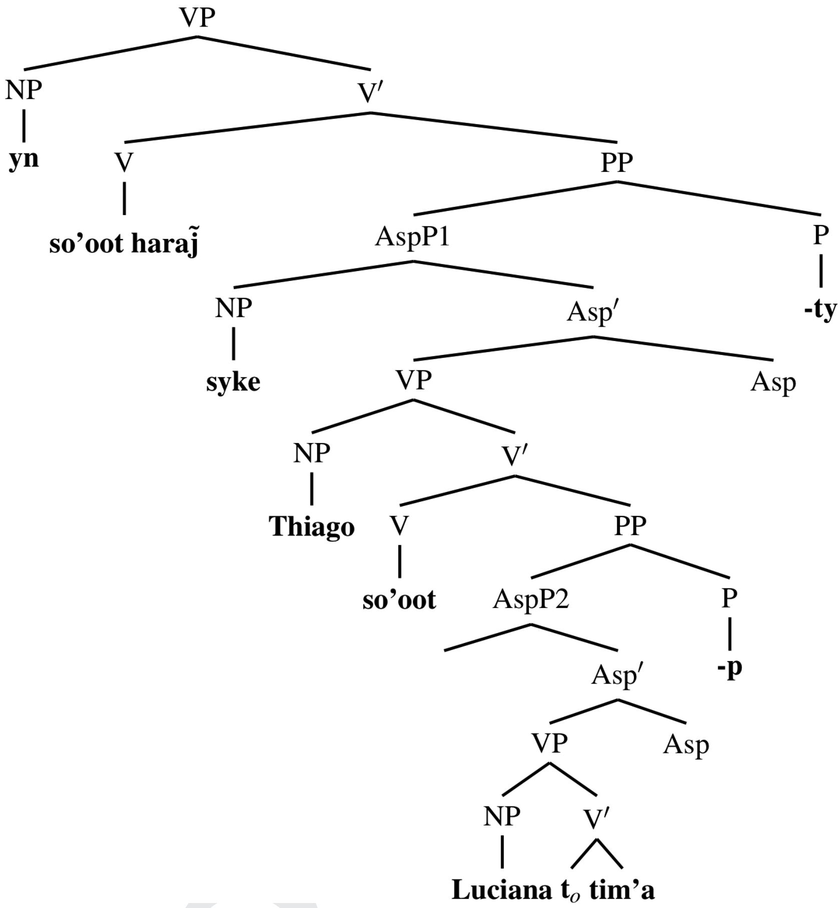



Figure 13.8 Simplified tree (without tense, agreement, and mood) of (51)

an object is added to its argument structure, and that the option of extracting the head to the front in such cases is always realized in natural production to avoid ambiguity between subject and object relatives. When the extracted head has an oblique suffix in addition to the oblique case suffixed to the relative, this is a strategy the language uses to keep track of the referent of the relative, marking it as oblique because it is the head of an oblique relative clause. When more layers of embedding are added, the same strategy is maintained. It is a result of successive-cyclic movement of the head to the left periphery of intermediate clauses, but it is not agreement in the complementizer position as reported in other languages of the world for two reasons: it is not obligatory and, in our analysis, Karitiana does not project complementizers in embedded clauses.

The addition of more embedded clauses makes the relative even more ambiguous, because they add more NPs that could be the head of the oblique relative clause. Some languages employ various strategies such as frontalization or duplication to make their head more explicit. As seen before, Karitiana already has optional movement of the head, so the language must be using an additional strategy – case-marking of the head – as a device for the same purpose. We do not know yet how to explain the syntactic implementation of the repetition of the oblique suffix in the head and in every intermediary clause in such cases, but it is possible to hypothesize that it is agreement of a non-obligatory type in the aspectual head of the embedded clause, because to raise to Spec, AspP, the head of the relative probably stops by every intermediary Spec, AspP projection (successive-cyclic movement).

Finally, it is worth saying that the Karitiana relative clauses discussed here shed light on the topic of clause recursion in Amerindian languages. We have seen that Karitiana not only provides evidence that it is capable of embedding one clause into another, but that it also displays a more complex case of recursion.

# *Part IV*

# Recursion in the PP Domain

# 14 Recursion in the Acquisition Path for Hierarchical Syntactic Structure

*Tom Roeper and Yohei Oseki*[*]

At one moment in our fieldwork on Pirahã during the conference on recursion in Rio de Janeiro (*Recursion in Brazilian Languages and Beyond*), we asked the monolingual[1] Pirahã speaker to explain what we instructed him to do through Pirahã translation of the following English example:

(1) 'Put the coin on the paper on the rug.'

Interestingly, he spontaneously reversed the order of two PPs, as follows:

(2) 'Put the coin on the rug on the paper.'

Why? This does not seem to be coordination with respect to semantic interpretation:

(3) 'Put the coin on the rug and the paper.'

Is this a new type of recursion not only for Pirahã, but also crosslinguistically? If so, the prediction is that it is found in other languages as well. In fact, though little discussed, it is attested in English with sequences of PPs:

(4) a. Throw the waste in the garage in the back corner in the black barrel.
b. Put the jar in the kitchen in the closet on the second shelf.

In these examples, multiple PPs jointly fill the locative argument of the predicates. If (4) were recursive embedding of PPs, the order would be the opposite, like Pirahã:

[*] We would like to thank audiences at Durham University, Federal University of Rio de Janeiro, Leipzig University, University of Cambridge, University of Toronto, and the Language Acquisition Research Center (LARC) at the University of Massachusetts Amherst; in particular Luiz Amaral, Noam Chomsky, Jeremy Hartman, Wolfram Hinzen, Bart Hollebrandse, Marcus Maia, Andrew Nevins, Ana Perez-Léroux, Cilene Rodrigues, Filomena Sandalo, Uli Sauerland, and the reviewers of this volume. This work was partly supported by National Science Foundation BCS 1523459 awarded to Tom Roeper. Any remaining errors are our own.

[1] For a brief commentary of the methodological implications of a monolingual informant, please see footnote 23 in Rodrigues et al. (this volume).

(5) a. Throw the waste in the black barrel in the back corner in the garage.
b. Put the jar on the second shelf in the closet in the kitchen.

Notice that if (4) were recursive embedding of PPs, the meaning would also be infelicitous: the kitchen cannot be in the closet (unless miniature toy kitchens). This type of recursion seems to be present in another indigenous Brazilian language, Kaingang (Luiz Amaral, personal communication), as well as on the acquisition path in English.

In this chapter, given these observations in Pirahã and English, we propose a new type of recursion called *Direct Structured Recursion*, added to the typology of recursion in Roeper and Snyder (2005) and Roeper (2011). Specifically, we argue that there are three types of recursion, which are clearly distinguished in terms of syntactic behavior: (1) Direct Unstructured Recursion (DUR), (2) Direct Structured Recursion (DSR), and (3) Indirect Recursion (IR). Furthermore, it will be argued that these types of recursion may be reflected in the acquisition path of English through their increasing complexity. The theoretical implications for the debate on recursion in Pirahã will also be discussed (Everett 2005, 2009; Nevins et al. 2009a, 2009b; Levinson 2013; Legate et al. 2014; Roeper and Speas 2014).

This chapter is organized as follows. Section 1 descriptively introduces three types of recursion and their syntactic behaviors. Section 2 argues that the acquisition path of recursion in English corroborates their psychological reality, where syntactic complexity of each type of recursion is reflected in the time course of acquisition. Section 3 discusses the relevance of Direct Structured Recursion for the recursion debate in Pirahã. Section 4 concludes the chapter.

## 1 Typology of Recursion

In this section, building on Roeper and Snyder (2005) and Roeper (2011), we propose a new typology of recursion. In particular, three types of recursion are introduced, as in (6).

(6) *Typology of Recursion*:
a. Direct Unstructured Recursion
b. Direct Structured Recursion
c. Indirect Recursion

Roeper (2011) has argued that Direct Unstructured Recursion (DUR) adjoins XPs in a linear manner, while Indirect Recursion (IR) introduces XPs in a hierarchical way mediated through an additional category YP.[2] Direct Structured

[2] DUR and IR correspond to "direct" and "indirect" embedding of X within X in Arsenijević and Hinzen (2012). Note that DUR is simply called Direct Recursion in Roeper (2011).

Recursion (DSR) is the new type of recursion proposed in this chapter and displays an intermediate complexity between DUR and IR in that XPs are introduced hierarchically, but not through an additional category YP. Although full theoretical formalization of this typology of recursion is beyond the scope of this chapter, syntactic behavior of each type of recursion is described below.[3]

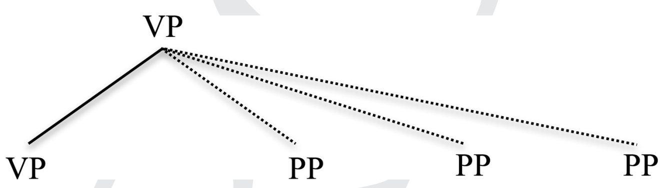
### *1.1 Direct Unstructured Recursion*

Direct Unstructured Recursion (DUR) is the "default" type of recursion and adds an indefinitely large number of XPs in a linear manner without generating hierarchical structures. DUR would be formulated with the phrase structure rule (7).[4]

(7) *Direct Unstructured Recursion*:
YP → YP XP*
(where "*" means zero or more)

Example (8) instantiates DUR, where YP = VP and XP = PP, and what Langendoen et al. (1989) call "coordinating."

(8) Put an apple [$_{PP}$ in the kitchen], [$_{PP}$ in the bedroom], and [$_{PP}$ in the balcony].




[3] We acknowledge that recursive procedures and recursive structures should not be conflated (Tomalin 2011; Lobina 2014; Watumull et al. 2014; see also Fitch 2010 for clarification of several definitions of recursion). Nevertheless, we simply focus on the recursive structures generated by the recursive procedures, because the abstract recursive procedure per se (e.g., Merge) does not explain empirical facts in particular languages and child languages. Arsenijević and Hinzen (2012:424) correctly point out that "Merge, which amounts to discrete infinity, and which consists in an analysis of discrete infinity that has been claimed to be 'minimal,' tells us no more and no less than that language is recursive. The question of why language is recursive in the particular ways in which it is must come from elsewhere."

[4] In fact, this type of structure has been called "unstructured coordination" and as problematic for phrase structure rules (Lasnik 2011). This was the motivation for Chomsky (2004) to propose Pair-Merge, which "can be applied indefinitely often, adding individual predications without further structure" (Chomsky 2013:45).

Semantically, DUR has a conjunctive interpretation. For example, example (8) means that each PP is individually predicated of the object "an apple" and PPs are not predicated as a unit (Chomsky 2013). Consequently, DUR shows no compositional relationships among recursive XPs, so that permutation yields no semantic differences, as in (9).

(9) Put an apple $[_{PP}$ in the balcony], $[_{PP}$ in the kitchen], and $[_{PP}$ in the bedroom].

Syntactically, since recursive XPs are coordinated in a linear manner, extraction out of them is impossible due to the Coordinate Structure Constraint (Ross 1967), as in (10).

(10) *What did John put an apple in the kitchen, in the bedroom, and in <what>?

In sum, DUR is semantically conjunctive and syntactically linear. This type of recursion is equivalent to "parataxis" in non-literate languages observed by Hale (1976), Everett (2005, 2009), and Evans and Levinson (2009). This corroborates the view that DUR is the "default" type of recursion available universally and predicts that children begin with producing and comprehending recursive XPs as DUR.

### *1.2 Direct Structured Recursion*

Our initial observations in Pirahã and English all motivate this second new type of recursion: Direct Structured Recursion (DSR), which appears similar to DUR but quite different in involving hierarchical structure, rather than linear structure. The phrase structure rule responsible for DSR can be formulated as in (11).

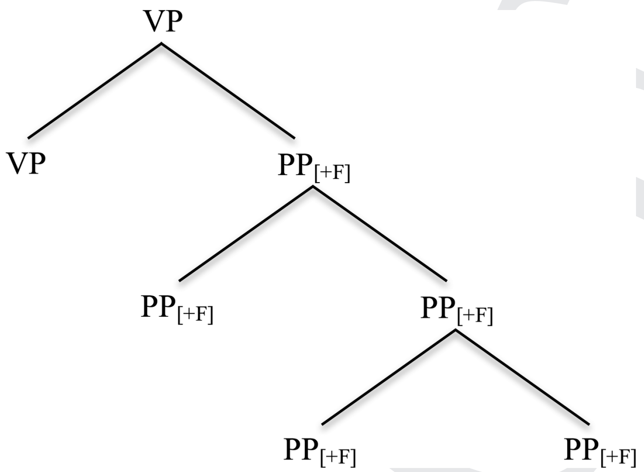
(11) *Direct Structured Recursion*:
$XP_{[+F]} \rightarrow XP_{[+F]}\ XP_{[+F]}$

Unlike DUR, the phrase structure rule is binary and crucially generates hierarchical structure; namely, more than two sisters are impossible. This is achieved by the shared feature [+F] between XPs (Chomsky 2013). Typical examples of DSR are what Langendoen et al. (1989) call "stuffing" (12), where XP = PP.

(12) a. Put an apple $[[[_{PP}$ in the house] $[_{PP}$ in the kitchen]] $[_{PP}$ in the cabinet]].[5]

[5] Chomsky (2013:46) analyzes an example like "put on the table in a box…" as "unstructured multiple adjuncts," but it is clear that these adjuncts are structured, even without Indirect Recursion.

b. Bill saw Mary [[[$_{PP}$ on Saturday] [$_{PP}$ in the morning]] [$_{PP}$ at nine]].




DSR, unlike DUR, is semantically compositional. For instance, in the example (12a), three PPs are jointly predicated of the object “an apple,” but PPs do not modify the preceding NPs (i.e., the house is not in the kitchen). In other words, PPs collectively saturate the obligatory locative argument of “put” and can be interpreted in a single event, unlike example (8). Similarly, in example (12b), three PPs together express one specific time (i.e., Saturday is not in the morning). Therefore, in contrast with DUR, permutation of recursive XPs does affect semantic interpretations, making the example ungrammatical or at least infelicitous, as shown in (13).

(13) #Put an apple [[[$_{PP}$ in the cabinet] [$_{PP}$ in the house]] [$_{PP}$ in the kitchen]].

Importantly, extraction out of DSR is possible, indicating that PPs here must be hierarchically organized and not coordinated in a linear manner.

(14) What did John put an apple in the house in the kitchen in <what>?

This observation is reminiscent of asymmetric coordination, where extraction is generally permitted (Nonato, this volume). In summary, DSR is different from DUR in that the former is compositional and hierarchical, while the latter is conjunctive and linear, as revealed by permutation and extraction facts. Nevertheless, DSR and DUR are similar in that both can stack adjacent identical XPs without an intervening category YP. This “direct” nature distinguishes DSR and DUR (i.e., recursion by one rule) from the third type of recursion (i.e., recursion by two rules), to which we now turn.

### 1.3 Indirect Recursion

The third and final type of recursion is Indirect Recursion (IR), which is fully compositional and hierarchical in nature. IR resembles DSR in that both involve hierarchical structure, but importantly IR arises through two phrase structure rules (15).

(15) *Indirect Recursion*:
$\text{XP} \rightarrow \text{X YP}$
$\text{YP} \rightarrow \text{Y XP}$

Representative examples of IR are recursive embedding of PPs mediated through NPs (16), where XP = PP and YP = NP. Compared to DSR (12), the order of PPs is exactly the opposite with the meaning roughly the same. This is what Langendoen et al. (1989) call “alternating”:

(16) a. Put an apple [$_{\text{PP}}$ in [[$_{\text{NP}}$ the cabinet] [$_{\text{PP}}$ in [[$_{\text{NP}}$ the kitchen] [$_{\text{PP}}$ in the house]]]]].
b. Bill saw Mary [$_{\text{PP}}$ at [[$_{\text{NP}}$ nine] [$_{\text{PP}}$ in [[$_{\text{NP}}$ the morning] [$_{\text{PP}}$ on Saturday]]]]].

IR is compositional in the sense that PPs modify the preceding NPs. In example (16a), the cabinet is inside the kitchen, which is further inside the house. Similarly, in example (16b), nine should fall inside the morning, which is in turn on Saturday. Consequently, permutation does change semantics in the same way as DSR, as exemplified in (17).

(17) #Put an apple [$_{\text{PP}}$ in [[$_{\text{NP}}$ the house] [$_{\text{PP}}$ in [[$_{\text{NP}}$ the kitchen] [$_{\text{PP}}$ in the cabinet]]]]].

Extraction out of recursive XPs is generally fine with IR, like long-distance *wh*-extraction from recursive VPs:

(18) What did John put an apple in the cabinet in the kitchen in <what>?

If both IR and DSR are semantically compositional and syntactically hierarchical, what is the difference between IR and DSR? The answer lies in the complexity of recursion. DSR can directly stack identical XPs, but IR never has adjacent identical XPs. Consequently, one phrase structure rule is sufficient for DSR (i.e., recursion by one rule), whereas two mutually dependent phrase structure rules are necessary for IR (i.e., recursion by two rules). This difference can be treated in terms of the “anti-identity” condition discussed by Leivada (2015) that adjacent XPs are not preferred (cf. OCP in phonology): DUR and DSR violate the “anti-identity” condition, while IR does not.[6]

[6] Di Sciullo (2015) and Sevcenco et al. (2016) further argue that Indirect Recursion is grammatically marked with functional categories, which are morphologically overt in some languages such as Romanian and Japanese.

## 2 Acquisition Path of Recursion

In this section, we explore the psychological reality of the proposed typology of recursion by showing that three types of recursion are reflected in the acquisition path of recursion. Since those types of recursion differ in syntactic complexity, the following time course of acquisition is predicted by the theory:

(19) *Acquisition Path of Recursion*:
Direct Unstructured → Direct Structured → Indirect

Furthermore, this particular order of the acquisition path is quite natural under the theory of the acquisition engine with automatic self-revision (Roeper 2014). Since adjacent identical XPs attested in Direct Unstructured Recursion and Direct Structured Recursion are not preferred by the "anti-identity" condition (Leivada 2015), the acquisition engine seeks to revise those dispreferred types of recursion to Indirect Recursion, which does not involve adjacent identical XPs. One consequence is that some speakers find "put the jar on the table in the box" (Direct Structured Recursion) to be worse than "put the jar in the box on the table" (Indirect Recursion), which is actually the case from informal investigation.

### *2.1 Acquisition of Direct Unstructured Recursion*

DUR has been shown experimentally for many constructions, as indicated by children's bias to comprehend recursive XPs as linear conjunction:

(20) *Adjectives*:
second green ball → second **and** green ball
(Matthei 1982)

(21) *Possessives*:
Mary's father's bike → Mary **and** father's bike
(Limbach and Adone 2010)

(22) *Compounds*:
tea-pourer-maker → tea-pourer **and** maker
(Hiraga 2010)

(23) *Sentences*:
What did Sue tell Mom Bill said… → What did Sue tell **and** Bill said…
(Hollebrandse et al. 2008)

The results of these various experiments clearly indicate that DUR is the default and simplest mode of recursion. Lebeaux (2000) and Yang and Roeper (2011) have also argued that children begin with adjunction before acquiring argument structures.

### 2.2 *Acquisition of Direct Structured Recursion*

We turn now to DSR in the acquisition path. Since DSR is syntactically simpler than IR, we predict that DSR occurs relatively early in acquisition as compared to IR. The examples in (24) from various corpora in the CHILDES database (MacWhinney 2000) show that it emerges around 2;3 years. In these spontaneous examples, the directional PPs go from larger to smaller, as in our previous examples:

(24) a. I will go right **on the street in a car**. [2;3.0]
b. He left his bear alone **in the park on the seat**. [3;6.9]

The following examples, based on searches for "there" with 2 years old, should also be regarded as DSR, not IR, because the PP *in there* is further modified by the following PPs, which would not be the case if they exemplified Indirect Recursion:

(25) a. Put it under the other puppet **in there on your hand**. [3;2.4]
b. Some milk # put them **in there in the water**. [2;8.30]
c. That one go **on there in the tower**. [2;2.12]
d. Let's look **down there on the ## floor**. [2;5.0]
e. Put that one **in there on that side**. [3;4.1]
f. In with somebody else right right **in there in the other room**. [3;6]
g. I saw him right **in there on the ceiling**. [3;2.29]
h. Snowman **down there in my trousers**. [2;3.15]

Naturalistic data in (26) also suggests that children indeed resist Indirect Recursion in favor of DSR (Gu 2008):

(26) Father: up on the shelf in the closet in the kitchen
Father: can you say that
Child: yeah
Child: up in the # up in the # what
Father: up on the shelf in the closet in the kitchen
Child: up on the shelf in the # what
Father: closet
Child: in the closet in the kitchen

| | |
|---|---|
| Father: | in the jar up on the shelf |
| Father: | can you say that? |
| Child: | I can't |
| Father: | you can |
| Child: | in the jar # say in the jar |
| Child: | **up on the shelf in the jar** in the closet in the kitchen |

Notice in the last sentence of (26) that the order of two PPs would be wrong if this example instantiates IR: the shelf is not in the jar. Therefore, we should conclude that this is an instance of DSR where the referent specified by the first PP is directly modified by the following PP.

In addition, the famous examples called "kindergarten path effects" originally discovered by Trueswell et al. (1999) and subsequently replicated by Weighall (2008) suggest that children misinterpret the first PP in sentences like (27) as the locative argument of the predicate, not the modifier of DP.

(27) Put the frog **on the napkin** in the box.

While these examples have been regarded as evidence of the processing limitations of children, this result can be interpreted as children's bias to avoid IR in favor of DSR, where the frog goes both on the napkin and in the box.

### *2.3 Acquisition of Indirect Recursion*

Finally, children acquire IR, but when exactly Indirect Recursion appears in child grammar is still under debate. Pérez-Leroux et al. (2012, this volume) argue that multiple adjectives and PPs do not occur regularly in children's production until 7–10 years. Roeper (2011) also observes that spontaneous and experimental results do not always converge on the same conclusion. For example, IR such as sentence embedding is sometimes found around 5 years:

(28) a. I think Daddy says he wears underpants.
b. I think he said they gonna be warm.

However, notice that the embedded sentences without the complementizer *that* could be argued to be conjunction (e.g., I think and Daddy says and he wears underpants). Therefore, our suspicion is that the discrepancy between comprehension and production, as Pérez-Leroux et al. (2012, this volume) argue, means that the representations generated for production might actually involve conjunction. If so, these early apparent examples of IR are compatible with the proposal that both DUR and DSR are available before IR.

### 2.4 *Neurophysiological Evidence*

The acquisition path defended above is motivated by the syntactic complexity of the typology of recursion. Interestingly, processing costs observed in the neurophysiological experiments also reflect this complexity effect in the acquisition path. Maia et al. (this volume) designed EEG experiments to compare DUR (coordination) and IR (embedding), and found that embedding is costlier to process than coordination in terms of both the latency and the amplitude. We suggest that DSR is a "stepping stone" on the acquisition path, whereby a non-restrictive semantic interpretation is projected prior to a restrictive semantic interpretation. If IR has tighter syntax-semantics mapping and is preferred with no violations of the "anti-identity" condition, children may ultimately reject DSR. Correspondingly, it is natural that DSR is sometimes perceived as substandard by adults.

## 3 Recursion in Pirahã?

Everett (2005) has argued against Hauser, Chomsky, and Fitch (2002) that Pirahã lacks sentential embedding, one major instance of IR, arguing instead that recursion is not universal but rather cultural in nature. However, Sandalo et al. (this volume) carefully show with various experimental tasks that Pirahã does have PP recursion, another instance of IR. Again, in the acting-out experiment, the following example of IR was first presented and understood perfectly by the monolingual speaker of Pirahã:

(29) *Indirect Recursion*:

| | | | | | |
|---|---|---|---|---|---|
| ihiaipati | gigohoi | kopo | ko | tiapapati | apo. |
| put | coin | cup | in | chair | on. |

'Put a coin in the cup on the chair.'

Interestingly, in spontaneous production, that Pirahã speaker inverted the order of two other PPs, creating DSR:

(30) *Direct Structured Recursion*:

| | | | | | | |
|---|---|---|---|---|---|---|
| tabo | apo | tiapapati | apo | kapiiga | apo | gigohoi. |
| board | on | chair | on | paper | on | coin |

= 'The coin on the paper on the chair.'

This fact not only serves as a strong existence proof of PP recursion in Pirahã, but also squarely fits with the theoretical claim that DSR is less complex than IR.

Critical independent confirmation came in the elicitation experiment reported by Sandalo et al. (this volume), where the following example of IR was elicited:

(31) *Indirect Recursion*:

| | | | | | |
|---|---|---|---|---|---|
| Kapiiga | ko | kapiigaitoi | ***xihi***-aip-aáti | kapiiga | ko |
| paper | inside | pencil | store-down-unexpected | paper | inside |
| kapiiga | ***ho***-áop-aáti | | | | |
| paper | Aux-imperfect-unexpected | | | | |

'You are putting down pencil inside paper inside paper.'

Here there are two verbs, main *xihi* 'store' and auxiliary *ho* 'be,' but there is only one tense marker on the auxiliary verb, which crucially rules out the possibility of parataxis, contrary to Everett's (2005) claim.

In addition, DUR occurs in Pirahã, as expected under the view that DUR is the default and simplest mode of recursion:

(32) *Direct Unstructured Recursion*:

| | | | | | |
|---|---|---|---|---|---|
| koxoahai | bege | apo | xaxai | apo | ***piai*** |
| alligator | floor | on | stone | on | also |

'Alligator on the floor and on the stone.'

This example is interpreted by the Pirahã speaker conjunctively, not compositionally, and requires the conjunct *piai* 'and' exactly as in English.

It follows that Pirahã does have recursion, at least in the domain of PP. But what about the alleged absence of recursion in the domain of CP? In fact, Sauerland (this volume) and Rodrigues et al. (this volume) have shown that Pirahã also does have recursion in the domains of CP (sentential embedding) and VP (obligatory control). In addition, Salles (2015) has shown that recursive possessives are found in Pirahã as well:

(33)

| | | | |
|---|---|---|---|
| Iapohen | baíxi | xapaitaí | kobiaí |
| Iapohen | mother | hair | white |

'Iapohen's mother's hair is white.'

Even without these pieces of evidence, the lack of recursion with specific categories is not surprising. As articulated by Watumull et al. (2014), the absence of recursion in particular domains simply means that there are some lexically specific constraints, not the absence of recursion in the grammar itself. For example, as documented by Roeper (2011), German lacks recursive possessives as in (34).[7]

[7] English is historically related to German and it appears now that both German and Dutch are beginning to allow recursion into the possessive system. A reviewer notes that examples like "Peters Mutters Auto" can be found. See Merx (2016) for experimental evidence on this point in Dutch. However, the lexical restriction to proper nouns remains. It becomes actually recursive when any kind of noun can work (cf. "the Saab's left rear tire's hubcap's color" in English).

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

In the same vein, there are no recursive compounds in Romance languages, no recursive prenominal adjectives in French, no recursive serial verbs in English, no sentential embedding in Warlpiri, and so on. In this light, the alleged absence of recursion in Pirahã is simply explained away by lexically specific constraints. From the acquisition perspective, this fact entails that children should not automatically extend recursion in one domain to another without language-specific experience; otherwise, impossible recursive XPs would be over-generated.

We also note that these results do not match the domain-general approach to recursion: for those who consider recursion to be domain general and not specific to human language (Corballis 2011), then lexically specific constraints on recursion are not expected, as in German recursive possessives. If recursion is derived from cognition outside human language, why are there language-specific constraints on the depth of recursive possessives? All of these linguistic arguments are incompatible with the claim that recursion is a domain-general capacity that is applicable across all forms of cognition.

## 4 Conclusion

Our proposal for how recursion is represented with the three primary types of recursion – beyond Merge – reflects increasing structural complexity. They are in turn reflected in the acquisition path: (1) DUR, (2) DSR, and (3) IR. We have found preliminary suggestive evidence at every possible data point (introspective acceptability judgments, child spontaneous production, child laboratory comprehension, electrophysiological measurement) to support our perspective (though much remains to be carefully explored).

The history of the generative enterprise has had enormous success in demonstrating that principles of grammar serve to describe grammars of natural languages around the world. The fact that the same experimental methodologies can be applied across Brazilian languages with parallel questions and comparable results strongly supports this enterprise. This not only provides important evidence for theoretical assumptions, but also demonstrates that experimental techniques developed in language acquisition can naturally transfer to fieldwork. Despite the diversity of languages, histories, cultural circumstances, and social environments, deep universal principles of grammar emerge repeatedly with surprising clarity.

# 15 Self-Embedded Recursive Postpositional Phrases in Pirahã: A Pilot Study

*Filomena Sandalo, Cilene Rodrigues, Tom Roeper, Luiz Amaral, Marcus Maia, and Glauber Romling da Silva*

## 1 Introduction

Our specific goal in this chapter is to use experimentation developed in acquisition work to identify the presence of self-embedding recursion in Pirahã.[1] Our broader goal, in concert with other chapters in this volume, is to jointly explore formal theoretical issues and extend experimental methodology to indigenous languages. We shall provide evidence that recursive self-embedding is present in Pirahã PPs and explore the consequences for the larger tapestry of recursive structures in human language in general. As a result, we reconsider the provocative claim by Everett (2005, 2009, 2012) that Pirahã lacks recursive syntactic structures altogether, showing that this view most likely results from a misunderstanding about the underlying grammatical system of Pirahã.

### *1.1 Broader Questions*

There are broader issues entailed in the type of research described here:

(a) What is self-embedding in the larger context of recursive operations?
(b) How can a mathematical theory of grammar become visible to researchers in a language whose grammar is not fully understood?
(c) Can we reliably engage with such issues despite the necessity of translation and the presence of cultural differences?
(d) Can we apply a common methodology across a variety of indigenous languages and a variety of self-embedding constructions?

Our work is essentially just a step in this larger quest.

[1] We thank our Pirahã consultants, Yapohen and Iaoá, and Augusto for Pirahã translations into Portuguese. We also thank the audience of the conference *Recursion in Brazilian Languages and Beyond 2013*, the reviewers of this volume, and CAPES, which enabled the research to be carried out via a support grant to bring Pirahã speakers to UNICAMP and to UFRJ.

### 1.2 Experimental Fieldwork

Large challenges exist in doing fieldwork on isolated languages. It is not straightforward to obtain acceptability judgments from monolingual speakers without a writing system, relying mostly on uneasy translations. Yet it is very much like scientific inquiry elsewhere. In astronomy, observations can be severely clouded by limits on visibility. In biology, the extraordinary diversity in the physical environment of organisms, from the microscopic to the macroscopic, can be daunting. Our environmental challenge in discovering grammars may be less severe than in biology: it can be largely overcome once known experimental methods are imported into the inquiry. By utilizing stories and picture choice experimentation, we can create sharp pragmatic contrasts that allow us to highlight minimal pairs. This approach avoids subtle and frequently inconsistent grammaticality judgments.[2]

In general, we find not a contradiction but a refinement of results when informal judgment, as well as truth-functional experiments and on-line approaches, are jointly explored. We see this approach as a harbinger of future work throughout linguistics.

### 1.3 Abstract Principles and Fieldwork

The claim that sophisticated, abstract Universal Grammar (UG) principles could be quickly and directly visible in a new language may seem very surprising. Half a century of painstaking and subtle explorations of intuitions of grammaticality have been needed to isolate distinctive characteristics of human grammar, such as the cyclic rules, Logical Form, barrier constraints on movement, and underlying parametric patterns (Baker 2001). As a result, one might expect that each new isolated grammar produces an equal challenge that would take decades before an appropriate analysis succeeded. However, we believe that the opposite expectation emerges when scientific principles are fully clarified: if a UG principle can be expressed with formal precision, we should be able to isolate it easily in a new language.

In fact, recursion can be signaled by visible surface identity in morphemes, like *–'s* in 'John's friend's hat' or *–er* in 'coffee-maker-maker,' or specific prepositions like (*de–* in Romanian or *–no* in Japanese). Therefore, it is an excellent candidate for this expectation.

### 1.4 Overview of Recursion

Two meanings of recursion stand out in the literature in linguistics, derived from work in mathematics and computer science (Graffi 2015):

[2] See Nonato (this volume) and Maia (2015) for further discussion.

(1) Recursion as an iterative operation of Merge on words, and

(2) Recursion as self-embedding of structures.

There can be little doubt that the formation of every phrase requires the recursive algorithm of Merge or an equivalent formal operation that combines elements and operates upon its own output.[3] Therefore, this fundamental form of recursion must be universal for every structure identified as human language.

As for self-embedding, it is easily spotted in English PPs (*the dog next to the cat next to the horse*), possessives (*John's friend's hat*), adjectives (*the second green ball*), compounds (*coffee-maker-lover*), or in derivational morphology (*re-re-reread*), as well as in embedded sentences and in relative clauses.

It is well known that not every form of embedding is found in every language (Hale 1975; Evans and Levinson 2009). So the question arises: which forms are found where? Tightly coordinated use of experimental materials developed in English (Pérez-Leroux et al., this volume), Japanese (Terunuma and Nakato, this volume), Portuguese (Maia et al., this volume), and Spanish, Dutch, and German have shown the presence of self-embedding not only with adults but also with children for both common (relative clauses) and rare (possessive) structures.

In this volume, Franchetto, working on Kuikuro, Lima and Kayabi on Kawaiwete, Amaral and Leandro on Wapichana, and Maia et al. on Karajá apply virtually identical or comparable materials on recursive locative PPs. Even though the tests have varied from non-chronometric acting-out tests applied to a single subject to direct on-line measures obtained with many subjects, all this work presents gratifyingly comparable results, showing the existence of self-embedding in these less-studied languages. Is it possible that Pirahã is a completely different language, banning any form of self-embedding? While Everett, based on his fieldwork, denies the presence of all forms of self-embedding, independent evidence first gathered by Sandalo in 1991 from informants, discussed below, runs directly counter to his claims. Moreover, Sandalo's data fall together with Sauerland's and Rodrigues et al.'s contributions (this volume) for recursively embedded sentential complementation in Pirahã, and with further work by Salles (2015) on self-embedded possessive nominal phrases.

At any rate, it is the full panoply of results within a language, using a variety of methodologies, that produces the kind of empirical robustness that science traditionally seeks. To capture all these facts, we need a more refined representation of recursion varieties.

[3] However, Everett (2009:438) states that "Merge is unnecessary in Pirahã, just as recursion is," and that there are "alternative approaches to syntax" that can account for the existence in Pirahã of sentences containing more than two words. This statement cannot be taken into consideration here, as Everett provides no discussion on the alternative approaches he alludes to.

## 2 Recursion Types

The universal form of Merge has been defined by Chomsky (2013) in the following terms:

(3) Merge $(\alpha,\beta) = \{\alpha,\beta\}$
Recursive Merge: T $(\alpha,\beta) \rightarrow \{T\ [\alpha,\beta]\}$

That is, recursive Merge refers here to a structure-building algorithm where only set formation ($\{\alpha,\beta\}$) is combined, without a built-in label assigned to nodes.

In this recursive procedure, every step in structure-building is an operation of Merge that takes as its input ($\alpha$ and $\beta$) two lexical items and merges them, delivering as its output a more complex object ($\{\alpha,\beta\}$). In the next step, Merge may take a new phrase as input and combine it with the complex object formed in step 1.[4]

When we turn to self-embedding recursion, it is easy for us to conceive it in terms of node labels, which abstractly are maximal projections, represented as XP or YP, projected from heads, as X or Y. From there, we can differentiate three types of structures with rules that operate upon labelled nodes. Each entails a different formal representation, although their ideal formal representation will no doubt undergo further evolution. Snyder and Roeper (2004) and Roeper (2011), building upon work in computer science, have identified Direct Recursion (DR) and Indirect Recursion (IR). Roeper and Oseki (this volume) have further divided Direct Recursion into Direct Unstructured Recursion (= Conjunctive) (DUR) and *Direct Structured Recursion* (DSR).[5]

DUR delivers a conjunction, which can be generated in accordance with the rewriting rule in (4a):

(4a) Direct (conjunctive) Recursion: X → X (and X)

The signature characteristic of DUR can be represented as in (1) and it is interpreted as *conjunction* or "and."

Everett (2005) calls this elementary form "parataxis," and claims that all phrases in Pirahã are interpreted in this straightforward way. Arsenijević and

[4] For a detailed discussion of how the notion of recursive enumerable sets was incorporated into linguistic theory, see Tomalin (2006), Watumull et al. (2014), and Salles (2015). The discussion moves towards mathematical definitions of recursion, which Bar-Hillel (1953) proposed to be extended to contexts outside mathematics.

[5] For a discussion on recursive procedure versus recursive structures, see Pinker and Jackendoff (2005), Lobina (2014) and references therein. There are many formalisms that capture recursive structures, such as TAG grammar substitution (Joshi 2014; Frank 2006). We hope that experimental empirical work like ours will eventually enable linguistics to make the ideal choice among formalisms.

Hinzen (2012)[6] suggest that this default form actually lies outside of grammar itself and it applies to every structural level (XP-level, sentence-level, word-level).[7] Classic evidence for this kind of structure comes from forms like (4b), where order has no interpretive effect and little evidence of binary structure is present:

(4b) John, Bill, Susan, and Fred arrived

A second form of recursion, Indirect Recursion, involves an extra derivational step, or an extra rewriting rule (5):

(5) $X \rightarrow Y\ Z$
$Z \rightarrow W\ (X)$

According to this, a category Z may emerge from the combination of other categories. In this second step of the derivation, X, created in step 1, is optionally re-introduced, resulting in a structure with self-embedding or "mutual recursion" in some accounts. The core forms of self-embedding in grammar are expressed through IR because they entail interpretive dependencies. An interesting case for the present discussion is DP-PP recursion (6), where PPs are introduced within DPs, creating a loop:

(6) Indirect Recursion
$DP \rightarrow D\ NP$
$NP \rightarrow N\ PP$
$PP \rightarrow P\ DP$

This can produce forms like (7) (marking the maximal projections: DP, NP, PP):

(7) a. The jar on the shelf in the closet in the kitchen
b. $[_{DP}$ the $[_{NP}$ jar $[_{PP}$ on $[_{DP}$ the $[_{NP}$ shelf $[_{PP}$ in $[_{DP}$ the $[_{NP}$ closet $[_{PP}$ in $[_{DP}$ the $[_{NP}$ kitchen]]]]]]]]]]]

In (7), we have a cascade of referential DPs containing a NP with a PP specifying the reference of the DP. This means that the DP *the jar* is defined by the

[6] See Arsenijević and Hinzen (2012) for a characterization of direct recursion as a marginal form.

[7] A reviewer pointed out that our presentation has some simplifications. The semantic composition of coordination can be quite complex and can plausibly lead to the presence of intermediate categories and interpretive relations involving implicatures (i) and binding (ii)–(iii). Although this is an important observation, these cases might constitute relevant forms of IR, as the reviewer suggests. More complex theories of coordination are discussed in Munn (1993) and Koster (2000).
(i) She got pregnant and got married → interpreted as "and then"
(ii) John told Bill to invite himself and Mary → himself, interpreted as Bill
(iii) John told Bill to invite Mary and himself → himself = John (or perhaps Bill)

PP *on the shelf*, and *the shelf* is defined by the PP *in the closet*, which is further defined by the PP *in the kitchen*. The significant fact here is, ultimately, the complex way in which recursion controls reference or interpretation dependencies. Pérez-Leroux et al. (this volume) provide discussion of the syntax/semantics interface entailed by this type of structure.

A third form of recursion involves linked or "stacked" PPs or relative clauses and has been called feature-sharing by Chomsky (2013). Roeper and Oseki (this volume) call it DUR because it is formed in accordance with the rules in (6), in which a category PP emerges from merging a PP with a *PP, but the result involves referential dependencies and structural domination. This is best illustrated through VP recursion (notation adapted from traditional Kleene* system):

(8) Direct Structured Recursion:
VP → V DP (PP*)
PP* → PP (PP*)
PP → P DP

It is evident in cases of phrases describing motion following a path:

(9) a. The ball rolled down the stairs into the street into the gutter into a hole
b. Stand the chair up in the living room in the corner on the small rug

It can also generate examples like (10) with order opposite to (7):

(10) Put the jar <u>in</u> the kitchen <u>in</u> the closet <u>on</u> the shelf

Notably these forms allow wh-extraction, which requires c-command:

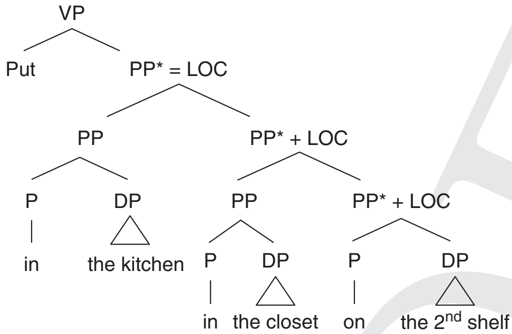
(11) a. Where did you say you put the jar in the kitchen in the closet?
→ On the second shelf

(10) and (11) involve a series of locative interpretations dependent upon each other, and is, therefore, not conjunctive, as it would be for (12), where conjunction would allow multiple jars to be placed:

(12) Put a jar in the kitchen <u>and</u> in the closet <u>and</u> on the shelf

Therefore, DUR behaves syntactically and semantically differently from DSR, as in (13):

(13) Direct Structured Recursion through linked PPs:



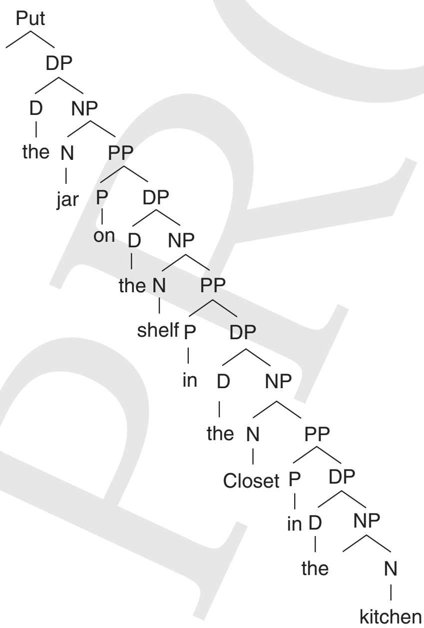

The PP* shares the [+LOC feature] and represents one argument of the verb ‘put.’ It also reflects the direction of motion and the fact that a single action of putting is usually entailed. That is, one does not first put the jar in the kitchen, then move it into the closet, and then move it onto the second shelf.

IR through DP, however, is the more common form:

(14) Indirect Recursion through DP:
$[_{DP}\ [_{PP}\ [_{DP}\ [_{PP}\ [_{DP}\ [_{PP}]]]]]]$

Or a more fully expanded DP:

(15) $[_{DP}\ [_{NP}\ [_{\mathbf{PP}}\ [_{\mathbf{DP}}\ [_{NP}\ [_{PP}\ [DP\ldots]]]]]]]$



Roeper and Oseki (this volume) show very early spontaneous use of PP recursion in language acquisition, which suggests that it is less difficult for a child to recognize it. Maia et al. (this volume) also observe that DUR is a more accessible default form, which does not exclude the presence of Indirect Recursion.

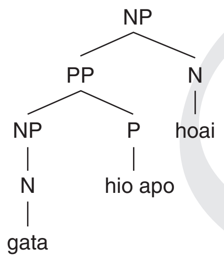
## 3 Pirahã Recursion

Now we have to adjust our structures to account for the left-branching nature of DP-PPs in Pirahã. The structures run the opposite way, but with the same relations:

(16) gata hio apo hoai
*can inward match box*
'The match box is in the can'

Based on the example in (16), where *hio apo* likely represents a complex preposition akin to English *into*, we could represent the internal structure of the DP in (16) as in (17):

(17) Head-final NP constructions in Pirahã

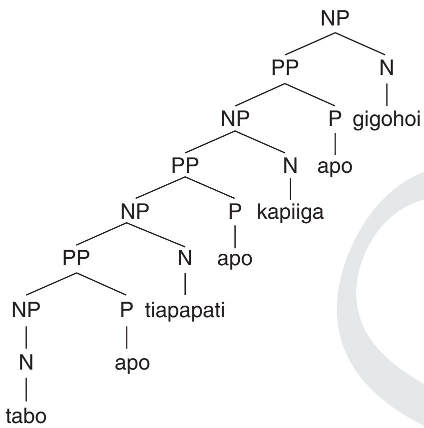



What would happen to the internal structure of the construction if Pirahã accepted multiple PP embedding? The example above suggests that should Pirahã speakers be able to understand multiple embedded PPs under DUR, then sentences like the one in (18) would be preferred over IR, as it is along the acquisition path from DUR to DSR to IR. The left-branching reverses the order: 'coin on paper on chair on board' to 'on board on chair on paper coin':

(18) tabo apo tiapapati apo kapiiga apo gigohoi
*board on chair on paper on coin*
'The coin on the paper on the chair on the board'

Notice that the sentence in (18) allows for a representation following the Indirect Recursion example presented in (15) above for English. The main distinction would be based on the fact that Pirahã is a head-final language, which would give us the structure in (19):

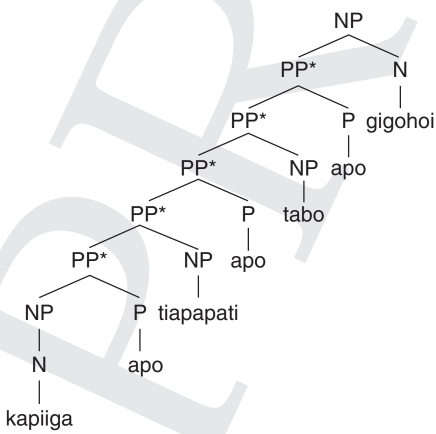
(19) PP Indirect Recursion in Pirahã




This also allows PP DUR with the implied conjunctive 'and.' If PP DSR is available in Pirahã, then speakers would be able to interpret DPs like those in (20), with the structure in (21):

(20) kapiiga apo tiapapati apo tabo apo gigohoi
*paper on chair on board on coin*
'The coin on the board on the chair on the paper'

(21) PP Direct Structured Recursion in Pirahã



We should, therefore, seek all three forms of recursion in Pirahã, although it is conceivable that Indirect (and, consequently, Structured) Recursion might be less evident, since it seems to be rarer among languages in general. Nevertheless, as we shall see, there are indications that they are all present. It might be that Pirahã blocks some forms of IR, as so many languages do. For instance, it is impossible to have recursive possessives in German (of the type, 'John's friend's father's house'), but Franchetto (this volume) and Lima and Kayabi (this volume) find them in Kuikuru and Kaiweiwete, respectively. Pirahã also allows recursive possessive DPs as shown in Salles (2015), who collected data containing three levels of self-embedding within possessive DPs. Can we predict where this type of recursion will be found? It is not obvious where one should look, and in fact any language might have a form of syntactic recursion never seen before. For Pirahã, in addition to sentence recursion, PP recursion is a natural choice to investigate.

Thus far, there are no known criteria for what links recursive structures in a given language, but it is very noticeable that, although English has both left and right-branching recursion, Romance languages with SVO structures appear to favor right-branching, while languages with SOV structure allow more left-branching recursion. The question of whether different forms of recursion are linked typologically and along the acquisition path is the next frontier in this research.

### *3.1 Naturalistic Examples of PP Recursion in Pirahã*

During fieldwork, Sandalo collected examples like (22) that immediately suggest that Pirahã allows recursive PPs. (22) is a description provided by a Pirahã speaker for a scenario in which a pen is placed inside a small paper boat, which is placed inside a bigger paper boat.[8]

(22) kapiiga ko kapiigatoi xihi-aip-aáti kapiiga ko kapiiga
*paper inside pencil store-downward-unexpectedly paper inside paper*
ho-áop-aáti
AUX-*impefective-unexpectedly*
'(You are putting down) pencil inside paper inside paper'

This example contains two verbal forms: a main verb *xihi* 'put' and an auxiliary *ho-áop-aáti*.[9] The main verb root, *xihi*, is inflected by two morphemes: a directional morpheme (downward) and a morpheme indicating 'unexpected.' It is the auxiliary verb that carries inflection related to tense (imperfective), as in other languages: for example, Basque. The presence of only one tense morpheme suggests that there is only one sentence with a postpositional phrase

[8] Sandalo, fieldwork, 1991.
[9] The auxiliary status of *ho* is assured in Everett's (1990) dictionary: "*ho-* stem verb; although it is a stem verb it must always have some other verb occurring with it" (26).

embedded under another. Therefore, with respect to PP recursion, Pirahã might not be different from other Brazilian native languages, for instance Kaingang, which seems to allow PP recursion as well.[10,11]

(23) Kãkénh tá runja kãki lata ki krẽkufár vyn kỹ pó ki
*canoe on bucket inside can in fish grab thn rock in*
krẽkufár rẽ fi
*fish near put*
'Grab the fish in a can inside a bucket in the canoe then put (it) near the fish in the rock'

One might imagine that examples like (23) are not spontaneously found in Pirahã, as this type of complex sentence may overload the parser. Thus, in order to verify the availability of examples like this in Pirahã, we ran two experimental pilot studies. Two monolingual native speakers of Pirahã were tested: Iapohen Pirahã, who is about 40 years old, and Iaoá Pirahã, who is about 20 years old.[12] These two speakers participated in our research in two different venues: in July 2012 at the University of Campinas/Brazil and in August 2013 at the Federal University of Rio de Janeiro/Brazil.[13] Given the small amount of speakers we had access to and the fact that we did not have a controlled experimental set-up, our experiments should be understood as pilot studies.

In these experimental pilots, we worked with picture description (experiment 1) and acting-out routines (experiment 2).

### *3.2 Pilot Study 1: Teasing Direct and Indirect Recursion Apart*

*Method: Participants, Materials, and Design* Iaoá and Yapohen Pirahã, our participants, are native speakers of Pirahã with no apparent knowledge of Portuguese. They were exposed to a series of six pictures, like the ones shown in Figure 15.1, and after hearing a sentence in Pirahã (pronounced by one of the experimenters) they were expected to point towards the picture that best fit the description provided in the sentence.[14]

[10] Kaingang is a Je family language spoken in southern Brazil. Nascimento and Maia (2014) presented an oral sentence/picture experiment demonstrating the existence of PP self-embedding in Kaingang.

[11] Data from Marcia Nascimento Kaingang (personal communication).

[12] Augusto Diarroi, who is not a native speaker of Pirahã, but has some knowledge of it, helped us whenever interventions were necessary.

[13] Iapohen was our participant in 2012, and Iaoá in 2013. It is important to mention that, in spite of the different ages of the study participants, the same study conducted twice with different participants at different times had the same results. Here we report Iaoá's data.

[14] Iaoá was exposed to three different situations (three sets of pictures). Here for space reasons, we will illustrate our discussion with the pictures in Figure 15.1 only. The experiment involving Figure 15.1 was also done with Iapohen Pirahã. The same results were obtained, independently of the speaker tested and the situations used.

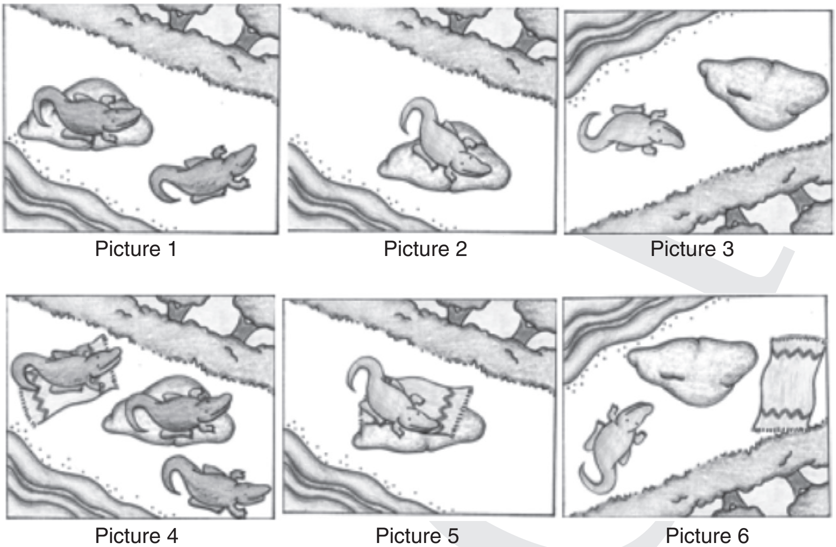



Figure 15.1 Pictures in pilot study 1

Pictures 1 to 6 in Figure 15.1 were borrowed from Maia (2012) and Maia et al. (this volume) and were crucial to this experiment, as they visually describe the following grammatical possibilities:

I. No recursivity or coordination of PPs (pictures 3 and 4)
alligator on the beach on the stone =/=> not on stone on the beach (picture 3)
=/=> not on stone and beach

II. Coordination of two PPs (picture 1)
alligator on stone on beach => alligator on stone *and* on the beach

III. Coordination of three PPs (picture 4)
alligator on blanket on stone on beach => on blanket and on a stone and on a beach

IV. Recursivity of two PPs (picture 2) (pictures 1, 2, 4, 5)
alligator on stone on beach = alligator is on the stone that is on the beach

V. Recursivity of three PPs (picture 5)
alligator on blanket on stone on beach = alligator that is on the blanket that is on the stone that is on the beach

We started the procedure with lexical elicitations. Each of the objects composing the pictures in Figure 15.1 was first introduced to the speakers, and the corresponding lexical items were elicited. Then, we pointed to each picture and asked the speaker to describe it for us. Note that it was mandatory for this study that a picture representing direct and IR (e.g., pictures 5 and 6) be shown together in contrast to highlight a minimal pair.

Through controlled elicitations, we collected the following target sentences where *apo* 'on' re-appeared with reference to recursive pictures.

(24) a. koxoahai bege apo xaxai apo
*alligator floor on stone on*
b. koxoahai bege apo xaxai apo tahoasi apo
*alligator floor on stone on mat on*

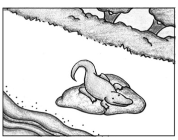
The second part of our procedure was an interpretation task, which reversed the tasks done in the first procedure. The experimenter pronounced out loud each one of the elicited sentences to the participant, and asked him to show the situation (a picture in Figure 15.1) described by the sentences he heard. This was done sentence by sentence, situation by situation, and the trials were randomly ordered in order to prevent saturation.

If the participant treated the target sentences in (24) as involving conjoined PPs, then he was expected to point towards picture 1 or 4. If, however, the prepositional phrases were treated as a case of self-embedding, then the participant should point towards either picture 2 or 5.

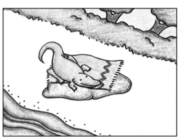
### *3.3 Results and Discussion*

The results of this first experiment suggest that Pirahã speakers are able to process, comprehend, and differentiate ambiguous prepositional phrases. The speaker consistently paired the target sentences with the recursive pictures, as shown in the following:

*Paired picture* *Target sentence*

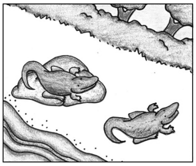
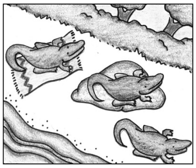


(24a) koxoahai bege apo xaxai apo
*alligator floor on stone on*
'Alligator on the stone on the floor'



(24b) koxoahai bege apo xaxai apo tahoasi apo
*alligator floor on stone on mat on*
'Alligator on the mat on the stone on the floor'

To describe pictures with coordination, the speaker modified the target sentences, introducing an additional word, *piai*, a coordinative particle translated as ‘also’ by Everett (1990).[15]

| *Paired picture* | | *Target sentence* |
| --- | --- | --- |
|  | (24a’) | koxoahai bege apo xaxai apo piai<br>*alligator floor on stone on also*<br>‘Alligator on the floor (and) on the stone also’ |
|  | (24b’) | koxoahai bege apo xaxai apo (piai) tahoasi apo piai<br>*alligator floor on stone on also mat on also*<br>‘Alligator on the floor, on the stone, (and) on the mat also’ |

These results clearly show that Pirahã speakers are capable of teasing coordination and recursion apart. It suggests that the target sentences, (24a) and (24b), might not even be ambiguous. If they are, however, the results presented here indicate that: (a) a recursive structure (IR) is available for these sentences; (b) speakers have a preference for treating (24a) and (24b) as containing IR PPs; and (c) the ambiguity is resolved by inserting an overt conjunction, reinforcing a coordinative reading.

In formal terms, we conclude, thus, that Pirahã, similar to English, Portuguese and many other known languages, has both DUR (Direct) and IR.

### *3.4 Pilot Study 2: Spotting Indirect Recursion*

*Methods: Participants, Materials, and Design* This test followed test 1. Iaoá was our only participant. The test consisted of an acting-out game, with the participation of two players. The player in charge would give commands that

[15] “pí(x)ái conjunction. Free form. And, to join or add, also” (Everett 1990:57).

Figure 15.2 A scene from pilot study 2 in which the experimenter gives commands to the participant

the other had to execute. The picture (Figure 15.2) shows one of the scenarios involved in the activity. Two chairs were placed on the floor, one above a wooden board. There were two cups, one placed on the wooden board, and the other placed on the chair, which was placed on the wooden board.

As in the first test, we started with lexical elicitations. Each of the objects composing the scene above was first introduced to the speakers, and the correspondent lexical items were elicited. Then we executed actions of putting coins in/on different objects present in the scene. This procedure allowed us to elicit target sentences, such as (25), which describes a scene in which a coin is placed inside the cup on top of the wooden board to the left and another coin is placed on the blue chair to the right, and (26), which describes a scene in which a coin is placed inside the cup on the chair on the wooden board.[16]

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (25) | ihiaipati | gigohoi | kopo | ko | tiapapati | apo | piai |
| | *put* | *coin* | *cup* | *in* | *chair* | *on* | *also* |

| | | | | | | |
|---|---|---|---|---|---|---|
| (26) | ihiaipati | gigohoi | kopo | ko | tiapapati | apo |
| | *put* | *coin* | *cup* | *in* | *chair* | *on* |

[16] Note that these sentences were given in the imperative/command form and there was a pause between the verb and the elaborated object, so, in English: put: # DP. The imperative form in Pirahã can be identified by the suffix *–ati*.

Once the participant felt comfortable with the game, we changed the scenario to include situations involving three pieces of paper, one sitting on the top of the chair placed on the wooden board, one on the top of the other chair, and another one on the wooden board. This scene allowed us to test the following target sentences:

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| (27) | ihiaipati | gigohoi | kapiiga | apo | tiapapati | apo | (piai) | tabo | apo | piai |
| | *put* | *coin* | *paper* | *on* | *chair* | *on* | *(also)* | *board* | *on* | *also* |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (28) | ihiaipati | gigohoi | kapiiga | apo | tiapapati | apo | tabo | apo |
| | *put* | *coin* | *paper* | *on* | *chair* | *on* | *board* | *on* |

These four target sentences are samples of the following type of structures:

(29) a. Coordination of two PPs (25)
b. Recursivity of two PPs (26)
c. Coordination of three PPs (27)
d. Recursivity of three PPs (28)

In the first part of the game, the experimenter provided the participant with a handful of Brazilian coins, and asked him to put coins in different places. The commands were the target sentences in (25)–(28).

In the second part of the game, the roles of the participants were reversed, and Iaoá became the one in charge. He provided the experimenter with a handful of Brazilian coins and gave him commands about places to put the coins. This procedure allowed us to verify if Pirahã speakers were capable of comprehending and producing structures with multiple levels of PP embedding. Thus, similar to the first experiment, this experiment was originally designed to examine the availability of Direct (Unstructured Recursion) versus Indirect Recursion.

*Results and Discussion* In the first part of the procedure, the speaker had no problem in comprehending and, consequently, executing the commands he heard. Once he understood the game, he was fast in executing all the commands, including those involving two or three embeddings. However, in the second part of the game, when the speaker himself was producing the target sentences, he switched the order of the PPs in the sentence involving recursivity, providing examples like:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (30) | tabo | apo | tiapapati | apo | kapiiga | apo | gigohoi |
| | *board* | *on* | *chair* | *on* | *paper* | *on* | *coin* |

‘The coin on the paper on the chair on the board’
= (put) coin on board on chair on paper = DSR

In (30) the PPs are computed bottom up, which fits the claim that the lower PP nodes share interpretative features with the upper PP nodes, rather than indirectly modifying DPs. This is then spontaneous evidence of DSR. These results corroborate the first experiment: Pirahã grammar allows DUR, DSR, and IR. These spontaneous data suggest that Pirahã may prefer DUR. This type of recursion is arguably easier for them to produce, just as it seems to be for children (see Roeper and Oseki, this volume).

## 4 Conclusion

These pilot studies constitute informal, experimental evidence that Pirahã allows recursive syntactic structures of three types. Once again, the speakers who participated in our pilot studies demonstrated no difficulties in comprehending and producing self-embedding postpositional phrases (IR), in contrast to conjunctive, or paratactic, structures, which Everett claimed were the only available structures.

Although Everett's strong claim (2005, 2012) is not upheld, it had the merit of provoking fruitful discussion on Pirahã grammar and recursion in general. Based partly on data published by Everett and Nevins, Pesetsky, and Rodrigues (2009b) developed an interesting cross-linguistic study, showing that Pirahã is in no way exceptional with respect to recursion.

Their work has now initiated new fieldwork beyond this study, as has the work by Sauerland (this volume) for sentential self-embedding and Rodrigues, Salles, and Sandalo (this volume) for self-embedding VPs in control configurations. Silva (2014), looking at constructions with focus and topicalization, points out that movement is possible out of self-embedding/recursive PPs, in contrast with coordinated PPs. Additionally, Salles (2015) demonstrates clear cases of recursive possessive DPs. The studies here and throughout this book demonstrate that the extension of acquisition experimentation to fieldwork is quite straightforward. It has created a new vista of possibilities for experimental fieldwork.

As such, support for UG has emerged from fieldwork with isolated indigenous languages. With such compelling support, we maintain that the same type of complex grammatical phenomena and formal constraints upon them are found in all known languages in the world.

# 16 Strong Continuity and Children's Development of DP Recursion

*Ana T. Pérez-Leroux, Anny Castilla-Earls, Susana Béjar, Diane Massam, and Tyler Peterson*

Does children's capacity to represent, process, and produce complex structures change during development? Are some configurations more complex for children? These questions involve three, interrelated dimensions: (i) the question of structural complexity, (ii) referential complexity, and (iii) the continuity or discontinuity in children's language abilities.

Is there continuity in the types of operations available to children to articulate complex phrasal structure? Do children initially favor paratactic associations over embedding? If so, why? Some propose that there are dual mechanisms for combining constituents: merge, which yields hierarchically headed structures, and concatenation, which does not. According to Cowart and McDaniel (2012), coordination is an evolutionary predecessor of merge and falls outside of the X-bar schema. In Hornstein (2009), merge is the simultaneous incorporation of concatenation and labeling. Within the child language literature, Lebeaux (1988) proposed that children start with a high-attachment rule (conjoin alpha), which is eventually bled by an adjunction rule. Givón (2009) proposes that complexity proceeds by synthesis. Structures that are initially linked by parataxis eventually integrate into larger, more complex structures.

Referential complexity is a separate dimension. Processing studies show that children process prepositional phrases (PPs) in temporarily ambiguous structures, such as *put the frog on the napkin in the box*, with a preference for high attachment (i.e., less embedded) interpretations. Children and adults initially misanalyze the PP as a goal argument, but only children persist in this misanalysis, ignoring additional contextual cues that block the garden-path effect in adults. According to Trueswell et al. (1999), children's inability to revise garden-path sentences stems from their limited capacity to integrate referential, lexical, and structural cues during sentence processing.

These issues touch on the traditional problem of continuity versus maturation in acquisition. The continuity hypothesis holds that children's language contains the same categories and processes that are present in adult grammars. Under this view, children's grammars only differ from those of adults in the same way that adult grammars differ from one language to another. In contrast, maturational approaches hold that certain categories or processes mature during the course of development. We propose to explore the continuity approach in the domain of NP recursion, understood in the narrower linguistic sense of iterative self-embedding of phrasal categories.

This chapter aims to investigate whether children have a special difficulty with embedding, specifically with recursive embedding of PP modifiers. We present a study of children's and adults' production of complex determiner phrases (DPs) of two types. One is the result of recursive PP modification, as in (1), and the other consists of sequentially modified PPs, which do not add further structural depth, as in (2).

(1) [The bird [on the alligator [in the water]]]

(2) [The plate [with oranges] [under the table]]

Through this comparison of double and simple embedding, we simultaneously explore whether children's structural representations of complex DPs are continuous to adults and whether children have a bias towards less embedded representations.

## 1 Simplicity and Complexity in Children's Language

Children's early utterances lack complexity (Brown and Hanlon 1970; Brown 1973; among others.). Much of the process of development can be described as growth of complexity, and much of it might be due to growth of processing capacities (Bloom 1990). Complexity itself, however, has not been given a coherent definition in acquisition. It has been operationalized in terms of mean length of utterance (MLU), subordination, or diversity of grammatical markers and constructions in children's sentences. All of these phenomena correlate with complexity but are distinct from it. Alternatively, complexity has been described in terms of derivations and locality conditions (Friedmann, Belletti, and Rizzi 2009; Friedmann and Costa 2010; Jakubowicz 2011).

Utterance length provides a limited perspective on the development of complexity in child language. Modified NPs can illustrate precisely why this is so. At the age of five, most children have MLUs that roughly approximate those of adults (Brown 1973); yet, their spontaneous and elicited speech seems to lack NP modification. Complex NPs in child language have low productivity. Until the age of five, NPs consist mostly of single, unmodified nouns. PPs and adjectives are commonly produced, but rarely in NP-internal position. Eisenberg et al.'s (2008) analysis of narrative samples shows that less than 60 percent of English-speaking 5 year olds produce any nouns modified by a PP (e.g., *aliens with legs*). NP-internal adjectives (e.g., *the yellow ball*) are more common (around 80 percent of children). Double adjectival modification (e.g., *big yellow thing*) is not (25 percent of 5 year olds). Full productivity with nominal modification is achieved in the school years. According to Eisenberg et al., 11 is the age when most children are able to use PP modifiers and double adjectival modifiers in elicited narratives. Recursive PP modifiers such as those targeted in this study are altogether absent.

This observation cannot be explained in terms of functional development. Possession (sister > *Elmo's sister*) and modification (dog > *big dog*) are among the earliest semantic primitives identifiable in children's speech (Bloom, Lightbown, and Hood 1975). The grammatical connectors (such as genitive *'s* and prepositions) are learned early in many languages (Brown 1973; Hernández Pina 1984; Aguado 2000; Eisenbeiss 2000), but there is a lag between their first uses and their use as NP-internal modifiers. It seems unlikely that 5-year-old children do not understand the grammatical function of modification. NP modification is a response to specific referential demands. Young speakers are sensitive to context when deciding to produce modification. Nadig and Sedivy (2002) found that 5 year olds produced adjectives (*the small glass*) only when a referential competitor was present in the context (for instance, *a large glass*). Children also demonstrated their ability to use adjectives according to the referential perspective of their conversation partners.

There are various accounts of how structural complexity develops in children, mostly focused on the acquisition of sentence subordination. Diessel and Tomasello (2001) and Diessel (2004) argue that structural complexity grows through expansion. From a usage-based perspective, these authors propose that in children's early subordinates (such as *I think my Daddy took it* (Sarah 3;07), *I bet I can* (Sarah 3;09)), the main verb acts as an epistemic or deontic marker for the second proposition. Under this view, early subordinates are not considered biclausal. Later, children learn that matrix and embedded verbs belong in separate clauses. Thus, development from a monoclausal to a biclausal structure proceeds through analysis. Other perspectives focus on children's use of appositive sequences in lieu of sentences with more complex structure. Children are known to produce unintegrated clauses linked by a coordinating use of the complementizer, in lieu of object relatives, as in (3).

(3) a. The cat washed the dog that the dog pushed the elephant.
    b. The dog that the cat washed pushed the elephant. (Ferreiro et al. 1976)

Under the alternative accounts, development proceeds by synthesis, i.e., by the grammatical integration of paratactic configurations over time (Abbedduto and Rosenberg 1985; Lebeaux 1988; Givón 2009).

Examining the same data as Diessel and Tomasello (2001), Givón (2009) reached the opposite conclusion. In his account, the first step in syntactic development is for single words to combine by fusion into simple clauses. Next, simple clauses combine into clausal chains, linked paratactically. Finally, clausal chains become proper embedded clauses, which are hypotactically linked. This proposal is not that different from work by Lebeaux (1988, 2000), within the generative framework, identifying parataxis as a precursor to embedding. Lebeaux proposed that at some early stages, children's representation of complex clauses does not necessarily involve structural subordination. When their analysis of a complex structure fails, they resort to a default conjunction operation. According to Lebeaux, these two operations (adjoin and conjoin) describe the course of development, as well as the distinction between languages with DP internal relative clauses and languages where relatives are peripheral to the main clause, as in the Hindi correlative construction.

The emergent literature on recursion in children suggests that depth of embedding is constrained. According to Roeper and Snyder (2005), children do not use recursive NPs in spontaneous interactions or understand them in parental speech. Comprehension experiments confirm this for a range of recursive structures, including locatives (*Up on the shelf in the closet in the kitchen*), compounds (*Christmas tree cookie*), and possessives (Roeper 2011; Limbach and Adone 2010; Amaral and Leandro 2013). In one sense, it is natural that children have to learn the recursive step, given that languages vary as to which categories iterate (Roeper and Snyder 2005). A language can have a form of embedding while blocking further self-embedding of that category. For instance, German has a possessive marker that is historically related to the English Saxon genitive. The English case is recursive (*John's friend's father's hat*), but the German is not (*Marias Haus*, **Marias nachbars Haus*; Roeper 2011). Similarly, Spanish noun-noun compounding (*mujer araña* 'spider woman') only happens once (**mujer araña móvil* 'spider woman mobile'). Such variation indicates that, although a fundamental feature in language, recursion must be learned beyond the initial step of acquiring the connectives (Roeper and Snyder 2005; Roeper 2011; Pérez-Leroux et al. 2012). Acquisition evidence such as in Terunuma and Nakato (this volume) supports the idea of recursion as a distinct step in acquisition.

The only production study to date supports available comprehension data. Pérez-Leroux et al. (2012) elicited recursive possessives (4) and PP modifiers (5) in children between the ages of 3 and 5.

(4) Elmo's sister's ball

(5) The baby with the woman with the flowers

Adults used recursive PPs quite frequently, but few children did. One third of the children under 5 could produce the first level of NP embedding. Second-level embedding appeared after 5, with only 43 percent of children at that age producing them. Children often understood the referential demands of the task, producing elaborate answers that expressed the desired meaning but which lacked recursive syntax (*This baby*, *look*, *the mother got flowers*). Coordinate structures, however, were easy to produce even for the youngest children.

## 2 The Question of Performance: PP Attachment Ambiguities, Processing, and Children

Understanding embedding problems in children can make use of a body of work on children's comprehension of temporarily ambiguous PP structures. Children fail to reanalyze garden-path sentences such as (6) (Trueswell et al. 1999), but have less difficulty with their unambiguous counterparts, as in (7):

(6) Put the frog on the napkin in the box.

(7) Put the frog that is on the napkin in the box.

Sentences such as (6) are temporarily ambiguous. At the moment in which listeners hear the first PP (*on the napkin*), they might treat it as the goal of the motion verb *put*. As the sentence progresses and the second PP (*in the box*) is heard, adult listeners realize that the first PP is in fact a modifier within the direct object NP (*the frog on the napkin*). Children behave unlike adults both in explicit action (which object they reached to move), and in their patterns of looking preferences to one referent or the other. With temporarily ambiguous sentences, looking preference data suggest that children maintain the high attachment of the initial locative PP as goal argument to the ditransitive verb *put*, and fail to correct this interpretation. The presence of a second frog in the context allows adults to treat the first PP as a modifier and converge faster on the target frog. It makes no difference for children, who continue to assign a goal interpretation to the first PP. Furthermore, children persevere in this initial incorrect parsing to the extent that in 60 percent of the trials they actually ignore the second PP and go on to perform the action of moving the frog to the napkin.

Trueswell et al. (1999) interpret the data within a constraint satisfaction framework. They propose that children's parsing problems relate to their inability to coordinate lexical and contextual cues. They reject the possibility that children's performance could be based on structural economy strategies such as the Principle of Minimal Attachment (Clifton, Speer, and Abney 1991). Subsequent work has pointed out that these effects can result from either minimal attachment or early overreliance on lexical cues (the ditransitivity of *put*). To disambiguate the two possibilities, Snedeker and Trueswell (2004) subsequently studied how lexical verb bias affected PP attachment.

(8) a. Choose the cow with the stick. (Modifier Bias)
b. Feel the frog with the feather. (Equipollent Bias)
c. Tickle the pig with the fan. (Instrument Bias)

Children remained biased towards instrument (high-attachment) responses. However, the effect appeared only with instrument-bias and equipollent verbs. In other words, children's high-attachment preference does not override lexical constraints. The high-attachment preference is thus due to ignoring the contribution of the referential context. Snedeker and Trueswell (2004) concluded that children do not show a general preference for high attachment, but over-rely on lexical cues.

Kidd, Stewart, and Serratrice (2009) explored how the structural distance between ambiguity point and target constituent affected children's errors. For this purpose, they combined verbs with high bias for instruments (such as *to cut*), with potential instruments of low plausibility (such as *a candle*):

(9) Cut the cake with a candle.

Adults allowed both interpretations, realizing that *with a candle* could function as either modifier of the cake or as instrument for cutting. Children looked at the plausible instrument at the initial region of the sentence and again at the end. They also followed up with using the final NP as instrument. Kidd, Stewart, and Serratrice (2009) did not consider minimal attachment as a possibility, concluding instead that children favor high attachment because they over-rely on bottom-up, lexical cues for interpretation. They favored a probabilistic parser model, that relies on multiple comprehension cues from the start, while acknowledging that not all cues are present or are as strongly represented at the outset of language development. Snedeker and Trueswell (2004) carefully noted that such theories, unlike general domain theories of cue competition, assume representational modularity. Semantic, syntactic, and phonological information are independently represented, but are available to interact with other sources of information.

Meroni and Crain (2011) objected on the grounds that this violates continuity. They proposed that children are sensitive to the same referential and thematic constraints that guide adult parsing, but are unable to revise an analysis once started. Because children's responses are less automatic than adults', due to their lesser verbal memory capacities, they tend to act out parts of the analyses generated before all planning is complete (see McDaniel, McKee, and Garrett 2010). Meroni and Crain's experiments demonstrated that as long as children are forced to process the entire sentence before acting, they can treat the first PP as modifier.

## 3 Articulating the Challenge of Recursion: Acquisition, Processing, and Theory

The previous section suggests that children can acquire different components of a grammatical system without putting their full power to use. By the age of four, children have a strong grasp of syntax, including the ability to use a variety of pre- and post-nominal modifiers, and to produce multi-clausal sentences. However, at that age, children still process complex structures differently from adults (Snedeker and Trueswell 2004). The processing evidence has been attributed to differences in the ability to integrate various sources of knowledge. However, it is still the case that, beyond the lexical facts, children produce more high-attachment responses overall. This is compatible with the view that children have a minimal attachment bias and that such bias is driven by processing economy. Within the range of possibilities given by lexical constraints, children consistently choose VP attachment at rates higher than adults. Both perspectives fit well with the general view that resource limitations shape children's language processing.

We now summarize the three observations about children's grammar and processing of complex nominal structures:

1. complex nominals are rarer in children's speech than they perhaps ought to be;
2. children prefer less embedding, when it comes to PP attachment, within the range of possibilities allowed;
3. children seldom produce recursively embedded possessives or modifiers, and have substantive difficulty comprehending them.

Recursive structures appear to present a specific learning problem for children. Before discussing the implications of this, let us clarify the concept of recursion. Watumull et al. (2014) critiqued the common misunderstanding that equates linguistic recursion with embedding, or particular forms of it (Levinson 2013). Recursion depends on properties of the formal system (computability, definition by induction, mathematical induction), not on properties of the actual strings of language it outputs. In their words:

> Recursiveness is a property of the procedure applicable to any input rather than a property of potential output, equating recursion with syntactic embedding is simply a fallacy. (Watumull et al. 2014:5)

Any language, insofar as it is not a list of utterances, is generative, and arises as the result of recursive procedures. Whether the utterances it generates contain actual embedded or recursively embedded sentences is beside the point. Recursion is a property of the intensional system, not of the e-language extensions.

In this broad conception, recursion refers simply to the fundamental operation of asymmetric merge. Children possess this form of recursion from the onset of word combinations. Children unfailingly map utterances into hierarchical structure as soon as they can produce multiword utterances. This ability is the gift of the language faculty. While there is a position within the developmental field that explicitly argues against generativity in the earliest utterances produced by children (Tomasello 2000; Ambridge, Pine, and Lieven 2013), the argument against productivity has not withstood the empirical tests (Valian 2009; Yang 2010, 2013; Ninio 2011). Hunsicker and Goldin-Meadow (2012) documented evidence that deaf children without access to sign language develop hierarchical nominal constituents in their home sign systems. Endocentric NPs appear in the language created by these children in the absence of a conventional language model.

There is also a narrower notion of recursion as iterative self-embedding of phrasal categories, such as a DP within a DP, or a CP within a CP (Arsenijević and Hinzen 2012). In this narrow sense, we have seen that recursion is both a locus of language variation and a specific challenge in acquisition (Roeper 2011; Pérez-Leroux et al. 2012). Roeper and Pérez-Leroux et al. pointed out that since all human languages have hierarchical, asymmetrical concatenated structures, one would expect continuous access to this fundamental property. Therefore, it should be easy for children to acquire recursive embedding, but it is not. Why is that?

Herein lies the relevance of the processing data. The parsing system, although highly sensitive to lexical demands, shows a bias against embedding. When thematic constraints are pitted against referential contrast, children first satisfy the thematic constraints.This is in accordance with the prediction of minimal attachment, which attributes more complexity to embedded adjunct PPs than to argumental PPs. Probabilistic input also goes against low attachment. Recursive modification, such as elicited in Pérez-Leroux et al. (2012), is rather rare. It is only used in contexts where a speaker must disambiguate from multiple competing referents. To illustrate, we turn to (10) and (11), where the initial head noun *baby* is followed by two prepositional modifiers.

(10) The baby with a lollipop with his mother

(11) The baby with a woman with the flowers

Such sentences will be produced only when speakers need to distinguish between babies in two ways: one, on whether they are paired with women, and two, on the basis of an additional property applicable to either baby or woman. Neither property can uniquely identify the given baby. In (10), there might be babies that have lollipops but are not with their mothers. In (11), it could be that there are two babies held by women, but only one of the women is holding flowers. The amount of information to be coordinated is substantial. It is not surprising that children can produce three coordinated NPs, which are both common and semantically simple, but fail to produce recursively modified NPs. If we want to evaluate the challenge of embedding, we need to compare recursive embedding with non-recursive double modification, i.e., on the contrast between (10) and (11). In (10), each modifier independently restricts the head noun. We describe these cases as two instances of level 1 modification. In principle, (11) has two interpretations, but we focus here on the one where it is the mother who is carrying the flowers, which is an instance of recursive modification, wherein the nominal under the first PP is itself restricted by a second PP modifier, presumably requiring more complex coordination of information. By comparing these two types of complex nominal, we isolate the question of children's embedding preferences from that of the competition between lexical constraints and referential constraints.

## 4 Study

### *4.1 Methods and procedure*

We designed an elicited production study to test whether children differentiate between recursive and non-recursive double modification, as in (1) and (2). In principle, since both of these targets involve two modifiers, they should represent comparable degrees of difficulty for children and adults. Alternatively, if embedding, in and of itself, introduces complexity, we predict an asymmetry in the productivity of the two types. If the tendency to avoid embedding is related to planning capacities, we also predict that working memory might be part of the asymmetry. Last, we examine whether the effect of recursive embedding is comparable in children and adults. These hypotheses can be summarized as follows:

**Null Hypothesis:** No difference in the frequency of complex modification in contexts where successful reference requires recursive and non-recursive double modification

**Alternative Hypothesis:** Asymmetry in productivity of recursive and non-recursive doubly modified DPs.

**Performance Hypothesis:** Working memory plays a role in the difficulty presented by embedding.

**Continuity Hypothesis:** If children have access to the same processes and mechanisms as adults, they should treat doubly modified NPs in an analogous manner.

We employed a referential elicitation task similar to the one in Pérez-Leroux et al. (2012). A visual context with multiple referential competitors is arranged so an adequate description of the target referent required two different modifier PPs in order to uniquely refer to the target. Examples are given in (12) and (13).

(12)

**Recursive condition.** This little worm is afraid of the birds. The birds are afraid of the two crocodiles. One of the crocodiles is in the water; one is on land. But look, somebody caught the worm! Which bird got the worm?
Target: [The bird [on the alligator [in the water]]]

(13)

**Non-recursive condition**. Mary had many oranges, so she puts them on different plates. Somebody threw a rock in the kitchen and broke one of the plates. Look! Which plate got broken?
Target: [The plate [under the table] [with the oranges] ]

These phrases are surface-ambiguous. The context alone determines the underlying structure. In (12), the bird itself is not in the water; just the alligator is. The speaker must specify which bird got the worm, since another bird also stands on another alligator, crucially standing outside the pond. Similarly, in (13), the visual context shows that the plate has oranges and the table does not, and the other plate with oranges differs from the target in terms of location: it is not under the table.

### *4.2 Participants*

Fifty monolingual English-speaking children and thirteen adults from Western New York participated in the study (N=50). Ages of the children ranged between 4;00 and 5;11. In addition to the recursion elicitation task, children were administered two standardized language tests (CELF Preschool 2, PPVT-IV), a standard non-word repetition task (Dollaghan and Campbell 1998), and the Non-Verbal Scale of the Kaufman Assessment Battery for Children Second Edition (KABC-II; Kaufman and Kaufman, 2004). These children had no history of language disorders, and their overall language and cognitive development was within the normal range.

### *4.3 Coding*

Responses were classified according to depth of embedding in the NP produced (level 2 embedding > level 1 embedding > single NP), as in Pérez-Leroux et al. (2012). We additionally coded the structures in terms of referential success, as summarized in Figure 16.1. This coding system determined whether (i) the target referent was successfully described (by whatever means);

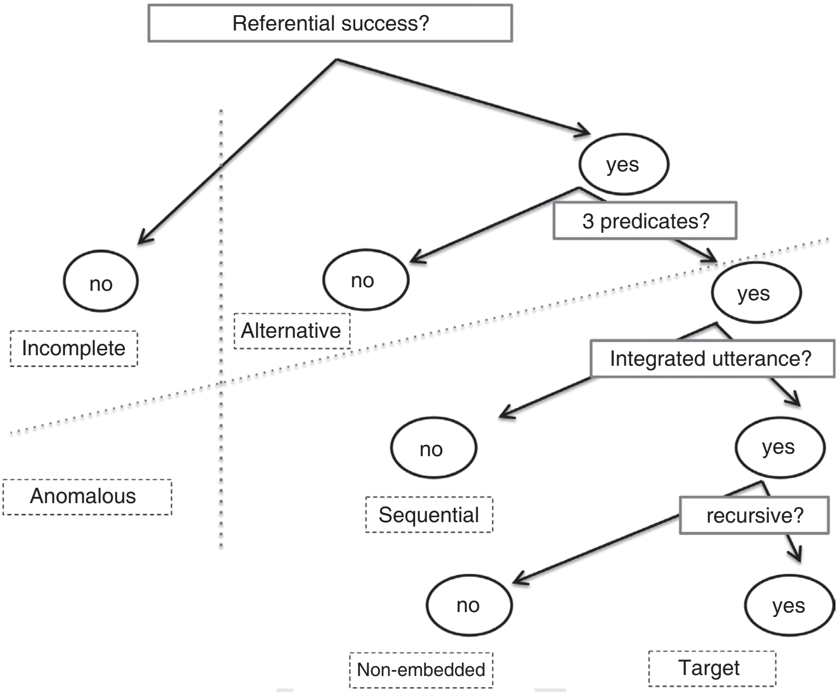



Figure 16.1 Decision tree for referential coding of responses

(ii) the description included the target semantic predicates; (iii) the description was descriptively incomplete or complete (i.e., it made reference to three contrasting referents, i.e., alligator, bird, water); or (iv) the description was integrated syntactically as a complex NP, which provides the most felicitous and economical response to the question presented by the experimenter.

Children gave responses where they were able to uniquely identify the target referent, while failing to embed the modifiers into a single complex NP. Such cases of referential success with syntactic failure include various strategies, including coordination and distribution of the modifiers in different clausal constituents.

(14) Target: The worm in an apple on the plate
Response: The worm inside the apple and the apple is on the plate and the worm is green. (DA, 5;10)

(15) Target: The worm in an apple on the plate
Response: The worm that's in an apple and on the plate. (IR, 5;08)

(16) Target: The toothbrush in the cup on the shelf
Response: The big toothbrush is in the cup on the shelf. (MD, adult)

(17) Target: The bird on the crocodile in the water
Response: The birds that's on top of the crocodiles the crocodiles that's in water. (AL4, 5;04)

Note that only the target complex NP constitutes a proper answer. Cases that approach referential success, while lacking the target syntax, remain suboptimal. A clausal response such as (16) does not address the question under discussion, about which toothbrush is the largest. Such clausal responses (which effectively eliminate recursive embedding) provide truthful but infelicitous responses.

For the non-recursive condition, reordering the modifiers has no effect, but it degrades a response to the target condition. Responses such as (18) and (19) are not quite right, since one of the other toothbrushes is on the surface of the shelf, but the target is not.

(18) Target: The toothbrush in the cup on the shelf.
Response: The toothbrush on the orange shelf in the bowl. (DA9, 5;10)

(19) Target: The toothbrush in the cup on the shelf
Response: A big one on the orange shelf with a little cup. (JS21, 5;04)

Reordering in the recursive NP forces the application of the second modifier to the head noun. The resulting description might now be false: in *The bird in the water on the alligator*, the bird is not in the water; the alligator is. Of course, we can charitably assume that children giving such responses know what they intend to describe but have sentence planning difficulties. These difficulties might range from mild to severe. For instance, the nouns might be part of the structure but not articulated as required, including cases of predicate-argument reversals and various prepositional choices that render the description nonsensical, as in the following examples:

(20) That one [=bird] is in the water and that one is on a crocodile. (JS20, 5;01)

(21) Prompt: Which worm is green?
Target: The worm on the apple in the plate
Response: The one [=apple] that has yellow plate but that has the green um the green worm. (AN, 5;11)

(22) Prompt: Which books are blue?
Target: [The books [inside the (green) box] [under the chair]]
Response: The ones [=books] under the chair that has a green box on them. (PS42, 5;01)
Response: With the blue box on it and it's under the table. (SS, 4;04)

We also observed a pattern of responses that were syntactically quite complex but semantically incomplete. Children produced some responses that incorporated supplementary nominal structure by further specifying the modifier, such as adding a relational noun over one of the modifiers. In (23), the use of *on top of* and *eye* effectively increases the level of embedding of the response. However, lack of mention of the second contrasting modifiers renders the response referentially unsuccessful. Children also produced sentences where the most embedded NPs redundantly made reference to a higher referent, as shown in (24):

(23) The bird on the top of the alligator's eye. (DA, 5;10)

(24) The yellow plate with the apple on it. (LM, 4;09)

Here, the speaker merely introduced two of the nouns (*plate*, *apple*), iterating the reference to the second noun. The result is tautological: if there is an apple on the plate, the plate has an apple on it (see Peterson et al. 2015)

### *4.4 Results*

Table 16.1 presents the overall frequencies of responses, classified according to the referential schema.

Children produced few target responses. Not all the non-target responses were referential errors. However, since our focus is on examining children's ability to articulate complex NPs, we concentrate only on responses that contain the three target nouns. These semantic predicates were introduced in the story, which highlighted them as the source of contrast between referents. We group these as descriptively complete attempts: unembedded, sequential, and target responses. Figure 16.2 groups the various response patterns into incomplete (including incomplete and alternative responses), complete but non-target, and target. The data show that children can produce more descriptively complete responses and more target responses for non-recursive than recursive NPs.

Our next step was to compare overall frequencies of target responses across groups. Adults were far from ceiling. This is not entirely surprising in an open elicitation task, which allows a certain degree of expressive freedom. The majority of non-target responses in the adults were either incomplete, as participants at times failed to notice one of the contrasting referents, or an alternative description (which is not helpful to our comparison but still correct). Figure 16.3 shows that adults produced the target structures much more frequently than children, at about a ratio of four to one. Individually, twelve of the thirteen adults produced the recursive target, while only eighteen out of fifty children were able to do so. Both groups produced target responses

Table 16.1 *Number of responses by group and condition, classified according to the referential schema*

| Coding | Description | Example | Children | | Adults | |
|---|---|---|---|---|---|---|
| | | | Recursive | NonRec | Recursive | NonRec |
| Incomplete | Single NP or level 1 embedding | *The plate*<br>*The bird on the alligator* | 204 | 182 | 25 | 21 |
| Alternative | Appropriate but alternative description that does not include the target modifiers | *The one on the left*<br>*The smallest statue* | 25 | 8 | 13 | 6 |
| Sequential | Sequences of independent NPs that together contain the three target predicates | *The bird on the alligator. The one in the water.* | 32 | 56 | 3 | 3 |
| Unembedded | Referentially complete, single utterance without embedded NP syntax | *The worm inside the apple and the apple is on the plate and the worm is green.* | 15 | 32 | 9 | 25 |
| Target | Specified level 2 or two level 1 N PP PP sequence: These have both target syntax and referential success | *The plate with oranges under the table.*<br>*The bird on the alligator in the water.* | 24 | 22 | 28 | 23 |

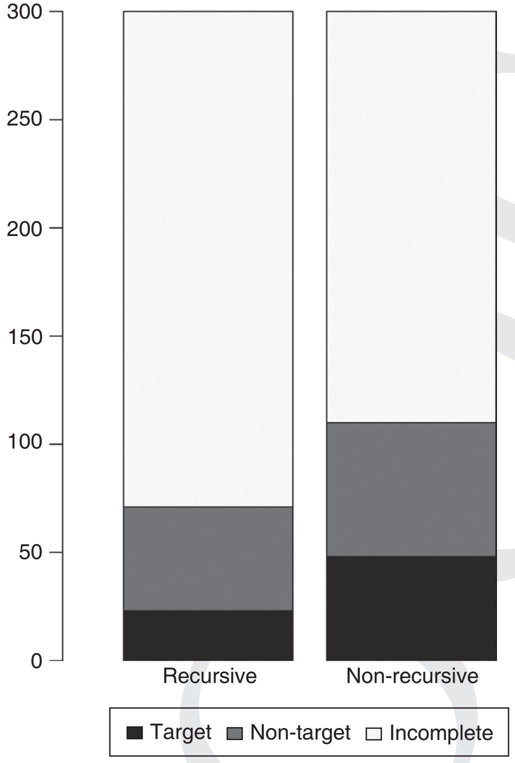



Figure 16.2 Frequency of children's responses classified as descriptively incomplete, descriptively complete but non-target, and target, across conditions

approximately twice as frequently for the non-recursive as for the recursive condition.

Frequencies of target responses were submitted to a logistic regression analysis with group and conditions as fixed effects and participants as a random effect. The results show significant differences in the frequency of target responses across groups ($\beta$=2.21, $Z$=4.56, $p$<.001) and across conditions ($\beta$=1.38, $Z$=3.84, $p$<.001). The lack of interaction ($\beta$=0.45, $Z$=1.00, $p$=.31) shows that the recursive condition was not comparatively harder for the children.

Age was not a strong predictor of target production in children, unlike in other studies, such as Terunuma and Nakato (this volume) and Corrêa et al. (this volume). To investigate the role of phonological working memory, we tested the association between children's scores in the non-word repetition task and the two NP conditions. A partial (Kendall's) correlation controlling for the

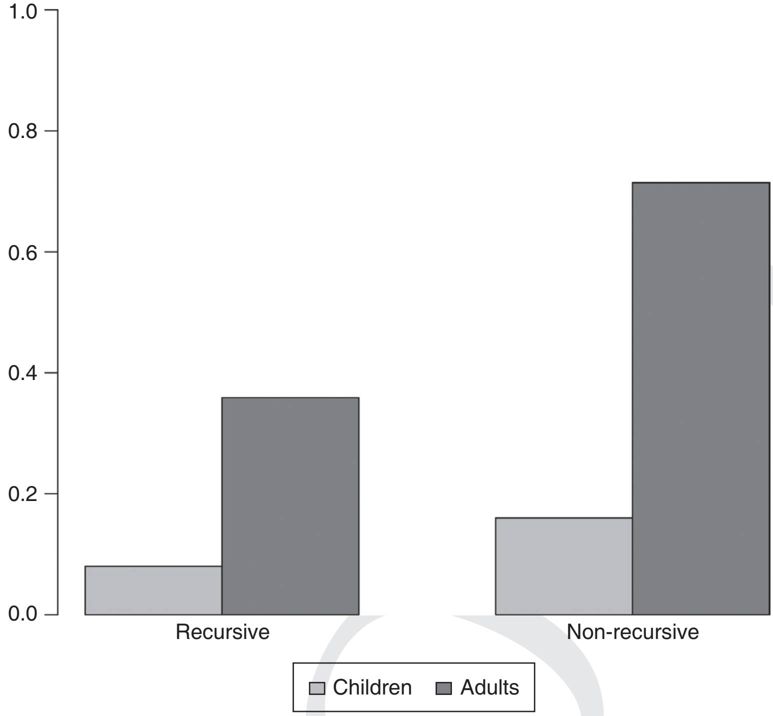



Figure 16.3 Proportion of target responses across children and adults

small but positive effect of age showed no effect of working memory in the non-recursive condition ($\tau$=.07, *p*=.45), but a small but significant correlation of phonological working memory on targets produced in the recursive condition ($\tau$=.20, *p*=.047).

## 5 Discussion

Recursive modification does not require that children learn additional functional vocabulary nor special operations beyond those present at the first level of embedding (*the bird on the alligator*). The semantic ingredients and operations are also the same for first and second level of embedding: the definite determiner; selecting a unique individual that fits the descriptive content of the relevant predicates; the semantic predicates (noun and PPs); and the semantic derivations which include predicate modification. Syntactically, there is no reason why one additional step in recursion should introduce complexity. From a competence perspective, we would predict no differences between level 1 and recursive modification. What about performance factors? The processing literature suggests a possible initial preference for high attachment. One potential explanation for such preference is performance limitations in children.

Our results show that recursive modification is specifically more difficult. Children produced target descriptions twice as often for non-recursive than recursive targets. Surprisingly, so did adults. Thus, the null hypothesis, that there are no differences between types, is rejected. Our data concur with other studies in this volume in showing that the second level of embedding is a distinct acquisition step from the first level (see Hollebrandse, this volume; Terunuma and Nakato, this volume).

How the difference is stated is no trivial matter. Given that the two types of nominal involve the same bits of syntax and semantics, the differences in complexity should be characterized at the interface of the syntax and the semantics. In the non-recursive description, when the highest DP is composed, a fully intersective interpretation is available between all three predicates: *the unique thing that is a plate and is under the table and has oranges.* The truth conditions that show commutativity are given in (25):

(25) The unique *x* such that *x* is a plate and ***x* is under the unique *y*** such that *y* is a table and ***x* is with the unique** *z* such that *z* are oranges [got broken]

The same variable linked to the head noun *plate* and the other two predicates derived from the constituent PPs is accessible to the definite function. In the recursive case, however, there is no simple Boolean intersect that describes the domain to which the definite functionapplies. The phase [*the alligator in the water*] introduces an opaque domain. In the highest NP, the water is not predicated of the bird, just of the alligator; the lower modifier does not relate to the head noun because its variable is closed off when it becomes part of the larger characteristic function λ*u. u* is an alligator and *u* is in the water. Intersection is only possible between the simple predicate λ*u. u* is a bird and the complex predicate λ*u. u* is on an alligator in the water. These truth conditions are given in (26):

(26) The unique *x* such that *x* is a bird and *x* **is on the unique** *y* such that *y* is an alligator and *y* **is in the unique** *z* such that *z* is water [got the worm]

Recursive structures require that speakers, at the moment of composing the higher NP, attend to a referent (*the alligator in the water*) that has become inaccessible in the active derivational workspace. At the point when the active predicates intersect, the lowest predicate is now just part of the descriptive restriction on the characteristic function of the higher predicate. In the terms of Arsenijević and Hinzen (2012), it has become intensionalized. The difference in complexity can be described in terms of the referential demands at the interface.

In other words, recursively modified DPs are challenging because the speaker is required to attend to material embedded in a closed phase. The referential task conflicts with phasal architecture. Referential intention drives the process: the syntactic phases construct a path from referent to referent until the target is identified. This analysis situates the cost at the interface, similar to Corrêa et al.'s (this volume) proposal that computational costs arise from the number of syntactic objects to be processed in parallel derivational spaces. We predicted that if children's avoidance of embedding was related to planning capacities, working memory and the ability to embed would be correlated. In fact, we found the correlations for recursive modification, but not for non-recursive modification.

Maia et al. (this volume) propose a role of learning in processing. Their adult comprehension experiments show an initially higher processing cost for self-embedded PPs. However, embedding becomes less costly with iteration. The N400 amplitudes elicited by PP processing (an indicator of processing difficulty) decrease sharply for the third embedded PP. This is interpreted as progressive facilitation from the processing of the first embedded PP, to the second and to the third. Maia et al. suggest that the algorithm in recursion is costly to launch, but once established, it can be easily redeployed. Their online measurements demonstrate facilitation in processing, whereas the offline measures showed the cumulative effect of referential complexity (in comparison to coordinated structures).

Our findings are not compatible with approaches positing discrete changes in the syntactic representation in the acquisition of the recursive structure. Terunuma and Nakato (this volume) propose a distinct representational shift, where the label assigned to the possessive phrase changes in the grammar of children. The initial non-recursive possessive has a less specified type (MODP) than the recursive target (POSSP). Subsequently, the label content is further refined and the configuration can recur. We believe that the same findings can be accounted for in terms of processing capacities without proposing discontinuous syntax. Because the cost of embedding is comparable for children and adults, our results support continuity approaches.

In sum, we have examined a unified account for the various paratactic trends in the acquisition literature, including the preference for minimal attachment in the processing of PP attachment ambiguities, the modification gap in production and the general difficulty with recursive structures. As we found that the predicted asymmetry is associated with recursive embedding, we conclude that embedding introduces an additional degree of complexity beyond the referential demands of modification. The data reviewed here are naturally more compatible with the *development as synthesis* approach, at least for nominal modification.

# 17 Prosody and Recursion in Kuikuro: DPs versus PPs

*Bruna Franchetto*

Kuikuro is a dialect of the Upper Xingu Carib Language (LKAX), the Xinguan Southern Branch of the Carib family (Meira and Franchetto 2005).[1] It is spoken by around 700 Amerindians in six villages in the southeastern part of the Xingu Indigenous Land, in the north of the State of Mato Grosso, Southern Brazilian Amazonia. LKAX/Kuikuro is an agglutinative, head-final, and ergative language from the point of view of morphosyntactic typology.

Different syntactic recursive strategies are available at the word, phrasal, and sentence levels. Starting from the basic idea that a canonical recursive structure is the embedding of one type of structure inside another of the same type, and that self-embedding poses a more intricate cognitive challenge than either concord or repetition (Roeper 2007), we will focus on the operations available in Kuikuro for the construction of Determiner Phrase (DP) and Postpositional Phrase (PP) recursive structures. In the absence of explicit complementizers, following Slobin (2007), we must consider the potential impact of prosody in detecting recursion in most of the Brazilian indigenous languages. As argued by Mithun (2009) and Sauerland (2010b), prosody and, specifically, prosodic integration, as well as matches and seeming mismatches between intonation contours and syntax, could be the key for the identification of these structures.

Grammatical and prosodic phenomena relevant to the subject in question are synthesized in Section 1, concentrating on the relationship between heads and their (absolutive) internal arguments. Sections 2 and 3 deal with recursive structures of DP and PP, respectively. We will see that DP and PP recursion cannot be reduced to one (or the same) phenomenon. On one side, DP recursive structures are easy to produce, with a potentially unlimited number of

[1] I acknowledge all those whose contribution to the development of the investigation on Kuikuro recursive constructions has been crucial: Mara Santos for our longstanding partnership in the study of Kuikuro language; Mutua and Jamalui Mehinaku for their essential role as consultants and native linguists. Mara, Mutua, and Jamalui should be considered co-authors of this text. I acknowledge Andrew Nevins and Rafael Nonato for their insightful suggestions and the acoustic analysis of the prosodic patterns, and Andrés Salanova as well as Cilene Rodrigues for the discussion of Kuikuro data and the initial approaches to Kuikuro recursive structures.

embeddings. Recursive constructions with kinship terms, inherently inalienable nouns, are the outputs of complex calculations of kinship relations, a common and daily exercise for any member of a traditional and small-scale society. In Kuikuro, at least, alienable nouns do not behave differently regarding the possibility of virtual unlimited recursion.

At the same time, it must be said that our study is for now limited to complex PPs denoting exclusively spatial relationships between objects in contact. In this domain, PP recursion is only partially analogous to DP recursion and it seems that cognitive constraints are at work. Recursive PP structures with more than one embedding are not easy to produce: trained Kuikuro consultants usually produce sequences, not necessarily ordered, of alternative constructions, some of them judged as 'not good' (unacceptable, if not really ungrammatical). It was an interesting exercise to trace a path between the translation of the visual or verbal (in Portuguese) inputs and a fully acceptable construction. The dissolution of very complex PP recursive structures in sequences of loosely tied subordinate or coordinated syntactic units provides the only preferred phrasing in most cases. In the absence of explicit complementizers and following our perceptual insights, prosodic cues have been our road map.

A brief description of the methodology used in this first study of Kuikuro DP and PP recursion forms Sections 2 and 3. The selected data were recorded with one consultant, an adult man, 30 years of age, who was a native speaker of Kuikuro and learned oral and written Portuguese after the age of 15. Each word or sentence was repeated three times with an interval of a few seconds between one repetition and another. The relevant recorded data were edited and submitted to acoustic analysis using PRAAT, in order to extract the pitch track visualizing the prosodic contour of each construction. The sample pitch tracks included in this chapter are more than similar to the other recordings made in this same study. For the elicitation of PP recursive structure, two crucial observations must be registered. First, the recorded sentences were obtained having at the same time oral and visual inputs: the targeted constructions or situations spoken in Portuguese to be translated to Kuikuro, as well as pictures. Our main consultant then would draw the situations designated by the sentences; the reader will find these pictures in the Appendix. Next, other Kuikuro consultants, all bilingual young men, participated in the discussion of the data elicited on DP and, especially, PP recursive structures.

Beyond the expected clear prosodic integration as the cue for syntactic and cognitive recursion and the fact that recursion and coordination are clearly distinguishable through their distinct phrasal prosodies, some of the obtained results, even if preliminary and to be checked through a more careful future investigation, are nevertheless exciting as well as intriguing. We focus on the asymmetry between DP and PP recursion and on the strategies mobilized to split cognitively heavy complex PP recursion into loosely tied syntactic pieces.

The empirical investigation in this chapter relates to the volume as a whole in that it compares the availability of PP recursion and DP recursion within a single language. The structure of the examples, with recursive possessors and spatial expressions, are similar to those examined in other chapters in this volume, including those in Lima and Kayabi's chapter and Maia et al.'s chapter. Despite the patent morphological and syntactic differences between Kawaiwete and Karajá (the two indigenous languages introduced by these chapters) and Kuikuro, the three languages share some basic structural properties, including the fact that they are all head-final languages. Although discussions are based on different analytical foci and methodologies, the authors' discussions all reveal intriguing asymmetries between DP and PP complex embedding.

## 1 Relevant Generalities about Kuikuro Grammar and Prosody

As mentioned above, Kuikuro is ergative. Internal arguments (of postpositions, nouns, Patient/Experiencer of a verb) are morphologically unmarked for (absolutive) Case and they always form a phonological-prosodic unit with their heads. All intransitive verbs are unaccusative, as shown by examples (1) and (2). The sentence in (3) is an example of a transitive sentence: the External Argument (external Cause/Source/Agent of an event/action) is marked by *heke*, which is a postposition used to mark ergative case (ERG), though semantically can be thought of roughly as expressing the spatial distance between two points measured from the perspective of one of them (Franchetto 2010):[2]

(1) kangamuke atsaku-lü
child run-PNCT
'(The/a) child/children run(s)/ran'

(2) kangamuke agu - ti - lü
child thin-VBLZ-PNCT
'(The/a) child/children got thin'

(3) [kangamuke agu-ki-jü] is-ügünu heke
child thin-VBLZ-PNCT 3-sick. PNCT ERG
'His sickness made (the) child thin'

Kuikuro has one single set of bound (prefixed) pronominal forms, which encode the absolutive pronominal argument of a verb, the possessor of a noun

[2] The Kuikuro data are transcribed using the current orthography established by the Kuikuro teachers and by ourselves, the linguists. The correspondences between written and IPA symbols (where these differ) are as follows: ü [ɨ], j [ʝ], g (uvular flap), ng [ŋ], nh [ɲ], nkg [ᵑg]; N represents a sub-specified floating nasal feature.

or the argument of a postposition. There are no auxiliaries and there is no explicit agreement on verbs or nouns.

For a fuller understanding of the prosodic patterns discussed in Sections 2 and 3, a brief introduction to Kuikuro phrasal prosody is necessary, summarizing the findings presented in an earlier publication (Silva and Franchetto 2011). The main stress is generally on the penultimate syllable of the isolated word; stressed syllables are basically distinguished by high pitch (and associated with lengthening). As previously stated, internal arguments (of postpositions, nouns, Patient/Experiencer of a verb) always form a phonological-prosodic unit with their heads. Then, as a first level of prosodical integration, any head constitutes with its direct or internal argument an intonation unit: the phrasal main stress is on the juncture, manifested on the last syllable of the argument or on the first syllable of the head (Silva and Franchetto 2011). Consider the following examples in order to understand the two patterns of Kuikuro phrasal prosody. Main stressed syllables are in bold and marked with [ˈ]. First of all, observe that in the isolated words *tahinga* ('cayman' in (4a)) and *kangamuke* ('child' in (5a)) the main stress is, as expected, on the penultimate syllable. When the nominal word becomes the argument of a head, like a verbal head, however, something happens in the prosodic domain. Compare *tahinga* when it is the internal argument (direct object) of the transitive verb 'to see' in (4b) and the internal argument (actor or theme) of the intransitive verb 'to fall' in (4c).

(4a) taˈ**hi**nga
'cayman'

(4b) [tahiˈ**nga** iˈngilü] iheke
Tahinga ingi-lü i-heke
cayman see-PNCT 3-ERG
'he saw (the/a) cayman(s)'

(4c) [tahiˈ**nga** alamaˈkilü]
tahinga alamaki-lü
cayman fall-PNCT
'(the/a) cayman(s) fell'

In (4b) and (4c), the syllable perceived by the native speakers and researchers as carrying the main stress is the last one of the argument, but it is the first syllable of the head (the verb) that has the prominent F0 peak of the whole VP (σ). This is the first pattern of Kuikuro phrasal prosody:

**Pattern 1: [ˈσ # σ]**

If we place focus on the external argument in the transitive sentence (5b), where unlike (4b) which has a postposed pronominal subject, this full DP with a postpositional phrase comes before the VP, the syllable perceived as prominent is the last one of the (internal) argument of the PP *heke*, and, in fact, it is this syllable that is marked by the prominent F0 peak of the whole PP [kangamuˈ**ke** heke].

(5a) kangaˈ**mu**ke
'child'

(5b) [[kangamuˈ**ke** heke] [tahinga ingi-lü]]
kangamu**ke** heke tahinga ingi-lü
child ERG cayman see-PNCT
'(the/a) child/children saw (the/a) cayman(s)'

The left-hand phrase in (5b) is an example of the second pattern of the Kuikuro phrasal prosody:

**Pattern 2: [ˈ<u>σ</u> # σ]**

The environments of the two patterns of prosodic integration, briefly described here, are verb phrases, nominal phrases and postpositional phrases, and we will see that they occur in the data recorded during our study of Kuikuro DP and PP recursive constructions. The problem is to understand how and where they are at work when we have multiple embedding.

## 2 DP Recursion in Kuikuro: Possessives

In recursive DP constructions, the two prosodic patterns described above characterize the first argument/head relation. Any embedded N to this first merge maintains its own lexical stress on the penultimate syllable, but the prosodic pattern of the whole phrase reveals a clear recursive structure. The same recursive constructions are productive for alienable and inalienable Ns. Recursion and coordination are thus clearly distinguishable through their distinct phrasal prosodies.

### *2.1 DP Recursive Possessives with Alienable Nouns*

In the following examples, the genitive suffix on the 'possessed' N – glossed as GEN – marks the dependence between NPs. Stressed syllables are marked with a preceding [ˈ]; the syllable perceived as bearing the main stress of the whole construction is marked with [ˈ] and in bold. The relational marker *–gü* undergoes assimilation to *–gu* when following an /u/ in the preceding syllable.

**Alienable N:**

(6a) eˈ**te**ne 'paddle'
ˈ**i**ku 'decoration'

(6b) [eteˈ**ne** iˈkusü]
etene iku - sü
paddle decoration-GEN
'paddle's decoration'

(7a) aˈ**ne**tü 'chief'
ˈ**e**hu 'canoe'

(7b) [aneˈ**tü** eˈhugu]
anetü ehu - gu
chief canoe-GEN
'chief's canoe'

(8) [[[[aneˈ**tü** eˈhugu] eteˈnegü] iˈkusü]]
anetü ehu-gu etene-gü iku-sü
chief canoe-GEN paddle-GEN decoration-GEN
'chief's canoe's paddle's decoration'

Declination reset (Ladd 1986, 1988; see also Mithun 2009) is used as a diagnostic of prosodic domain delimitation. The pitch movement or intonation of the recursive construction in (8) is shown in Figure 17.1 and is coherent with the first pattern of prosodic integration between argument and head. A rising intonation reaches the highest pitch of the whole construction exactly on the internal juncture in [*anetü ehugu*], 'chief's canoe.' After this, the following stressed syllables are characterized by a sequence of increasingly lower pitches or declination resets, until the final fall.

(9b) results from adding one more level of embedding to (8).

(9a) ngiˈ**ko**go '(wild) Indian'

(9b) [[[[ngikoˈ**go** aneˈtü-gü] eˈhu-gu] eteˈne-gü] iˈku-sü]
ngikogo anetü-gü ehu-gu etene-gü iku-sü
indian chief-GEN canoe-GEN paddle-GEN decoration-GEN
'Indian's chief's canoe's paddle's decoration'

Figure 17.2 shows the prosodic profile of (9b).

Examples (8) and (9b), with the pitch tracks shown in the figures below, reveal just one higher pitch exactly on the juncture of the first merge between head and argument, and then declination during the entire course of the complex DP. This can be directly contrasted with an example of coordination, which contains two syntactically independent DPs, and as a result, no declination reset and two declination domains, as shown in Figure 17.3.

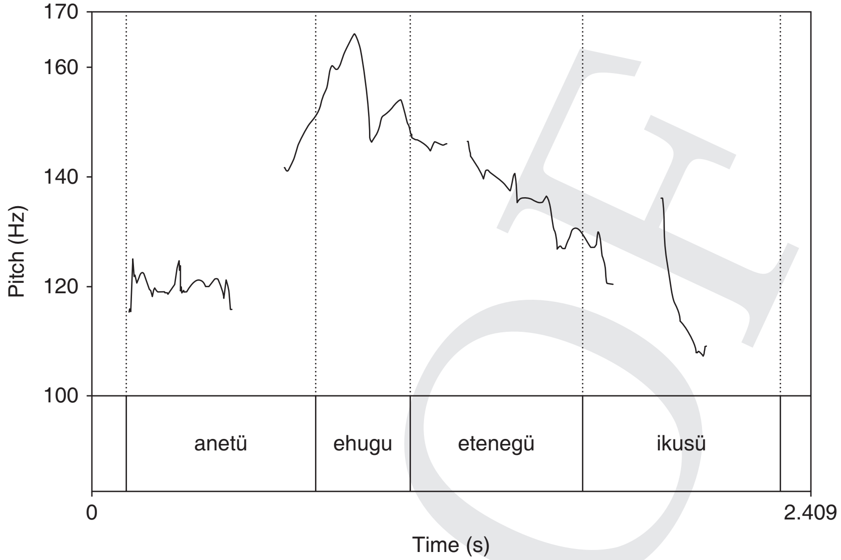



Figure 17.1 Pitch movement of the recursive construction in (8)

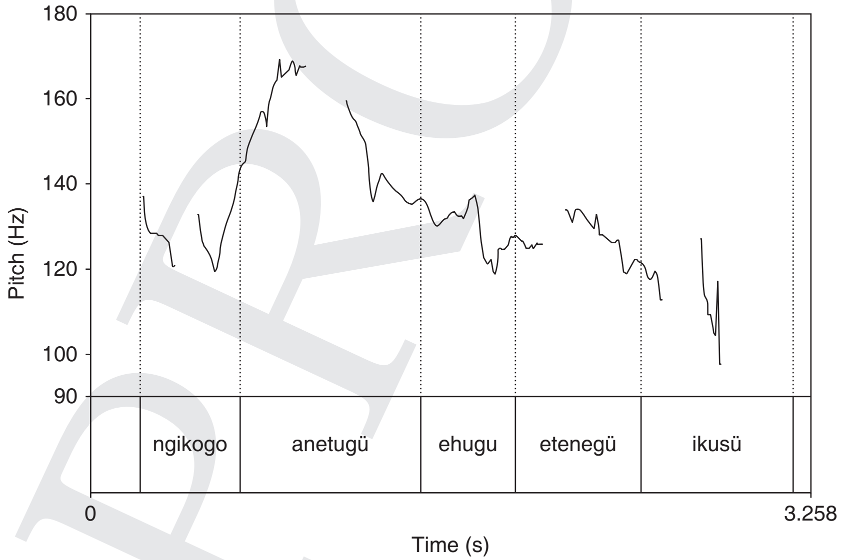



Figure 17.2 The prosodic profile of (9b)

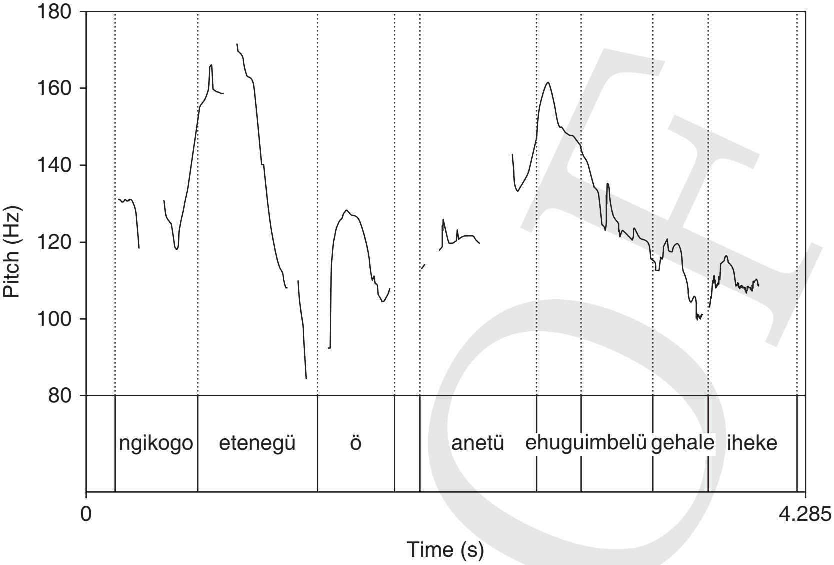



Figure 17.3 No declination reset and two declination domains

(10) [ngikoˈ**go** eteˈne-gü] õ [aneˈ**tü** eˈhu-gu] iˈmbe-lü geˈhale iˈheke
ngikogo etene-gü õ anetü ehu-gu imbe-lü gehale i-heke
Indian paddle-GEN & chief canoe-GEN bring also 3-ERG
'he brought the Indian's paddle and the chief's canoe'

Two equal higher pitches and two falling intonations constitute evidence that DP coordination is distinct from DP recursive structure, a crucial piece of evidence from the intonation domains as correlates of syntactic domains.

## *2.2 DP Recursive Possessives with Inalienable Nouns*

The phrasal prosodic pattern of possessive recursive constructions containing inalienable nouns is not different from that described in Section 2.1 for alienable nouns. The following data result from the expansion of the recursive construction by adding, one by one, more levels of embedding.

(11a) uaˈ**ko**ngo
u-akongo
1-companion
'my companion'

(11b) uhameˈ**ti**gü
u-hameti - gü
1-brother-in-law-GEN
'my brother-in-law'

(11c) [uakoˈ**ngo** hameˈtigü]
u-akongo hameti - gü
1-companion brother-in-law-GEN
'my companion's brother-in-law'

(11d) [uhametiˈ**gü** hisü]
u-hameti - gü hi - sü
1- brother-in-law-GEN younger.brother-GEN
'my brother-in-law's younger brother'

(11e) [[uakoˈ**ngo** hisü] ˈhitsü]
u-akongo hi- sü hi-tsü
1-companion younger.brother-GEN wife-GEN
'my companion's younger brother's wife'

The first level of embedding exemplified in (11e) results in a construction with the highest pitch on the first syllable of the head (ˈ**hi**sü) of the first syntactic-prosodic integration and then a partial reset with a lower peak on the first syllable of [ˈhitsü]. This can be seen in Figure 17.4.

The example in (12) has one more level of embedding:

(12) [[uakoˈ**ngo** hameˈtigü] ˈhisü] ˈhitsü] etijiˈpügü]
u-akongo hamet i- gü hi-sü
1-companion brother-in-law- GEN younger.brother-GEN
hi-tsü etiji-pügü
wife-GEN sprout-PERF
'my companion's brother-in-law's younger-brother's wife's children'

As shown in the Figure 17.5, the single highest pitch is exactly at the juncture between the complement and the head of the first merge: *uakongo* (or *uakango*) and *hametigü*. This highest pitch is followed by a ladder of lower pitches, each one corresponding to the stressed syllable of *hisü*, *hitsü*, and *etijipügü*.

The example in (13) results from a further level of embedding:

(13) [[[uakoˈ**ngo** hameˈtigü] ˈhisü] ˈhitsü] etijiˈpügü] muˈkugu]
u-akongo hameti - gü hi- sü
1-companion brother-in-law-GEN younger.brother-GEN
hi-tsü etiji-pügü muku-gu
wife-GEN sprout-PERF son-GEN
'my companion's brother-in-law's younger-brother's wife's children's son'

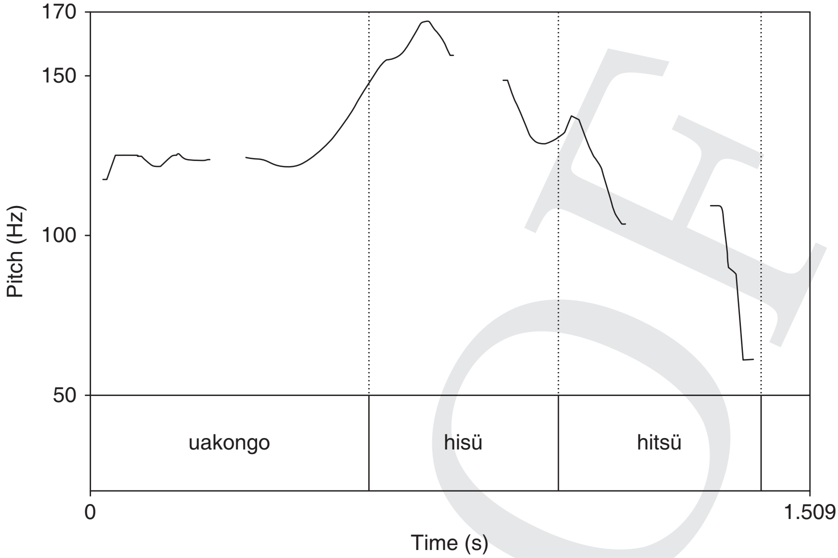



Figure 17.4 Pitch profile of (11e)

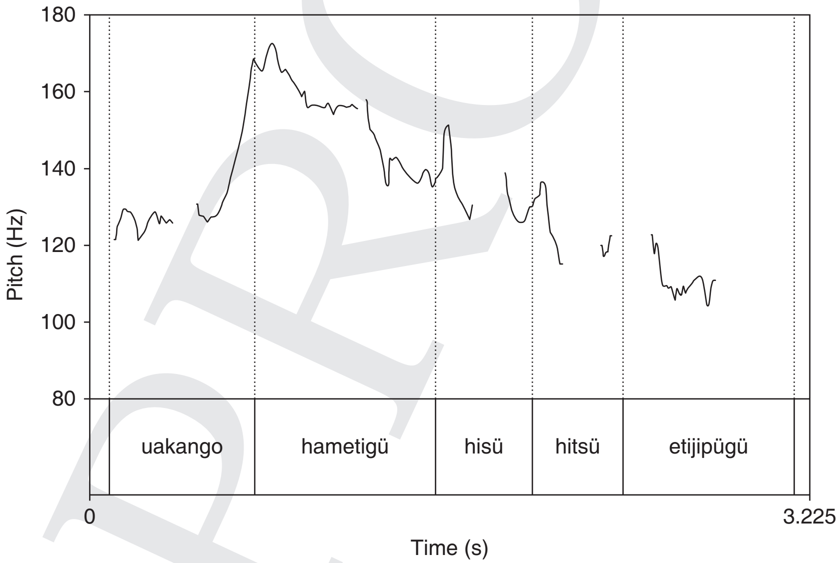



Figure 17.5 Pitch profile of (12)

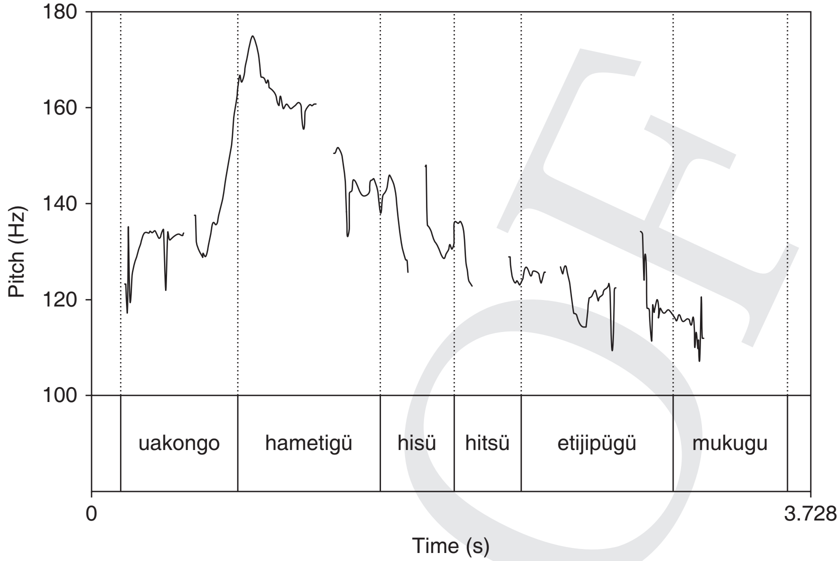



Figure 17.6 Pitch profile of (13)

No matter how many possible embeddings, the expanded recursive DP, as exemplified in (13) and in Figure 17.6, shows a striking prosodic integration with just one highest pitch on the first merge and then a declination of continuously lower pitches on the stressed syllables of the following embedded possessed nouns.

## 3 PP-Level Recursion

If the production of DP recursive constructions, like those exemplified in Sections 2.1 and 2.2, is an easy task for Kuikuro speakers, we cannot say the same for the production of PP recursive constructions with more than one or two levels of embedding. For the time being, we do not have a clear answer to the question of why recursive PPs would be more difficult to process and to produce than recursive possessive DPs. We encountered two main difficulties during the elicitation of recursive PP constructions. On the one hand, our Kuikuro consultants took longer: several attempts were discarded as unsatisfactory or unacceptable, until they reached a construction consensually considered as "good (*atütü*)." On the other hand, our own perception of prosodic integration was far from clear if compared with the immediate apprehension of the whole intonation of recursive DPs. It is the pitch movement, however, that came to inform our analysis, showing, as we will see, intonation patterns similar to those already found in complex recursive DPs.

As this is an initial investigation of these structures, for now we only deal with locative PPs expressing spatial relations between objects. In this case, in order to elicit specific locative PPs, we used, together with verbal instructions, visual stimuli such as the direct or indirect manipulation of familiar objects (bench, gourd, mat, platform, fish, turtle, etc.), in order to obtain precise descriptions. Since the speaker could produce a sentence that he considered as "good," he made a drawing representing exactly the specific spatial arrangement of the objects, generally one inside or on another, as described by the complex construction. The Appendix contains the drawings associated with the examples selected.

In the apparently less complex constructions, as in (14b), the matching between syntax, perception, and the intonation contour displayed in the figure generated using PRAAT is apparent. We found just one higher pitch and then declination during the entire course of the complex PP [*uagisuˈ**gu** agiˈsugu aˈtalü ˈata*], both delimiting one single phrasal domain, as shown by the pitch track in Figure 17.7. Note that the last two words *ainde kuihi* are not part of the recursive PP structure and hence the last pitch peak, i.e., the one on *ainde*, is not relevant to the question at hand.

(14a) uagiˈsugu
u-agisu-gu
1-bag-GEN
'my bag'

(14b) [[u-agisuˈ**gu** agiˈsu-gu] aˈtalü] ˈata] aˈinde kuˈihi

| | | | | | |
|---|---|---|---|---|---|
| u-agisu-gu | agisu-gu | ata-lü | ata | ainde | kuihi |
| 1-bag-GEN | bag-GEN | inside-GEN | inside | DEIC | needle |

'the needle (is) inside the bag inside my bag' (lit. inside the inside of my bag here (is) needle)

More complex recursive cognition of spatial relations is expressed by different and apparently non-recursive syntactic strategies.

(15a–c) present a first set of examples, with the aim to produce the translation of 'the turtle on the stone on the beach of the lagoon':

(15a)

| | |
|---|---|
| ˈipa | 'lake' |
| ˈtehu | 'stone' |
| nheˈtune | 'sand/beach' |
| hikuˈtaha | 'turtle' |

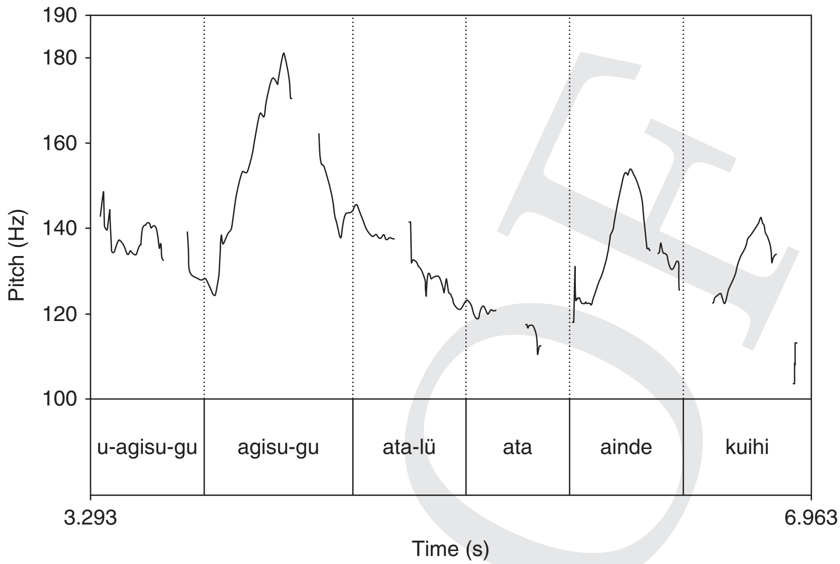



Figure 17.7 Pitch profile of (14b)

A first attempt by our Kuikuro consultants, in order to describe 'the turtle on the stone on the beach of the lagoon,' was judged as "not good" (*atütühüngü*, good-NEG), even if not ungrammatical (*kütsü*, 'bad'):[3]

(15b) **??** [hikuˈtaha teˈhu uˈgupo] [[iˈpa inhetuneˈgüho]
hiku<u>ta</u>ha tehu ugupo ipa inhetune-gü -ho
turtle stone on lake sand-GEN LOC

Then, they consensually considered the construction in (15c) as finally 'good' (*atütü*):

(15c) [iˈ**pa** inhetuneˈgüho] hikuˈ**ta**ha [teˈ**hu** ugupo]
Ipa inhetune-gü-ho hikutaha tehu ugupo
lake sand-GEN-LOC turtle stone on
'turtle on the stone on the beach of the lagoon'(lit. on beach of lagoon, (there is) turtle, on stone)'

[3] Literate Kuikuro speakers have a sophisticated metalinguistic awareness and vocabulary, due also to the fact that they live in a multilingual regional system (the Upper Xingu), where an intense interaction between speakers of genetically distinct languages and the non-existence of a lingua-franca stimulate a constant activity of comparison and translation. Our Kuikuro consultants understood easily the meaning of the word 'recursion' and without much delay they translated it as:

aki tegupotsihekuinhü
'word/sentence/utterance that can be easily/well increased'

A full sentence was immediately uttered as an appropriate syntactic context:

(15d)

| | | | | | |
|---|---|---|---|---|---|
| iˈ**pa** | inhetuneˈgüho | hikutaˈ**ha** | iˈngilü | uˈheke | teˈ**hu** uˈgupo |
| ipa | inhetune-gü-ho | hikutaha | ingi-lü | u-heke | |
| lake | sand-GEN-LOC | turtle | see-PNCT | 1-ERG | |

| | |
|---|---|
| te**hu** | ugupo |
| stone | on |

‘I saw (a/the) turtle on (a/the) stone on (a/the) beach of (a/the) lagoon’

(15b) was considered just a translation of the Portuguese corresponding construction. The “heavy” recursive PP in the less “good” construction (15b) was split in two parts by *hikutaha* (‘turtle’) in order to have (15c), the “good” one. As the consultants explained, a “good” sentence would be one which expresses the right sequence of the objects in contact, in a kind of bottom-up cognitive apprehension of a vertical spatial relation: on the left side of the sentence, the base or the ground, and on its right side of what is on the base.[4]

(16b), an even more complex PP, is an example of one of the usual solutions, in Kuikuro, for avoiding ‘heavy’ syntactic objects, splitting the whole into two units tied by an anaphoric pronoun, *üle*:

(16a)

| | |
|---|---|
| ˈogo | ‘platform’ |
| huˈkugu | ‘small pot’ |
| ˈüle | anaphoric demonstrative pronoun |
| tuˈahi | ‘mat’ |
| tüheˈnkginhü | ‘gourd’ |

(16b) [[oˈ**go** uguˈpongo] ahuˈkugu]] [üˈle uˈgupo] [tuaˈhi uˈgupo] tüheˈnkginhü

| | | | | | |
|---|---|---|---|---|---|
| ogo | ugupo-ngo | ahukugu | üle ugupo | tuahi | ugupo |
| platform | on-NMLZ | pot | AN on | mat | on |

| |
|---|
| tühenkginhü |
| gourd |

‘the gourd on the mat on the pot on the platform’ (lit. the one on platform, pot, on this, on mat, gourd’)

The match between prosody, syntactic and cognitive integration is evidence that (16b) is not a paratactical construction. The pitch trace of example (16b), shown in Figure 17.8, is evidence of a single intonation unit, a clear manifestation of prosodic integration.

Looking at Figure 17.8, we see that the higher pitch of the whole complex construction is at the juncture of the first merge (syllable in bold in [*o*ˈ***go*** *ugupongo*]), followed by descending partial pitch resets on the stressed

[4] Sequential order with a specific direction, starting from a ‘base’ (*enga*), is a structuring general principle in many Kuikuro cognitive and cultural domains, such as music, dance, ritual choreography, writing, narrative performance, memorization, and learning.

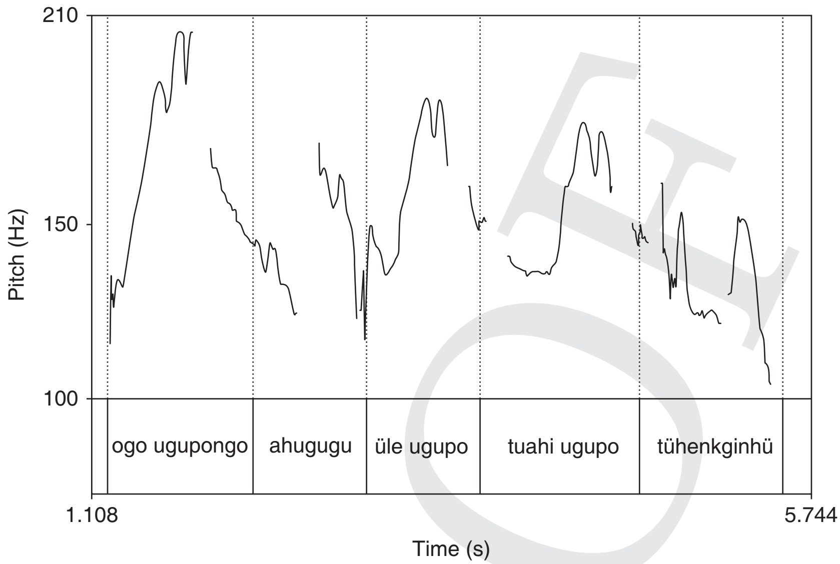



Figure 17.8 Pitch trace of (16b)

syllables in [*ü'**le** ugupo*], [*tua'**hi** ugupo*] and [*tühe'**nki**nhü*]. Then, we have an overall intonation contour that includes three prosodic sub-contours with prosodic breaks between them (similar to the kind of evidence adduced in Mithun (2009)).

Before they reached the 'good' construction in (16b), the Kuikuro consultants produced two attempts (16c–d), with the first one judged as less 'good' than the second one, but this latter one less good than (16b), manifesting a kind of growing gradient of acceptability:

(16c) ?? [[[oˈgo uguˈpongo] ahukuˈgu ugupo] tuaˈhi ugupo] üˈle ugupo] tüheˈnkginhü
ogo ugupo-ngo ahukugu ugupo] tuahi ugupo]]
platform on-NMLZ pot on mat on
üle ugupo tühenkginhü
AN on gourd
'(lit.) the one on the platform on the pot on the mat, on this one the gourd'

(16d) ? oˈgo uguˈpongo ahukuˈgu uguˈpongo tuˈahi üˈle uˈgupo tüheˈnkginhü
ogo ugupongo ahukugu ugupongo tuahi
platform on-NMLZ pot on-NMLZ mat
üle ugupo tühenkginhü
AN on gourd
'(lit.) the one on the platform, the one on the pot, mat, on this, gourd'

Once more, as we saw before, a full sentence was uttered as the appropriate syntactic context for the situation described by (16b) and depicted by the correspondent drawing (see Appendix):

(16e) oˈgo uˈgupo tühenkgiˈnhü iˈngilü uˈheke ahukuˈgu uˈgupo tuaˈhi ugupo

| | | | | | |
|---|---|---|---|---|---|
| ogo | ugupo | tühenkginhü | ingi-lü | u-heke | |
| platform | on | gourd | see-PNCT | 1-ERG | |
| ahukugu | ugupo | tuahi | ugupo | | |
| pot | on | mat | on | | |

'lit. on the platform / I saw the gourd / on the pot / on the mat
'I saw the gourd on the mat on the pot on the platform'

Once more, our consultants clarified the reason why (16b) is the best construction, reproducing the same cognitive apprehension of the bottom-up order of a vertical spatial relation between objects in contact, as we saw in (15c).

Contrasting with (16b) and parallel to the coordinate structure in (10) and Figure 17.3, (17b) could be considered an example of dissolution of complex spatial cognitive relations between objects into two syntactic units, loosely tied by the anaphoric *üle*.

(17a)

| | |
|---|---|
| ˈogo | 'platform' |
| akaˈ$^{n}$doho | 'bench' |
| aˈtange | 'pot' |
| ˈkanga | 'fish' |
| ˈüle | anaphoric demonstrative pronoun |

(17b) [oˈ**go** uguˈpongo] akaˈ**ndo**ho [üˈ**le** uˈgupo] [ataˈ**nge** ata] ˈ**ka**nga

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| ogo | ugupo-ngo | akandoho | üle | ugupo | atange | ata | kanga |
| platform | on-NMLZ | bench | AN | on | pot | inside | fish |

'fish in the pot on the bench on the platform' (lit. the bench (is) the one on the platform, on this, inside the pot (is) the fish)

Looking at Figure 17.9, we see that between *ogo ugupo akandoho* and *üle ugupo atange ata kanga*, there is a total pitch reset on the main stressed syllable of [*üˈ**le** ugupo*]. Thus, we have two distinct prosodic units or phrases, revealing a coordination in a way that is perfectly parallel to what we saw in Figure 17.3, corresponding to the canonical coordination exemplified by (10). Partial resets are visible inside each intonation domain. Note that the one in the second domain points to a first-level recursive structure (*üle ugupo* / *atange ata*, '(fish) inside the pot on the platform'). Could this coordination-like construction be interpreted as a mismatch between cognitive integration and syntactic/prosodical integration?

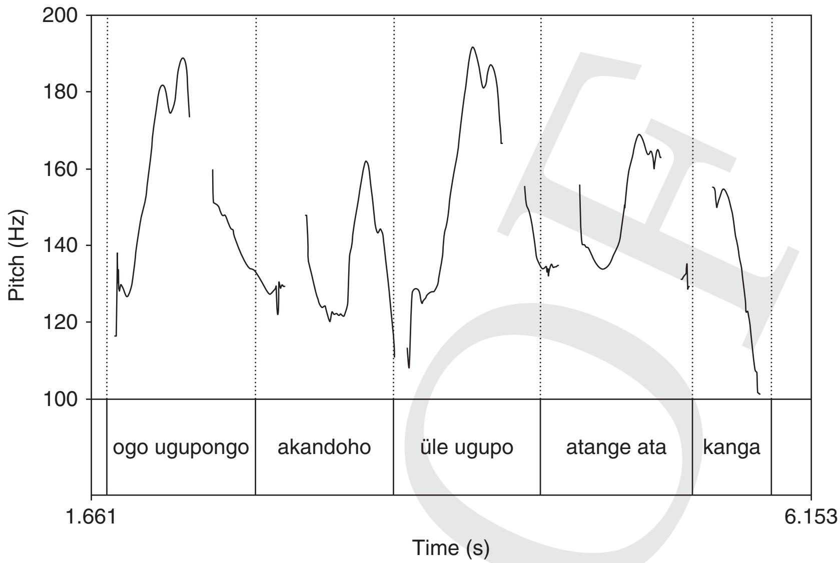



Figure 17.9 Pitch trace of (17b)

The ‘not good’ constructions produced by the Kuikuro consultant on the path to the ‘good’ one are yet again interesting. (17c) was considered a direct translation from Portuguese:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (17c) | ?? | [[[ataˈ**nge** | ata | ˈkanga] | akandoˈ**ho** | ugupo]] | oˈ**go** | ugupo]] |
| | | pot | inside | fish | bench | on | platform | on |

Consequently, they produced (17d) after the comment: “it’s not right to say this, you must take off something,” but it was judged as ‘not good’ because the ‘platform’ does not come first, as in the ‘good’ (17e):

| | | | | | | |
|---|---|---|---|---|---|---|
| (17d) | ? | [[[ataˈ**nge** | ata | ˈkanga] | oˈ**go** | ugupo]] |
| | | pot | inside | fish | platform | on |

| | | | | | |
|---|---|---|---|---|---|
| (17e) | [[oˈ**go** | ugupo | ˈkanga | [ataˈ**nge** | ata]] |
| | platform | on | fish | pot | inside |

(17f) was offered as a ‘good’ sentential context:

| | | | | |
|---|---|---|---|---|
| (17f) | [oˈgo | uˈgupo] | [akandoˈho | a-tüˈhügü uˈgupo geˈhale] |
| | platform | on | bench | be-PERF on also |
| | [atange ata] | kanga | | |
| | pot in | fish | | |

‘on (the) platform bench is on also, inside (the) pot (the fish)’

## 4 Final Remarks

The incorporation of finely graded phonological knowledge into syntactic properties allows a much better understanding of the DP and PP recursive constructions in Kuikuro, not only when the match between prosodic integration and syntactic structure is manifestly clear, as we discovered in our first incursion in Kuikuro phrasal prosody where the syntactic merge between head and complement was nicely mirrored by their prosodic integration.

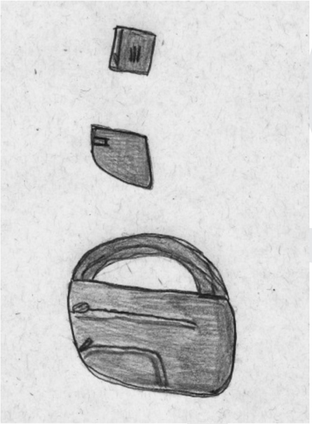
The prosodic contrast between two syntactically parallel sentences, e.g., (16b) and (17b), shows two different strategies in order to simplify a complex PP. The paratactical coordination in (17b) could be a case of an apparent mismatch between syntactic and prosodic structures, contrasting with the clear prosodic integration in (16b), shown by Figure 17.8. This led me to mention the idea of a matching between prosodic and cognitive integration following Mithun (2009). We saw the paths followed by Kuikuro speakers in order to avoid unnecessary and unmotivated complexity and then reach the ‘good’ construction when dealing with multiple spatial embedding. However, this points to the need for a new and deeper syntactic analysis. This would be a more cautious descriptive and theoretical step forward,[5] rather than to accept immediately the conclusions presented by some authors (see Mithun 2009; Hunyadi 2010; Hulst 2010).[6] These authors state that if we are facing phenomena at the interface between prosody and semantics or cognition, then syntax must be discarded as the central computational device generating structures interpreted at the phonological and the conceptual interfaces. By contrast, I contend that prosody is the key for the understanding of recursive structures, but it pushes us back to syntax.

[5] See Bolinger’s (1984, cited in Mithun 2009:61) cautious but insightful statements: “I start with a claim and a disavowal. The claim is that intonation is autonomous and one can speak of intonational subordination without reference to the segmental side of language. The disavowal is that intonation has any direct connection with subordination in syntax, however this is to be defined. Syntax nevertheless benefits handsomely from the games that intonation plays with it. I see anything that is tributary to something else as subordinate to it. In syntax, this means not only the classical dependent clauses in relation to main clauses, but also their reduced counterparts …”

[6] Hulst (2010) notes that the intonation grammar displays recursion in its semantic component; see also Hunyadi’s notion of “cognitive grouping and recursion in prosody” (Hunyadi 2010). Mithun (2009) suggests that prosodic structuring might precede syntactic structuring.

# Appendix: Drawings Associated with PP Constructions Exemplified in the Chapter

(14b)

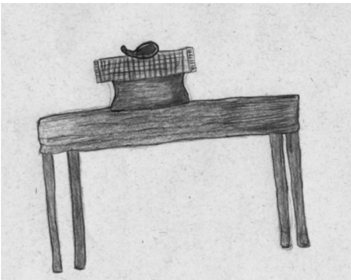


Example 17.13a *the needle inside the bag inside my bag*

(15c)

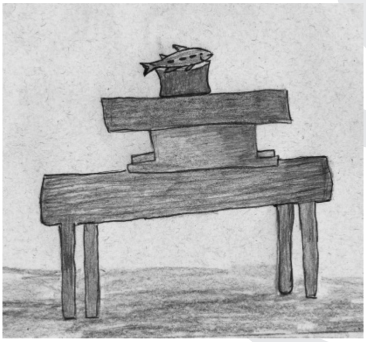
Example 17.14b *turtle on the stone on the beach of the lagoon*

(16b)



Example 17.15b *the gourd on the mat on the pot on the platform*

(17b)



Example 17.16b *fish in the pot on the bench on the platform*

# 18 The Processing of PP Embedding and Coordination in Karajá and in Portuguese

*Marcus Maia, Aniela Improta França, Aline Gesualdi-Manhães, Aleria Lage, Cristiane Oliveira, Marije Soto, and Juliana Gomes*

Recursive embedding, "an operation which takes its own output as an input" (Roeper 2010), has been widely identified as the most fundamental property of the combinatorial systematicity of the human language faculty (Chomsky 1957; Hauser, Chomsky, and Fitch 2002).[1] Even though there is robust evidence that embedding is a language universal, taking place in several structures in typologically different languages, embedded phrases seem to pose greater processing challenges than coordinated ones.

Concerning the acquisition of recursion, despite the fact that children seem to need explicit evidence of self-embedded structures to unleash a number of fundamental language computations, they seem to take rather a long time to understand and produce some types of embedded constructions (Roeper and Snyder 2004, 2005; Roeper 2011).

While embedded phrases do not seem to be present in children's earliest utterances, juxtaposition appears early, both in children's comprehension and in production (Pérez-Leroux et al. 2012; França et al. 2004). This contrast between embedding and coordination is also supported by evidence from imaging studies. Two of the pathways that process language differ both phylogenetically and ontogenetically, and process different levels of linguistic complexity. One of them, available since birth, underlies the mechanisms for acquisition of lexical items and simple phrases, but this circuit is not sufficient to process complex structure. In contrast, the other pathway, only available some years after birth, underlies processing of hierarchical structures (Friederici and Brauer 2009; Berwick et al. 2013).

A complexity effect connected with recursive structures is also found in adult language studies, using different languages and methodologies. When comparing eye-tracking fixation durations of one relative clause modifying the matrix object with those of two recursively embedded relative clauses in

[1] Karajá is a Brazilian indigenous language of the Macro-Je stock spoken by approximately 3,000 people who live in the Terra Indigena Araguaia and other villages on and around the Bananal Island (TO) in Central Brazil.

Japanese, Mazuka et al. (1989) suggest that the greater the depth of embedding, the harder it is to process the sentence. In a corpus-based study in English, Chafe (1982) found more coordinate sentences in spoken language than in written texts, arguing for a dichotomy equating "oral = syntactic simplicity" on one side and "written = syntactic complexity" on the other.

Nevertheless, there is opposition to the one-to-one relationship between embedding and computational complexity. On the basis of findings of computer modeling studies, Stabler (2014) argues that the recursive depth of a structural analysis "does not correspond in any simple way to depth of the calculation of that structure in linguistic performance" (p.159).

Other studies have reached similar conclusions. In a production study, Gayraud and Martinie (2008) had French-speaking subjects freely share their thoughts about a topic and analyzed occurrences of longer than 250ms in twenty individual recordings with a mean length of thirty-five clauses with a mean duration of 135ms. Gayraud and Martinie concluded that as far as pauses can be taken as indices of processing difficulty in production, there is no direct correlation between sentence complexity and processing difficulty.

Finally, contrary to traditional comprehension studies that argue that object center-embedded relative clauses are difficult to process for syntactic reasons (see Fodor and Garrett 1967; Ford 1983; Frazier 1985; Gibson 1998), Fernandez-Duque (2009) presents a review paper relying on imaging studies to argue that the greater processing difficulty of object relative clauses vis-à-vis their subject relative clause counterparts is a domain-general effect.

The possibility of attributing some degree of linguistic processing to general cognitive computation has also surfaced in linguistic theory. Chomsky (2005) proposes that three factors must be considered in human language design: (1) genetic endowment, which is uniform in the species; (2) experience, which leads to variation; and (3) principles not specific to the faculty of language, especially principles of structural architecture, such as efficient computation.

Trotzke, Bader, and Frazier (2013) assume current Biolinguistic Program proposals that tend to ascribe to Universal Grammar (UG) only basic properties, such as recursive Merge, binary branching structure and the valued/unvalued feature distinction, leaving all other universal properties to be explained by the interaction between UG and independently motivated third-factor principles. Their main claim is that systematic processing phenomena are part of the implicit knowledge of human language performance systems, lending to third-factor type of explanations of language architecture.

In order to contribute to this discussion, we report the findings of a series of psycholinguistic and neurophysiological studies designed to compare the computational costs involved in the processing of prepositional phrases in Brazilian Portuguese inserted either in coordinative or in recursively embedded constructions.

To enrich the analysis with data from typologically different languages, we also tested the computational costs of postpositional phrases in Karajá in coordination and in recursively embedded constructions. Thus, here we present a multi-methodological comparative study of the processing costs of phrase embedding and coordination. The theoretical framework assumed here relies both on the proposals in Trotzke, Bader, and Frazier (2013) and those in Chomsky (2005).

Trotzke, Bader, and Frazier claim that "performance data can provide evidence on whether the limited use made of certain syntactic structures can plausibly be attributed to performance factors, or whether grammatical constraints are necessary for this purpose" (2013:5). This consideration was used by the authors in relation to performance constraints on center embedding, but we claim it can also be extended to support the view that a grammatical algorithm (embedding) can interact with performance factors in a specific fashion. Ultimately, this view is also in line with the original classic proposal in Chomsky and Miller (1963) to the effect that grammar allows multiple embedding, while the parser constrains them.

This chapter is organized in the following way. In Section 1, we present three oral sentence/picture matching experiments that show that PP embedding is harder to process than PP coordination, both in Karajá and in Brazilian Portuguese (BP) as L1 or as L2 of Karajá native speakers. In Section 2, we present an event-related brain potential (ERP) test carried out with Karajá and, in Section 3, an ERP test in BP. The results of those tests indicate, however, a progressive facilitation going from the constructions with one embedded PP, to two PPs and three PPs. Finally, in the last section of the chapter we argue that our results illustrate an interesting performance or third-factor phenomenon in the processing of structural complexity: even though coordination yielded earlier N400s than those of embedding, once subjects were engaged in the recursive algorithm, subsequent embedding was facilitated.

## 1 The Psycholinguistic Sentence/Picture Matching Experiments

To investigate the hypothesis that recursively embedded PPs should be harder to process[2] than their coordinated counterparts both in Karajá and in

[2] As pointed out by an anonymous reviewer, the recursive condition triggers a restrictive interpretation of the PPs. As restrictive interpretations are known to pose complexity effects, our restrictive stimuli have this property inherently in them. Nevertheless, embedding is a syntactic factor and restrictiveness is semantic; this disjunction may only be teased apart in an on-line chronometric method in which different computations will occur in different time frames. Even though the off-line psycholinguistic experiment reported in this section is not capable of distinguishing between syntactic and semantic computations, the results establish a baseline for comparison with the on-line neurophysiological test that will be presented in Section 3.

Portuguese, we applied an auditory sentence/picture matching experiment in three groups of subjects: Karajá speakers tested in their native Karajá; Karajá speakers tested in their L2 Portuguese; and monolingual BP speakers. The objective of the experiments was to assess whether the processing of PP embedding was costlier than the processing of PP coordination. The independent variables of the study were, therefore, 2- and 3-PP/DP embedding and coordination and the dependent variables were the accuracy rates and decision times.

*Participants*

There were twenty-four participants in each study group, giving a total of seventy-two participants.

*Materials*

There were six conditions in the experiments, as exemplified in the Karajá and BP constructions in Figures 18.1–18.6. These figures, as well as all the other sets used in the experiment, displayed situations in which different locative PPs (e.g., in the basket, on the beach, etc.) may be either embedded or juxtaposed, as shown in the following six conditions:

**Condition 1. Recursion with two embedded PPs**

*utura* *ijõdire* *weriri-roki* *ynyra* *tyre-ki*
fish there is basket-inside beach on
Tem peixe na cesta na praia.
"There is fish in the basket on the beach"

Figure 18.1 Recursion with two embedded PPs

**Condition 2. Recursion with three embedded PPs**

*utura* *ijõdire* *weriri-roki* *myna* *tyre-ki* *ynyra-ki*
fish there is basket inside rock on beach-on
Tem peixe na cesta na pedra na praia
"There is fish in the basket on the rock on the beach"

Figure 18.2 Recursion with three embedded PPs

**Condition 3. Coordination with two PPs**

| | | | | | | |
|---|---|---|---|---|---|---|
| *utura* | *ijõdire* | *myna* | *tyre-ki* | *ijõ* | *ynyra* | *tyre-ki* |
| fish | there is | inside | rock on | other | beach | on |

Tem peixe na pedra e na praia
"There is fish on the rock and on the beach"

Figure 18.3 Coordination with two PPs

**Condition 4. Coordination with three PPs**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *utura* | *weriri-roki* | *ijõdire* | *ijõ* | *myna* | *tyre-ki* | *ijõ* | *ynyra* | *tyre-ki* |
| fish | basket-in | there is | other | rock | on | other | beach | on |

*Tem peixe, na cesta, na pedra e na praia*
"There is fish in the basket, on the rock, and on the beach"

Figure 18.4 Coordination with three PPs

**Condition 5. Coordination with two NPs**

| | | | | |
|---|---|---|---|---|
| *utura* | *weriri* | *wyna* | *ynyra-ki* | *ijõdire* |
| fish | basket | and | beach-on | there is |

*Tem peixe e cesta na praia*
"There is (a) fish and (a) basket on the beach"

Figure 18.5 Coordination with two NPs

**Condition 6. Coordination with three NPs**

| | | | | |
|---|---|---|---|---|
| *utura* | *weriri* | *myna* | *ynyra-ki* | *ijõdire* |
| fish | basket | rock | beach-on | there is |

*Tem peixe, cesta e pedra na praia*
"There is (a) fish, (a) basket, and (a) rock on the beach"

Figure 18.6 Coordination with three NPs

Notice that recursive embedding of PPs is not morphologically marked in Karajá or in BP (Conditions 1 and 2). Nevertheless, the conjoining of PPs in Karajá is operated by the quantifier *ijõ* 'other' (Conditions 3 and 4), whereas the conjoining of NPs may be obtained through the optional conjunction *wyna* 'and' (Conditions 5 and 6). In BP, as exemplified in the glosses of Conditions 3, 4, 5, and 6, the same conjunction *e*, which means 'and,' is employed both for the PP and NP conjoining.

*Procedures*

In the oral sentence/picture matching experiment, participants were asked to match a sentence they heard with a picture displayed on a computer screen. The picture remained on the computer for six seconds. Twenty-four existential target sentences distributed in a Latin square design were randomly presented amidst twenty-four fillers in six versions of the experiment.

*Results*

The results indicated that recursively embedded PP constructions were more difficult to process than PP and NP conjoined constructions, both for Karajá tested in Karajá and in BP as well as for the monolingual BP participants. Even though decision rates were not different across conditions, average reaction times were significantly higher for three embedded PPs than for two embedded PPs or for any coordinate constructions in all subject groups. Reaction times for constructions with two embedded PPs were significantly higher than reaction times for constructions with two coordinate PPs or NPs. Reaction times for coordinate PPs were not significantly different than for coordinate NPs. Table 18.1 and Figure 18.7 summarize these results.

A three-way analysis of variance (ANOVA) was applied to the PP conditions, crossing two within-factors and one between-factor. The within-factors were Syntax (recursive embedding × conjoining) and Number of PPs (two × three). The between-factor was the group of participants (KK, Karajá judging Karajá; KP, Karajá judging Portuguese; and BP, monolingual Brazilian Portuguese speakers judging Brazilian Portuguese). There was a highly significant main effect of the factor Syntax in the expected direction, indicating that PP embedding is harder to process than PP conjoining in the three groups ($F(1,46) = 51.2$ $p<0.000001$***). The factor Number of PPs also yielded a significant main effect, indicating that increasing the number of PPs increases response times regardless of the syntactic process ($F(1,46) = 40.1$ $p<0.000001$***) in the three groups. However there was no significant interaction of the factors Syntax and Group of participants ($F(2,92) = 0.200$ $p<0.818722$), indicating that the three groups did not differ in their pattern of responses: all participants decided faster in PP coordination than in PP embedding. Likewise, there was no significant interaction of the factors Syntax, Number, and Group ($F(2,92) = 0.183$ $p<0.833306$), confirming the similarity of response patterns across all the

Table 18.1 *Average reaction times (ms) in the oral sentence/picture matching experiment*

| Group/Condition | R2PP | R3PP | C2PP | C3PP | C2NP | C3NP |
|---|---|---|---|---|---|---|
| Karajá tested in Karajá | 1614 | 2990 | 1142 | 2004 | 1040 | 1553 |
| Karajá tested in BP | 1557 | 2694 | 1206 | 1570 | 1393 | 1780 |
| BP tested in BP | 1496 | 2018 | 916 | 1191 | 1388 | 1297 |

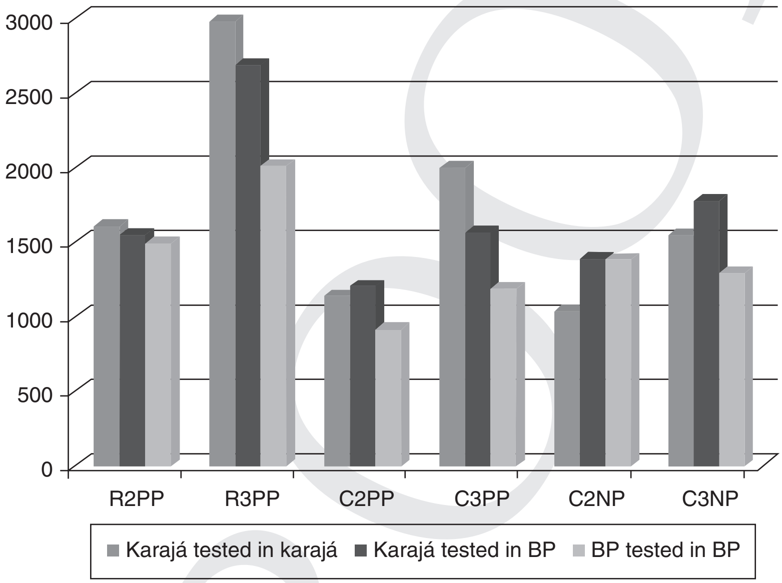



Figure 18.7 Average reaction times (ms) in the oral sentence/picture matching experiment

factors. Pairwise t-tests were also conducted across the conditions, supporting the hypotheses, as indicated in Table 18.2.

We interpreted these results as an additional piece of evidence that performance systems are habitual and may lie beyond narrow syntax in the domain of third-factor effects. As proposed by Trotzke, Bader, and Frazier (2013), performance systems must be taken as essential in the challenge to understand the boundaries of grammar. Note that Perez-Léroux et al. (this volume) offer acquisition evidence in line with our finding that PP embedding introduces an additional degree of complexity, in comparison with conjoined PPs.

Table 18.2 *Pairwise t-tests comparing conditions in the three groups of participants*

| | R2PP x C2PP | R3PP x C3PP | R2PP x R3PP | C2PP x C3PP |
|---|---|---|---|---|
| KK | t(46)=2.31 p<0.025 | t(46)=2.50 p<0.015 | t(23)=3.19 p<0.004 | t(23)=5.5 p<0.000 |
| KP | t(46)=2.44 p<0.018 | t(46)=3.52 p< 0.0010 | t(23)=2.20 p<0.038 | t(23)=1.41 p< 0.17 |
| BP | t(46)=2.73 p< 0.009 | t(46)=5.55 p< 0.0001 | t(23)=2.62 p< 0.015 | t(23)=2.12 p< 0.04 |

## 2 The Neurophysiological Assessment of Karajá Participants

With such interesting behavioral results in the sentence/picture matching, we set out to conduct an event-related brain potential (EEG-ERP) test, aiming at grasping subtler on-line effects that could be related to the reading of specific chunks of the stimuli. We carefully organized stimuli to be able to compare the electrophysiological responses (i.e., brain waves) related to the reading of SOV sentences containing three PPs, either conjoined or embedded in Karajá.

*Methods*

We recorded ERPs related to critical words (PPs) while participants read sentences in three different conditions: (1) coordinated PPs (thirty-two sentences); (2) embedded PPs (thirty-two sentences); and (3) fillers (sixty-four grammatical and sixty-four ungrammatical sentences). The independent variables were the number of embedded PPs (1, 2, and 3) and the number of coordinated PPs (1, 2, or 3). The dependent variables were the ERP latencies and amplitudes.

*Participants*

Eleven participants (nine males, 19–37 years old) were selected from a small group of Karajá speakers that were participating in an event in Rio de Janeiro. This is a smaller number of volunteers than usually tested, but the electrophysiological data were sufficiently reliable to analyze results. All participants were right-handed. Selection criteria required all participants to have normal or corrected-to-normal vision and to be native speakers of Karajá. Written consent was obtained from all volunteers before participation. After signing the consent form, the participants sat in front of a laptop screen, while the electrodes of a 21-channel EEG (EMSA, Brazil) were properly adjusted to their scalp,[3] following the 10–20 International System.[4]

[3] Electrodes were placed at the scalp by the use of electrolyte gels specifically formulated to make the metal tip of the electrode adhere to the scalp while providing the lowest impedance path (noise) for faithful measurement of EEG.

[4] The 10–20 International System is a standard method to place electrodes on the scalp so that different participants and different studies can be compared to each other.

Before starting the test, participants were instructed to read the computer screen as normally as possible and to try to understand the sentences so that they could judge if they were grammatical or not. They were instructed to indicate whether a sentence they read on the screen was grammatical by pressing the green key, or ungrammatical by pressing the red key on the keyboard. After instructions, there was a training session with ten stimuli that could be repeated until the participant was ready to start the test.

### *Stimuli and Presentation*

In Karajá, a sequence of PPs are embedded by juxtaposition, while a way of structuring conjoined PPs or DPs is by means of the particle *ijõ* 'other.' Tables 18.3 and 18.4 show a sample of the sixty-four experimental sentences (thiry-two with coordinated items and thirty-two with embedding). There were also 128 distracting fillers (sixty-four were grammatical and sixty-four contained a nonword).

Before starting the test, participants had to go through a training session to get used to the kind of sentences being tested. The idea was to clearly signal to the participant, as of the appearance of the first PP, that the sentence would have one of two structural possibilities: either a sentence with conjoined items (those that had the word *ijõ*) or a sentence with embedding (without *ijõ*). The sentences appeared on the screen in chunks, as can be seen in the experiment timeline (Figure 18.8).

Participants would first see a fixation cross for 500 ms. Then, after a 50 ms interval, the first word group displayed the sentence subject for 500 ms. After another interval of 50 ms, the second word group, displaying the object, appeared for 500 ms. Then, the three critical PPs, triggered so as to be time-locked to the ERP measurement, appeared on the screen for 500 ms each. Finally, there was a question prompt in relation to the grammaticality judgment of the sentence. The response was linked to a time-out routine of 1500 ms.

### *Results*

Figure 18.9 presents a comparison of stimulus sections corresponding to the three PPs. For the sentences with PP embedding, the waves from a central electrode (C3) are shown comparing the first embedded PP to the second one and the first to the third. The dependent measures, i.e., the voltages within the N400 mean voltage time-window, were analyzed by the Wilcoxon test and it was possible to eliminate the null hypothesis. The visual inspection of the N400 wave at trigger 3 clearly shows lower amplitude and shorter latency components than those of the two other triggers. These two attributes, lower amplitude and shorter latency, are usually interpreted as less complex computations. The first

Table 18.3 *Embedding*

| | | | | | |
|---|---|---|---|---|---|
| | | ↓ **Trigger 1** | ↓ **Trigger 2** | ↓ **Trigger 3** | |
| **Kua habu** | **utura** | **womati-ràbi** | **berysyna-roki** | **mana-tyretxi** | **riwyra** |
| *That man* | *fish* | *can from* | *bucket in* | *stone on top* | *took* |
| "That man took fish from the can in the bucket on top of the stone" | | | | | |

Table 18.4 *Conjoined*

| | | | | | |
|---|---|---|---|---|---|
| **1** | | ↓ **Trigger 1** | ↓ **Trigger 2** | ↓ **Trigger 3** | |
| **Kua habu** | **utura** | **womati-ràbi ijõ** | **berysyna-roki ijõ** | **mana-tyretxi** | **riwyra** |
| *That man* | *fish* | *can from other* | *bucket in other* | *stone on top* | *took* |
| "That man took fish from the can and from the bucket and from the stone" | | | | | |

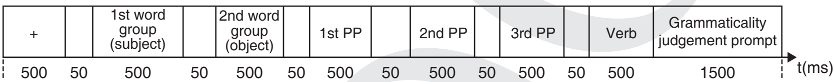



Figure 18.8 The experiment timeline

PP has a larger amplitude and longer latency than those of the others. This, in turn, indicates that higher structural complexity demands more energy and time.

While the two graphs relating to embedded structures show statistically different waves, the ones related to the coordinated structures show an overlapping pattern at 400 ms and were not statistically significant (p=0.6).

Despite the fact that the number of participants was not ideal in this experiment, it was possible to verify a number of aspects of the comparison between coordinated PPs and recursively embedded ones: (1) coordination computations seemed faster than those of embedding; (2) at each PP layer, the recursive embedding gets progressively easier and faster. Since there is an open morpheme signaling coordination in Karajá, a parametric comparison with a language that does not have an open morpheme marking coordination is desirable to understand the importance of this characteristic, computationally speaking.

## 3 The Neurophysiological Assessment of Brazilian Portuguese Participants

To understand the parametric difference between Karajá and BP, the former marking the coordination with an open morpheme (*ijõ*) but not the latter, we decided to run another EEG-ERP test, this time in BP, again comparing PP embedding with conjoining.

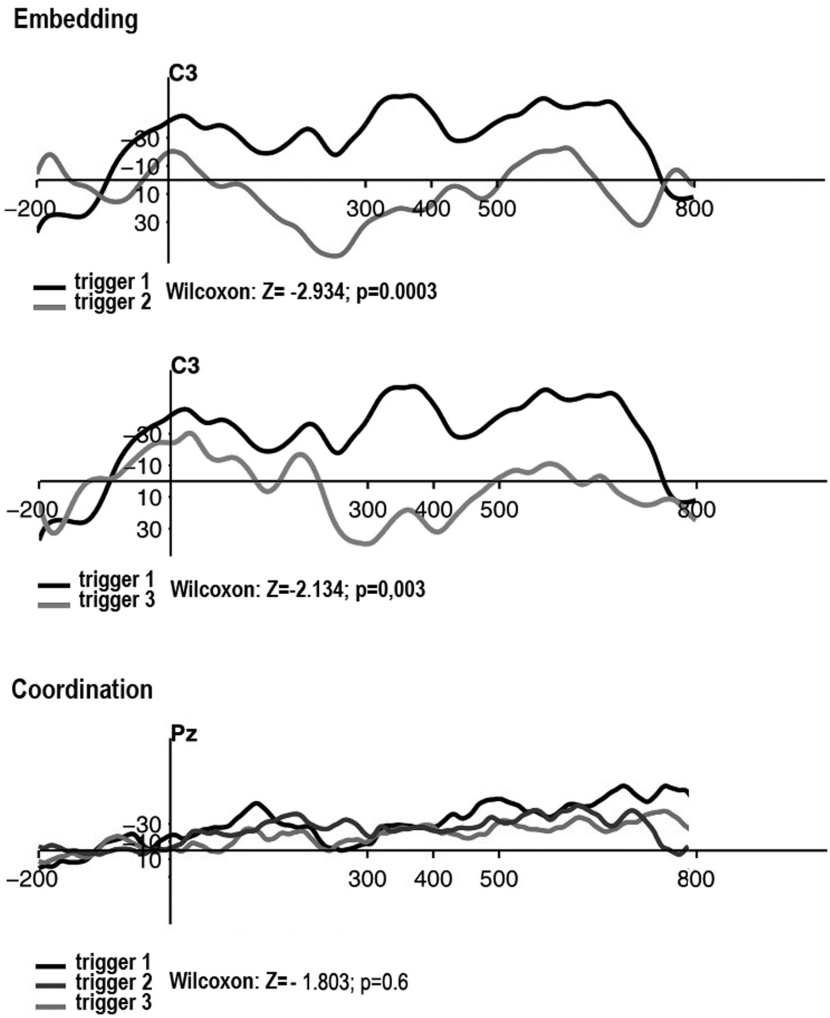



Figure 18.9 The waves corresponding to the different PPs both for the embedded conditions and for the coordination ones, sensed from a central-left electrode (C3)

*Methods*

We recorded ERPs to critical words (PPs) while participants read sentences in three different conditions: (1) coordinated PPs (thirty-two sentences); (2) embedded PPs (thirty-two sentences); and (3) fillers (sixty-four grammatical and sixty-four ungrammatical sentences). The independent variables were the number of embedded PPs (1, 2, and 3) and the number of coordinated PPs (1, 2, or 3). The dependent variables were the ERP latency and amplitude.

*Participants*

A total of thirty-nine participants (fifteen males), undergraduates from the Federal University of Rio de Janeiro, took part in this experiment. Participants were aged 18–34 (mean: 25;7). All participants were right-handed. Selection criteria required all participants to have normal or corrected-to-normal vision and to be native speakers of BP. Written consent was obtained from all subjects before participation. After being analyzed, the electrical signals from four participants were eliminated because they showed no response to over 30 percent of the trials. One participant was eliminated because she stood out from the standard deviation threshold by a factor of 3.

*Experimental Design*

In a 2×2 design, we manipulated two variables: (i) coordination versus embedding, and (ii) congruence versus incongruence. Coordinated sentences presented a sequence of three PPs in which the second and third could only be interpreted as being coordinated, since they presented the coordinating conjunction 'and,' whereas in the embedded sentences, the second and third PPs could only be interpreted by means of an embedded reading. Congruence was manipulated by adding an adverbial phrase at the end of the sentence, at the region known to give rise to the wrap-up effect. Manipulation made the sentences either make sense or not. Thus, lists of stimuli were compiled, each with ten items for four conditions (Table 18.5), as well as eighty fillers of which forty were congruous and forty incongruous, resulting in a total of 120 sentences per experimental list.

Participants were instructed to judge whether the sentence made sense or not at the end of each sentence, by pressing a key for YES and another one for NO. Sentences were presented in chunks of up to two words, respecting syntactic boundaries. Each chunk of the sentence was presented for 250 ms, followed by an interval of 100 ms. Before each sentence, a fixation cross was shown for 1500 ms, and after each sentence, participants had 2500 ms to respond.

Table 18.5 *Sample items*

| Condition | Congruous | Incongruous |
|---|---|---|
| Coordination | O zelador limpou as lixeiras da escada e do pátio e do prédio com cuidado (n=10)<br>*The janitor cleaned the trashcans on the stairs and on the patio and in the building carefully* | O contador calculou os lucros da drogaria e da livraria e da ótica depois de amanhã (n=10)<br>*The accountant figured the profit of the drugstore, and of the bookstore and of the eyeglasses store the day after tomorrow.* |
| Embedding | O contador calculou os lucros da drogaria da filial da empresa anteontem (n=10)<br>*The accountant figured the profit of one of the branches of the drugstore of the holding, the day before yesterday* | O zelador limpou as lixeiras da escada do pátio do prédio amanhã (n=10)<br>*The janitor cleaned the trashcans on the stairs and on the patio and in the building tomorrow* |

Sentences were presented on a computer screen, chunk by chunk, following the events depicted in Figure 18.10.

Each test started with a training session with eight sentences mixing the two experimental conditions and fillers. The training session could be repeated in case the participant was not completely sure of the procedures.

The test came immediately after the training, following a within-subject experimental design. Participants were tested in a single session lasting about one hour (including about 30 minutes of experimental preparation). Participants were randomly assigned to one of the two lists used, so as not to repeat tests across participants and to counterbalance participants across lists.

### *Data Acquisition and Analysis*

The EEG signals were recorded continuously from sixty-four sintered Ag/Ag–Cl electrodes attached to an elastic cap in accordance with the extended 10–20 International System (Nuwer et al. 1998). Several of these electrodes were placed in standard International System locations, including five sites along midline (FPz, Fz, Cz, Pz and Oz) and sixteen lateral/ temporal sites, eight over each hemisphere (FP1/FP2, F3/F4, F7/F8, C3/C4, T3/T4, T7/T8, P3/P4, and P7/P8). Also, another forty-three extended 10–20 system sites were used (AF3/AF4, F1/F2, F5/F6, FC1/FC2, FC3/FC4, FC5/FC6, FT7/FT8, C1/C2, C5/C6, CP1/CP2, CP3/CP4, CP5/CP6, TP7/TP8, P1/P2, P5/P6, P7/P8, PO3/PO4, PO5/PO6, PO7/PO8, CB1/CB2, O1/O2).

The EEG was referenced on-line to left and right mastoid channels. Impedances were maintained below 10 kΩ. EEG was amplified and digitized at

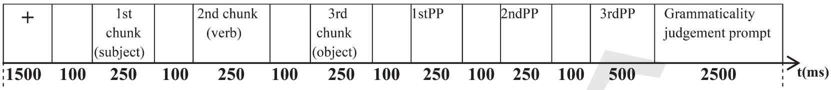



Figure 18.10 The experiment timeline

a sampling frequency of 500 Hz. After recording, data was filtered with a band-pass of 0.1–30 Hz. ERPs were averaged off-line within each experimental condition (coordination, embedding, congruous and incongruous) for each subject at each electrode site in epochs spanning −200 to 1000 ms relative to the onset of the target stimulus. Epochs characterized by eye blinks or excessive muscle artifacts were dependent on the experimenter's visual inspection. Accuracy was computed as the percentage of correct responses (min 95 percent).

ERP components of interest were identified based on visual inspection of ERPs, ROIs (regions of interest) and topographic maps, as well as prior findings. For each of the channels, we quantified ERPs for analysis as mean voltages within windows of 300–500 ms (capturing a broad negativity). Grand-averages were formed by averaging over participants.

These dependent measures, i.e., the voltages within the N400 mean voltage time-window, were analyzed with repeated measures ANOVAs. ANOVAs were performed separately at each electrode side, and then also averaged for analysis within six-channel-groups (see Figure 18.11). A three-way ANOVA model was used, and the factors were sentence-type (coordination, embedding), interval (1st PP, 2nd PP, and 3rd PP) and ROI (frontal-left, frontal-mid, frontal-right, central temp-left, central-mid, central temp-right, parietal-left, parietal-mid, parietal-right, occipital-left, occipital-mid, occipital-right).

The Greenhouse-Geisser correction for inhomogeneity of variance was applied to all ANOVAs with greater than one degree of freedom in the numerator. In such cases, the corrected *p* value was reported. Significant main effects were followed by simple-effects analysis.

*Results*

In an ERP test, visually inspecting the waves related to well-streamlined conditions gives an idea of how different these conditions are. Figure 18.12 is just a sample of the difference between embedded and conjoined PPs perceived at a central-parietal site. It is possible to follow each stimulus chunk in the two conditions, during the time-window of 1800 ms, that encompasses the five chunks of each stimuli. It is also possible to visualize both conditions running in parallel: the red line represents the electrical flow of coordination and the blue line, that of embedding. The black line represents the difference between the two conditions.

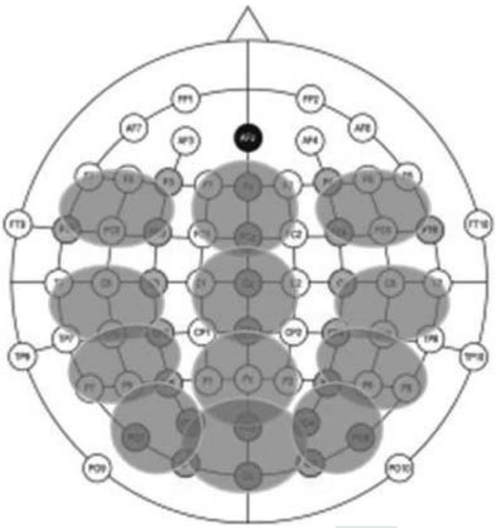


Figure 18.11 The gray shaded circles highlight the six regions of interest (ROIs) bilaterally distributed among a 64-channel scalp-electrode array, used for visual inspection and statistical analysis: frontal-left, frontal-mid, frontal-right, central temp-left, central-mid, central temp-right, parietal-left, parietal-mid, parietal-right, occipital-left, occipital-mid, occipital-right

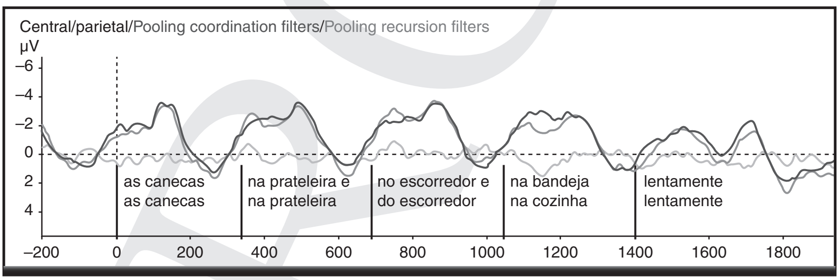



Figure 18.12 Grand-average ERPs recorded at central-parietal electrode midline sites. The onset of the critical DP and the three PPs is indicated by the vertical bars. Positive voltage is plotted down.

As can be seen, the black line flows relatively close to 0 μV, in the segments related to the second and third chunks of the stimuli that correspond to the first and second PPs. This means the conditions are not very different from each other. But at the fourth chunk, relating to the third PP, there is a more prominent difference, meaning the greatest contrast is between coordination and embedding of the third PP.

Beyond visual inspection, contrasts can be more accurately depicted in the statistical analysis of the waves, considering their main aspects: latencies and amplitudes. Starting with latencies, Table 18.6 shows the main effects. There is a main effect for the ROI comparisons. This means that when we subtract the waves related to the embedded stimuli from those of the conjoined ones, we can assume that each of the regions evaluated is different from zero.

Despite the fact that there was a main effect for latency in the ROIs, no other main effect could be observed in the interval or in the comparison between coordination and embedding as a whole. That is not critical, as the computations being compared here are qualitatively different and should not be relevant when all electrodes are averaged as a whole. Thus, an effect should not be expected in this kind of general comparison.

Figure 18.13 and 18.14 plot the coordination and embedding latencies, respectively, at different ROIs.

Embedding-related N400 latencies at relevant ROIs contrast with those related to PP layers connected by coordination at the second and the third PPs. While the coordinated PPs yielded in N400 latencies of similar value in the most relevant ROIs, the N400 latencies related with the embedding condition could be statistically differentiated at central, temporal, and parietal electrodes concerning the layers. Moreover, the third PPs show shorter latencies in all of the relevant ROIs. These results replicate those of the Karajá test. The PP embedding seems to be facilitated after the first layer, that is, after one enters the recursive embedding mode.

The amplitude differences that can be visually observed in the electric flow between coordinated PPs plotted together with embedded ones could be statistically testified by the main effect results plotted in Table 18.7.

The main effects for mean amplitude were observed in relation to interval (all electrodes as a whole) and ROIs, concerning the comparison between coordinated PPs and embedded ones. Nevertheless, a general comparison of latencies between coordination and embedding was not statistically relevant. This is probably due to the fact that the effect is qualitatively different among the three PP layers.

Figures 18.15 and 18.16 plot the coordination and embedding latencies, respectively, at different regions of interest (ROIs).

The results at relevant ROIs show that it is possible to differentiate among the PP layers connected by coordination by means of the statistically significant N400 amplitudes of the first, second and third PPs, an effect that is stronger on the left hemisphere ROIs. Since amplitudes are related to computational complexity, these results seem to point to a progressive facilitation at each PP within the coordination mode. The interesting aspect of this finding is

Table 18.6 *Main effect for mean latency: (a) comparison between two intervals (200–400 ms and 400–600 ms) was analyzed according to four different statistical criteria, with the most restrictive one being a Sphericity Assumption; (b) ROI with the same criteria; (c) Coordination versus Embedding (notated as Coor × Rec)*

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Power[a] |
|---|---|---|---|---|---|---|---|---|---|
| Interval | Sphericity Assumed | 53339.457 | 2 | 26669.729 | 1.030 | .363 | .033 | 2.060 | .222 |
| | Greenhouse-Geisser | 53339.457 | 1.901 | 28053.576 | 1.030 | .360 | .033 | 1.958 | .217 |
| | Huynh-Feldt | 53339.457 | 2.000 | 26669.729 | 1.030 | .363 | .033 | 2.060 | .222 |
| | Lower-bound | 53339.457 | 1.000 | 53339.457 | 1.030 | .318 | .033 | 1.030 | .166 |
| Error (interval) | Sphericity Assumed | 1553585.773 | 60 | 25893.096 | | | | | |
| | Greenhouse-Geisser | 1553585.773 | 57.040 | 27236.545 | | | | | |
| | Huynh-Feldt | 1553585.773 | 60.000 | 25893.096 | | | | | |
| | Lower-bound | 1553585.773 | 30.000 | 51786.192 | | | | | |
| ROI | Sphericity Assumed | 147778.316 | 12 | 12314.860 | 3.579 | .000 | .107 | 42.951 | .998 |
| | Greenhouse-Geisser | 147778.316 | 3.681 | 40151.011 | 3.579 | .011 | .107 | 13.174 | .836 |
| | Huynh-Feldt | 147778.316 | 4.259 | 34696.974 | 3.579 | .007 | .107 | 15.245 | .877 |
| | Lower-bound | 147778.316 | 1.000 | 147778.316 | 3.579 | .068 | .107 | 3.579 | .449 |
| Error (ROI) | Sphericity Assumed | 1238617.684 | 360 | 3440.605 | | | | | |
| | Greenhouse-Geisser | 1238617.684 | 110.417 | 11217.648 | | | | | |
| | Huynh-Feldt | 1238617.684 | 127.773 | 9693.864 | | | | | |
| | Lower-bound | 1238617.684 | 30.000 | 41287.256 | | | | | |
| Coor x Rec | Sphericity Assumed | 10994.349 | 1 | 10994.349 | 1.449 | .238 | .046 | 1.449 | .214 |
| | Greenhouse-Geisser | 10994.349 | 1.000 | 10994.349 | 1.449 | .238 | .046 | 1.449 | .214 |
| | Huynh-Feldt | 10994.349 | 1.000 | 10994.349 | 1.449 | .238 | .046 | 1.449 | .214 |
| | Lower-bound | 10994.349 | 1.000 | 10994.349 | 1.449 | .238 | .046 | 1.449 | .214 |
| Error (Coor × Rec) | Sphericity Assumed | 227669.651 | 30 | 7588.988 | | | | | |
| | Greenhouse-Geisser | 227669.651 | 30.000 | 7588.988 | | | | | |
| | Huynh-Feldt | 227669.651 | 30.000 | 7588.988 | | | | | |
| | Lower-bound | 227669.651 | 30.000 | 7588.988 | | | | | |

Tests of Within-Subjects Effects
Measure: latency

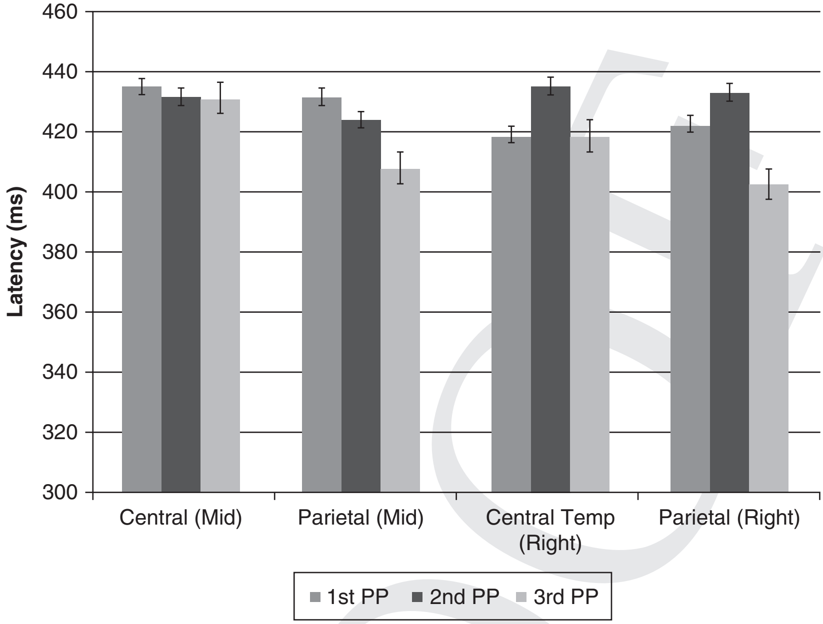



Figure 18.13 Coordination latencies of the N400 at relevant ROIs

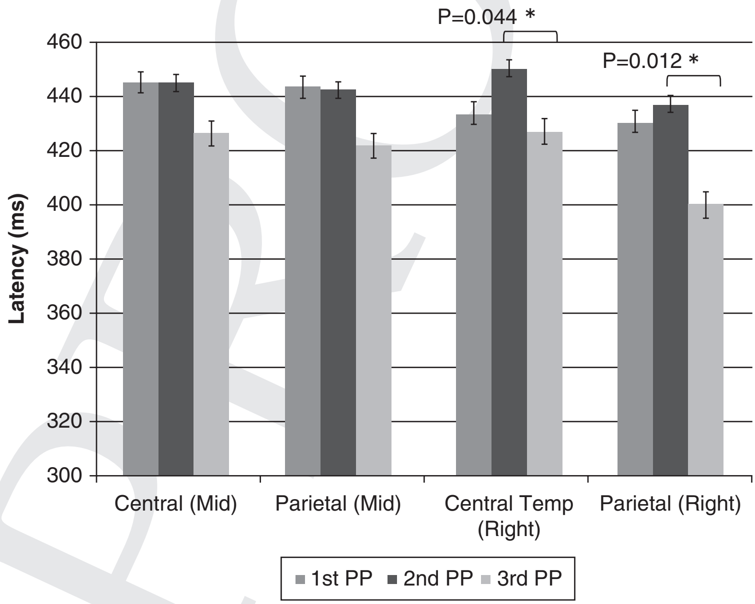



Figure 18.14 Embedding latencies of the N400 at relevant ROIs

Table 18.7 *Main effect for mean amplitude: (a) comparison between two intervals (200–400 ms and 400–600 ms) was analyzed according to four different statistical criteria, with the most restrictive one being a Sphericity Assumption; (b) ROI with the same criteria; (c) Coordination versus Embedding (notated as Coor × Rec)*

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig | Partial Eta Squared | Noncent. Parameter | Observed Power[a] |
|---|---|---|---|---|---|---|---|---|---|
| Interval | Sphericity Assumed | 326.945 | 2 | 163.473 | 9.093 | .000 | .233 | 18.186 | .969 |
| | Greenhouse-Geisser | 326.945 | 1.845 | 177.214 | 9.093 | .001 | .233 | 16.776 | .959 |
| | Huynh-Feldt | 326.945 | 1.960 | 166.783 | 9.093 | .000 | .233 | 17.825 | .967 |
| | Lower-bound | 326.945 | 1.000 | 326.945 | 9.093 | .005 | .233 | 9.093 | .831 |
| Error (interval) | Sphericity Assumed | 1078.656 | 60 | 17.978 | | | | | |
| | Greenhouse-Geisser | 1078.656 | 55.348 | 19.489 | | | | | |
| | Huynh-Feldt | 1078.656 | 58.809 | 18.342 | | | | | |
| | Lower-bound | 1078.656 | 30.000 | 35.955 | | | | | |
| ROI | Sphericity Assumed | 2955.186 | 12 | 246.266 | 16.018 | .000 | .348 | 192.211 | 1.000 |
| | Greenhouse-Geisser | 2955.186 | 2.671 | 1106.516 | 16.018 | .000 | .348 | 42.778 | 1.000 |
| | Huynh-Feldt | 2955.186 | 2.956 | 999.642 | 16.018 | .000 | .348 | 47.352 | 1.000 |
| | Lower-bound | 2955.186 | 1.000 | 2955.186 | 16.018 | .000 | .348 | 16.018 | .972 |
| Error (ROI) | Sphericity Assumed | 5534.903 | 360 | 15.375 | | | | | |
| | Greenhouse-Geisser | 5534.903 | 80.121 | 69.081 | | | | | |
| | Huynh-Feldt | 5534.903 | 88.687 | 62.406 | | | | | |
| | Lower-bound | 5534.903 | 30.000 | 184.497 | | | | | |
| Coor × Rec | Sphericity Assumed | 3.372 | 1 | 3.372 | .032 | .859 | .001 | .032 | .053 |
| | Greenhouse-Geisser | 3.372 | 1.000 | 3.372 | .032 | .859 | .001 | 032 | .053 |
| | Huynh-Feldt | 3.372 | 1.000 | 3.372 | .032 | .859 | .001 | .032 | .053 |
| | Lower-bound | 3.372 | 1.000 | 3.372 | .032 | .859 | .001 | .032 | .053 |
| Error (Coor × Rec) | Sphericity Assumed | 3160.276 | 30 | 105.343 | | | | | |
| | Greenhouse-Geisser | 3160.276 | 30.000 | 105.343 | | | | | |
| | Huynh-Feldt | 3160.276 | 30.000 | 105.343 | | | | | |
| | Lower-bound | 3160.276 | 30.000 | 105.343 | | | | | |

Tests of Within-Subjects Effects
Measure: meanAmp

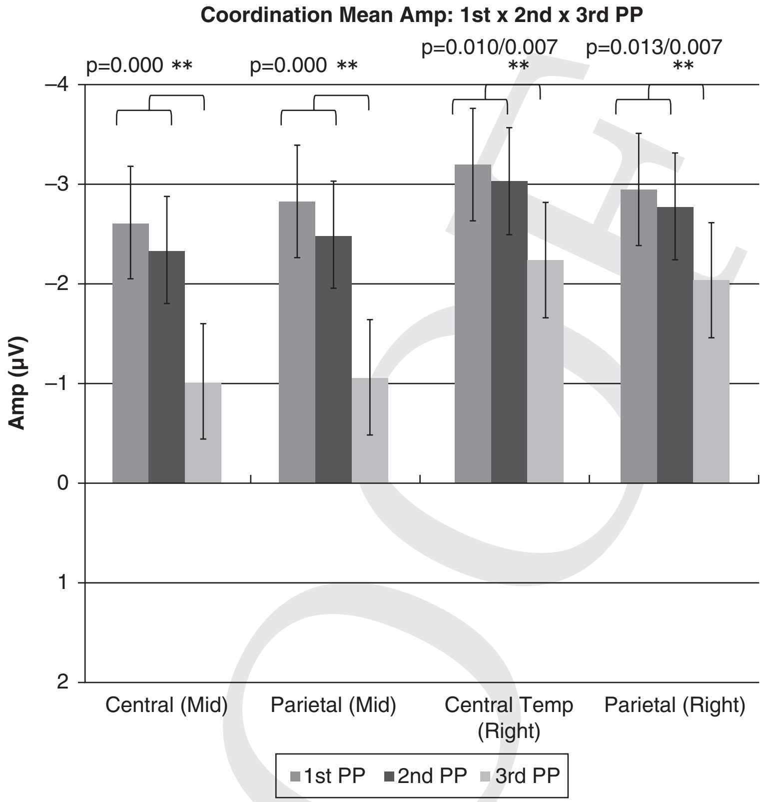



Figure 18.15 Coordination mean amplitudes of the N400 at relevant ROIs

that, as seen in Figures 18.13 and 18.14, this facilitation does not result in time advantage, since coordination of PPs presented the same latency times for each PP. As could be imagined, coordination must involve more memory resources,[5] often linked to increased processing time, but not necessarily more complex operations. It is possible that this effect was not found in Karajá because of the coordination morpheme that might make processing simpler.

Similar to the coordinated PPs, but not as strong and not as widespread, the N400 latencies for embedded PPs yielded different values in the most relevant

[5] Rummer, Engelkamp, and Konieczny (2003) provide relevant independent experimental evidence showing that subordinate sentences are merged more easily in memory than coordinate sentences. They also present an extensive literature review about memory research, starting from Miller: "the span of absolute judgment and the span of immediate memory impose severe limitations on the amount of information that we are able to receive, process, and remember. By organizing the stimulus input simultaneously into several dimensions and successively into a sequence or chunks, we manage to break (or at least stretch) this informational bottleneck" (Miller 1956:96).

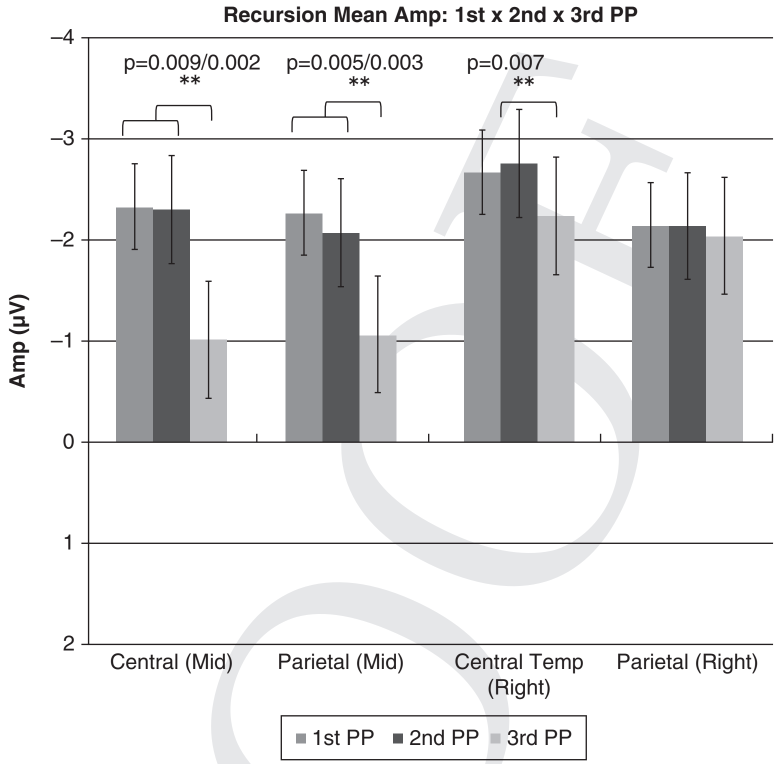



Figure 18.16 Embedding of PPs' mean amplitudes for the N400 at relevant ROIs

ROIs. Therefore, the N400 latencies related with the embedding condition could be statistically differentiated, showing a smaller amplitude at each PP. This progressive facilitation is followed here by time advantage. This result seems to replicate the results we found in Karajá, which made us conclude that the processing of the PPs seems to be facilitated after one enters the recursive embedding mode.

## 4 Conclusions

Despite the fact that the tests differed in methodology, i.e., a chronometric off-line psycholinguistic test with oral stimuli versus on-line electrophysiological ERP tests with visual stimuli, the results showed a marked facilitation of coordination compared to embedding.

Both Karajá and BP PP coordination and embedding, tested off-line and on-line, yielded compatible results in two aspects: (i) the three types of stimuli listing one, two, and three coordinated words had similar RTs and ERP latencies; (ii) coordination yielded earlier RTs and N400s than those of embedding; and (iii) strikingly, as to the embedded stimuli, there was a progressive facilitation going from the constructions with one PP layer, to two and three PPs. Thus, since marked N400s are connected with difficulties in word integration with the working context, according to this view, the more salient the N400, the harder the combinatorial process (Kutas and Hillyard 1980, 1984; Brown and Hagoort 1993; França et al. 2004; Lau, Phillips, and Poeppel 2008).

Our interpretation is, therefore, that embedding is the result of a syntactic algorithm that is costly to be launched, but once established, does not pose any extra significant effort to the system.

This result is striking also in view of the fact that the embedding condition has an inherent supplement of complexity, which is semantic restrictiveness. However, it can be explained because, within the ERP sensitivity, syntax is accessed earlier than semantics. Very early ERPs, within the 100–200 ms timeframe, are known to be sensitive to phrase structure building (Lau et al. 2008; Kim and Gilley 2013).

Additionally, the N400 in fact also reflects the minute semantic manifestation of syntax, the kind of semantics that derives anticipating meaning from syntactic configuration and not from root meaning (Lau, Holcomb, and Kupperberg 2012). If this is the case, then maybe the N400 does not result from lexical-level processes, but might be related to the effort to perform a combinatorial process: the syntactic head-complement combination.

Thus, we argue here that our ERP results reflect the basic syntactic algorithm of embedding, in contrast with the off-line psycholinguistic test, which probably captured cumulative semantic effects of restrictiveness.

Finally, it should be clear that we are not arguing here that embedding can be reduced to a processing effect, since such a conclusion could not be granted by the very findings in two sets of experiments conducted: our coordination results yielded faster RTs and shorter latency ERPs than those of recursively embedded PPs. More importantly, we assume that the two kinds of Merge that are necessary to coordinate and to embed PPs are not extra-grammatical, but primitive narrow faculty computations. However, the subtlety of the ERP results, disentangling syntactic and semantic computations, allowed us to ponder that since syntactic facilitation does appear in the subsequent embedding, a performance or third-factor phenomenon might be connected to this facilitation. Embedding is hard to deploy, but once engaged in its algorithm, subsequent embedding is facilitated.

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