# Chapter 1
# Pragmatics as the Origin of Recursion

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## Introduction

Hauser, Chomsky, and Fitch (2002) speculate that perhaps the sole feature of language that may be domain specific is the recursive nature of syntax. The implication is that it was the evolution of this syntactic ability that accounts for the species-unique character of human language. This chapter sets out a rival possibility, namely, that the focal type of recursion—understood here as centre embedding—has its natural home in principles of language use, not language structure.

The different senses of 'recursion', and the formal characterization of each of them, are amply discussed elsewhere in this volume. One notion in particular has played a central role in discussion, namely, centre embedding where one clause is embedded within another, as in *The rat the cat killed ate the malt* (Chomsky & Miller, 1963), a pattern isomorphic with a mirror language like ABBA or ABCCBA where there are nested dependencies. Like the 'counting language' (AAABBB), nested dependencies are—if of unrestricted depth—the stigmata of context-free languages. From a comparative linguistic point of view, central embedding is particularly interesting compared to edge recursion (as in *John thought he'd come*) since it is more easily distinguished from strings of sentences without an embedding relation (a practical problem rehearsed below). Hence centre embedding will have a central place in these remarks.

It is worth emphasizing that no string set can be assigned unambiguously to the context-free languages unless there is evidence of indefinite recursion.

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Besides, Chomsky soon realized that string patterns themselves are not the proper objects of study: what is psychologically interesting is the *structure* we map on the strings, which is nearly always underdetermined by the strings alone.

## Pragmatics and Embedded Construals

At the outset of generative grammar (Chomsky, 1957), the close relation was noted between sentence (1a) and the mini-discourse in (1b)—indeed the proposal was that (1a) was derived from (1b) by syntactic 'generalized transformation':

(1a) The ship which was the largest of its kind sank in high seas.
(1b) The ship sank in high seas. It was the largest of its kind.

That model of syntax is long gone, but the insight that strings of sentences are construed in complex ways remains and the striking systematicity of some of this has been explored in Gricean pragmatics (e.g. Levinson, 2000) or rhetorical structure theory (Mann & Thompson, 1988). For example, (2a) is naturally construed as (2b) and (2c) as (2d):

(2a) Buy a ticket. Win a thousand dollars!
(2b) If you buy a ticket, you can win a thousand dollars!
(2c) Sue screamed. Bill left.
(2d) Because Sue screamed, Bill left.
(2e) John may have been partly at fault. But Bill must take the blame.
(2f) Although John may have been partly at fault, Bill must take the blame.

Note how these construals mirror the more complex syntax of English, with relative clauses (as in (1)), conditionals (as in 2b), causal subordination (as in 2d) and concessives (as in 2f). We rely on these interpretations all the time in our understanding of texts (consider *veni*, *vidi*, *vici*).

Although no one has done the careful work to actually establish this, these kinds of construals seem universally available. Certainly I have encountered them in languages as diverse as Guugu Yimithirr, Tzeltal, Tamil or Yelî Dnye. It is the widespread availability of such understandings that makes it possible for many languages to simply not provide a conditional or relative clause (e.g. Guugu Yimithirr) or a disjunction (Tzeltal) or a concessive or causal connective (Yelî Dnye). We turn now to the case of languages that seem to offer quite restricted possibilities of embedding in their syntax.

## Languages with Restricted Embedding

Linguistic typologists are well aware that many languages show little evidence of indefinite embedding.[1] Recently, Pirahã has been a focus of debate, with the original fieldworker (Everett, 2005) claiming no evidence at all for recursive structures

[1] See, for example, the discussion of Amele in Comrie & Kuteva (2008).

and generativist reanalysis suggesting that embedding may in fact be evidenced (Nevins, Pesetsky, & Rodrigues, 2009). Analysis hinges on the distinction between embedding and parataxis and on whether (3) should be analysed as (a) (Everett) or (b) (Nevins et al.):

(3) *Hi xob-a'axa'ı'. Hi kahaı' kai-sai.*
He see-well. He arrow make-OLD.INFO
a.Everett: 'He is really smart. He makes arrows (as we were saying)'
b.Nevins et al. 'He is really good [COMP at making arrows]'

What is not in doubt, however, is that embedding is very limited and at most seems capped at one level deep.

As discussed above, it is the unlimited character of nested dependencies that is relevant for the theoretical issues. But in lacking evidence of indefinite recursion, Pirahã is not unique at all. The Australian languages provide a wealth of well-documented cases. As Hale (1976) pointed out,

> *In a large number of Australian languages, the principal responsibility for productive recursion in syntax is shouldered by a structure which I will refer to as the adjoined relative clause. It is typically marked as subordinate in someway, but its surface position with respect to the main clause is marginal rather than embedded—hence the locution 'adjoined'. Typically, but not invariably, it is separated from the main clause by a pause.*

A further property is that these juxtaposed sentences with the structure S1 + (particle) S2 function with a wide array of possible interpretations as relatives, temporal clauses, conditionals, etc. Hale (1976) pointed out that the Warlpiri sentence in (4) allows any of the indicated readings (the square brackets in the examples below indicate the putative embedded clause):

(4) *Ngajulu-rlu kapi-rna maliki rluwa-rni, [kaji-ngki yarlki-rni nyuntu].*
1-ERG AUX dog shoot-NP COMP?-AUX bite-NP you
a. 'I will shoot the dog, if / …when it bites you.'
b. 'I will shoot the dog that bites you / …that is going to bite you.'

Although Warlpiri has a particle that may be analysed as a complementizer, many Australian languages do not. It then becomes a completely live issue as to whether we are dealing with structural dependence or parataxis with 'subordinate'-like construals. Consider the following Wambaya sentence (Nordlinger, 2006):

(5) *[ Ilarri irri ngarabi ] daguma irri-ngg-i.*
grog.I(ACC) 3.PL.A(NP) drink hit 3.PL.A-RR-FUT
a. 'They'll drink grog (and then) they'll fight' (coordinate construal)
b. 'When they drink grog, they'll fight' (subordinate construal)

Nordlinger argues that the 'subordinate' construal may be forced by prosody, but as Hale noted there is often a pause between clauses of these types in Australian languages generally. It will not be easy then to come to a definitive conclusion either way, just as in the Pirahã case.

Many Australian languages nevertheless have some cases of relatively clear subordination. But in these cases indefinite embedding is hard to support, because the embedded verb typically takes a nominal case, for example, a purposive. This often constrains further embedding. Consider Kayardild (Evans, 1995) which adds an oblique case (COBL) to each of the subordinate constituents, as in (6). This case is terminal, so no further subordination is possible:

(6) *Dan-da* *banga-a* *[ kakuju-ntha* *ngijuwa* *raa-jarra-ntha* *walbu-nguni-nj ]*
This-NOM turtle-NOM uncle-COBL 3rdSUB.COBL spear-PST-COBL raft-INSTR-COBL
'This is the turtle [ uncle speared from the raft ]'

It is thus not possible to add, say, a relative clause to 'the raft'. Kayardild consequently systematically blocks recursion at one level deep. In general, polysynthetic languages show very restricted levels of embedding (see Evans & Levinson, 2009). And, in the opposite direction, languages with very limited morphology often offer no clear evidence for subordination at all (see, e.g. Englebretson (2003) on Indonesian). Pirahã is thus not an isolated case.

A frequent response to these sorts of findings is to invoke the metaphor of UG as a 'toolkit' whose tools may not be all deployed (as in Jackendoff, 2002): 'the putative absence of obvious recursion in one of these languages is no more relevant to the human ability to master recursion than the existence of three vowel languages calls into doubt the human ability to master a five- or ten-vowel language' (Fitch, Hauser, & Chomsky, 2005). But this sits uncomfortably with the claim (Hauser et al., 2002) with which we began, namely, that 'recursion' (understood as embedding) may be the one crucial domain-specific feature of linguistic ability: such a crucial design feature ought to be evidenced in any language system.

## Centre Embedding in Syntax

It has long been noted that there are comprehension problems associated with repeated centre embeddings. Chomsky and Miller (1963) said of the sentence *The rat [the cat [the dog chased ] killed] ate the malt* that it is '… surely confusing and improbable but it is perfectly grammatical and has a clear and unambiguous meaning'. They assumed that such sentences are licensed grammatically but run up against performance processing difficulties. There have been numerous theories since about why exactly the processing is difficult, but all revolve around short-term memory limitations (Folia et al., 2011; Gibson, 1991, 1998; Kimball, 1973; Perfors, Tenenbaum, Gibson, & Regier, 2010; Weckerly & Elman, 1992). Gibson (1998; Gibson & Thomas, 1999), for example, suggested that the problem not only involves keeping track of a number of unfulfilled dependencies but also follows a locality

metric: hence nested dependencies three or more deep are more difficult than cross-serial dependencies (Bach, Brown, & Marslen-Wilson, 1986), where the dependencies are serially and more locally discharged (see De Vries, Petersson, Geukes, Zwitserlood, & Christiansen, 2012 for recent confirmation). These studies repeatedly show severe performance difficulties at three levels of embedding or higher (Marks, 1968), allowing a connectionist account of performance (Christiansen & Chater, 1999).

Karlsson (2007) examined corpora in seven European languages (English, German, Finnish, French, Latin, Swedish, Danish). He found that in the Brown corpus of English written texts, 57 % of clauses have embeddings, of which 76 % were final, 13 % were initial and 11 % were centre embeddings (mostly relative clauses). This seems to be the general pattern at least for familiar languages of similar word order, but polysynthetic languages show a much lower incidence of embedding (e.g. 7 % for Mohawk, 6 % in Gunwinggu and just 2 % in Kathlamet; Mithun, 1984). Centre embeddings can be classified as degree 1 (one embedding), degree 2 (embedding within an embedding) and degree 3 (embedding within an embedding within an embedding). The following gives a (simplified) example of Karlsson's coding:

(7) Karlsson (2007)

| | | |
|---|---|---|
| 1 | *"If* | ← degree 1 subordinate clause |
| | 2 *as often happened* | ← degree 2 center-embedding |
| 1 | *she asked him* | |
| | 2 *to tell her about it* | ← degree 2 complement |
| 0 | *she thought* | ← matrix-clause (degree 0) |
| 1 | *that he* | ← degree 1 complement |
| | 2 *who had been so kind* | ← degree 2 center-embedding |
| 1 | *would understand* " | |

No examples of degree 3 embedding were found in corpora, although from hand-annotated historical texts from his and other earlier compilations, a total number of 13 cases have been found in the whole of Western literature. He therefore observes that the maximal degree of multiple centre embedding is three in written language. For spoken language, no cases at all have been found, and only three cases of degree 2 have been found, from which he concludes that degree 2 is the upper bound for spoken language. These findings are of course interesting, since they undermine the idea that natural languages are not regular and necessarily context-free or higher—it remains an interesting question whether treating, say, English as regular (with large numbers of simple rules) is more complex than treating it as context-free (with less more complex rules; see Perfors et al., 2010 on such trade offs).

The psycholinguistic findings and the corpus findings converge: after degree 2 embedding, performance rapidly degrades to a point where degree 3 embeddings hardly occur.

## Centre Embedding in Interactive Discourse

We are now in a position to appreciate a rather surprising phenomenon.[2] There are embeddings in interactive discourse that have the same basic properties exhibited in sentential syntax, but which are distributed over two or more speakers. Yet in this case there is no similar limit on embedding—multiple embeddings seem in principle indefinite, certainly at least of degree six.

The basic phenomenon is illustrated in 8. (Examples will be drawn largely from interaction in service encounters, e.g. from Merritt (1976), as these l end themselves to brief exposition.)

(8) A: "May I have a bottle of Mich?"
B: "Are you twenty one?" ← degree 1 center-embedding
A: "No" ← response at degree 1
B: "No"

Clearly, in this interchange the second question leaves the first unanswered until a preliminary question is addressed, which then allows the answer to the first question to be subsequently provided. The question–answer pair in the middle forms an island over which a discontinuous dependency is maintained. In these kinds of insertion sequences, paired utterances are embedded at the same level together. We have here a nested dependency just as in *The boy the horse kicked has a broken leg*. Sequences of this type $Q_1Q_2A_2A_1$ belong squarely in the class of the counting or mirror languages, the prototypes of context-free languages. A context-free grammar that would generate strings $Q^nA^n$ indefinitely might have the rules Q&A → Q (Q&A) A, Q&A → Q A.

Like nearly all the demonstrations of context-freeness in syntax, the assignment of structure to utterances in these cases is relative to a construal. In this case the construal depends not on the syntax and semantics so much as the speech act or illocutionary force: regardless of form or semantic content, the dependencies hold across utterances paired by function—across 'adjacency pairs' in the terminology of conversation analysis (Schegloff, 2007).

How deep do such embeddings go? Consider (9).

[2] The observations are not new, but take on a new significance in the light of recent discussion. They were made early in conversation analysis (e.g. Sacks, 1995 [1967]; see Schegloff (2007) for review), and I even pointed out their significance in terms of the Chomsky hierarchy 30 years ago (Levinson, 1981), noting however a number of non-syntax-like properties. See also Koschmann (2010). Merritt (1976) also discussed a range of discourse structures in services encounters, including embeddings.

(9) Merritt (1996)

C: Do you have master carbons? ← Q(0) (Pre-Request)
S: (pause) Yes, I think we do ← A(0)
What kind do you want? ←Q(1)
C: How many kinds do you have? ← Q2
S: Well, there are carbons for gelatin duplicators, and carbons for spirits ← A2
C: Well I'll take the carbons for spirits, please ← A(1)
S: ((goes to get)) ← Action(0)

Here we have a Q–A pair embedded within a Q–A pair embedded within a request–compliance pair and thus an embedding of degree 2—a depth that occurs vanishingly rarely in spoken language syntax, but which in spoken discourse is routine. As the bracketing makes clear, this is a pushdown stack, responses climbing back up the stack. That is because speech acts tend to come in 'adjacency pairs', so that a question expects an answer in next turn; where the adjacency criterion is not met, an answer is nevertheless still due.

There are a range of reasons for these 'insert sequences', but typically the inserted adjacency pairs deal with a prerequisite for handling the initial action (Schegloff, 2007). One prerequisite is hearing or understanding the prior turn. Thus (10) is an example of a different type involving other initiation of repair, with a further repair initiation on the first repair initiator. It takes us to degree 3 embedding, well beyond the attested bound for recursive embedding in spoken language:

(10) Merritt (1976)

S: Next ← Request to order (0)
0 C: Roast beef on rye ← Order (0)
1 S: Mustard or mayonnaise? ← Q(1)
2 C: Excuse me? ←Repair Initiator (2)
3 S: What? ← Repair (3)
3 C: Excuse me, I didn't hear what you said ← Repair (3)
1 S: Do you want mustard or mayonnaise? ← Repair(2)
C: Mustard please ← A(1)
0 S: ((provides)) ← Compliance with order (0)

Finally, consider (11), where a series of queries within queries takes us to degree 4, exceeding any attested depth of embedding in natural language syntax.

(11) Abbreviated from Levinson (1983)

C: .. I ordered some paint… some vermillion…..

And I wanted to order some more, the name's Boyd ←Pre-Order (0)

R: Yes how many tubes would you like sir? ←Q(1)

C: .. What's the price now with VAT? ←Q(2)

R: I'll just work that out for you ←Hold(3)

C: Thanks ←Accept Hold(3)

(10.0)

R: Three pounds nineteen a tube sir ←A(2)

C: Three nineteen is it= ←Q(3)

R: Yeah ←A(3)

C: That's for the large tube? ←Q(4)

R: Well yeah it's the 37 ccs ←A(4)

C: I'll just eh ring you back I have to work out how many I'll need ←Hold (2) for A(1)

((call-back with order and acceptance)) ← (0)

Human subjects performing psycholinguistic tests in an artificial-grammar learning paradigm show large degradation in performance at and after degree 3 embedding—'whereas two nested dependencies are still within our processing limits, three nested dependencies appear to be beyond what we can process' (De Vries et al., 2012). In contrast, the deepest attested nesting of centre-embedded insertion sequences seems to be of at least degree 6 (see Levinson (2013) and citations there).

## Discussion

It has been argued here that recursive embedding in syntax is not necessarily a prominent feature of languages—in some large class of languages (yet to be exactly determined, but including many Australian languages), it is either not clearly evidenced or capped at a very shallow level. These languages provide no evidence, therefore, that a core element of language design is indefinite embedding of the kind produced by a context-free grammar. On the other hand, whether or not languages have clear syntactic embedding, they always seem to make use of 'pragmatic embedding' as it were—that is uncoded construals that understand clauses as if they were complements, relative clauses or temporally subordinate. The two facts together suggest that 'recursion' understood propositionally (as relations between propositions) is not so much a universal property of grammar as a property of human psychology, most evident in language use.

Examining the patterning across turns in interactive discourse (dialogue in most of the cases examined), we find a curious analogue of the recursive embedding that has so much exercised linguists. Turns at talk are tied to each other as responses to prior speech acts, typically across adjacency pairs like question–answer, request–compliance and offer–acceptance. When so construed, we see that pairs of utterances may be embedded within other pairs of utterances, apparently with little effort and to a much great depth than is exhibited in syntax. Once again, pragmatics outplays syntax.

This phenomenon raises a central question: how can we explain that what is apparently cognitively impossible in syntax (namely, indefinite centre embedding) is so straightforward in the pragmatics of dialogue? The dialogue facts seem to rule out the idea that there is an absolute performance barrier due to short-term memory limitations; they also seem to undermine the idea that the difficulty found in syntax is based on holding dependencies over a lot of intermediate material (Gibson's, 1998 locality effects). In the dialogue case, exactly the same pushdown stack structure is involved, and the range over which these dependencies have to be held in memory can be immense (see Levinson (2013) for an example spanning 80 turns).

Perhaps the mystery can be partly dissolved in the following way. Note that our action planning system in general needs to be able to hold a stack of subgoals, and check them off one by one—to make the tea may require calling the water-getting subroutine, which may require the kettle-finding subroutine, etc. Many aspects of language use are best explained in terms of joint-action planning (Clark, 1996; Levinson, 2013), so that language usage is able to draw directly on the cognition of our action systems in a way that syntax cannot. Note that the indefinite centre embedding in interactive discourse is construed over speech acts—actions in linguistic clothing. In addition, interactive language use is 'distributed cognition' par excellence, and this may somehow lower the processing load, although to participate effectively in such joint action, each party must nevertheless model the whole emerging structure. If action, and specifically joint action, is indeed the root of this ability to parse embedded structures, then the more abstract and removed from this domain a mental task is, the more restricted human processing of this kind may be expected to be. That might explain our limited prowess in syntax. But this is speculation.

When an ability is much more developed in one arena than another, it seems reasonable to surmise that it is primarily adapted for the more developed arena. The inference then is that syntactic embedding may have evolved out of our capacities in the dialogue arena, which in turn draws directly on joint-action abilities. There is just some general evidence for this in the discourse sources of complex constructions. Geluykens (1992), for example, has shown that complex constructions like left dislocations are often interactionally produced with a slot for a minimal response. Likewise, specialists have noted that in language genesis, in the progression from pidgin to creole, paratactic constructions give rise to subordination (Sankoff & Brown, 1976). Thirdly, in child language development, structures like conditionals seem to arise from a distribution of turns across speakers (De Castro Campos, 1981, following Jespersen's, 1940): there are thus at least three lines of evidence—from corpora, from creolization or language change and from child language—that may suggest an origin of complex syntax in interactive language use.

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