WORKING BACKWARDS FROM MODERN LANGUAGE TO PROTO-GRAMMAR

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The possibilities for a stepwise evolution of grammar are evaluated through an analysis of which components of modern human grammar are removable, and in what order, while still leaving a functional communication system. It is found that recursivity is a prime candidate for being a late evolutionary addition, with flexibility and hierarchical rules coming next. Furthermore, it is argued that recursivity need not be the unitary infinite-loop concept of formal grammars, but can evolve in several smaller steps.

1. Introduction

Communication is certainly possible without grammar, as shown by the communicative abilities of both agrammatic patients and children at the one-word stage of language acquisition, and our remote ancestors certainly lacked grammar, as they lacked language in any form. This means that grammar, and syntax in particular, must have emerged during the course of human evolution.

It is sometimes argued that modern human grammar is a monolithic system that cannot be built piece by piece (e.g. Chomsky, 1972). But I will argue that such a stepwise construction of grammar (or deconstruction, from the perspective of modern grammar) is perfectly possible if the structure of grammar is looked at from an appropriate perspective, and the pieces are added in the right order — not all aspects of grammar are totally interdependent (cf. Jackendoff, 1999; Pinker & Jackendoff, 2005). Certainly, if any component of modern human language is removed, what is left is not equal to modern human language — but it may still be a functional language, if not as rich and expressive as what we're using today. A language with proto-syntax, missing one or two principles of modern grammar, may not be adequate to write this paper — but may nevertheless be adequate for the daily life of proto-humans.

2. Syntax precursors?

Useful exaptations or precursors for syntax among the capacities likely to be present among our pre-linguistic ancestors are difficult to identify, and even more

difficult to verify, though more or less speculative ideas abound.

The cognitive capacity needed to handle relational concepts would appear necessary. Several authors seek to base this relational capacity in social interactions or 'social scripts', e.g. Worden (1996), Tomasello (1999), Aiello (1998), or Calvin and Bickerton (2000). Others invoke tool-making in a similar role (Greenfield, 1991; Ambrose, 2001; Wildgen, 2004).

Armstrong et al. (1995) invoke the temporal structure of sign sequences as the roots of syntax, similar to the model for syntax origins proposed by Condillac (1746), an intriguing possibility as an iconic sign sequence describing mimetically an action indeed naturally possesses a rudimentary structure that might be a reasonable syntax precursor.

Nevertheless, none of these or other proposed syntax precursors takes us very far along the road towards modern human grammar, and there is little direct evidence supporting any of them.

3. Working backwards from modern grammar

What happens if we look at the problem from the other end, not at possible syntax precursors, but at modern human grammar, and contemplate which components of modern grammar might be removable? Removability of a component from a modern grammar reasonably entails its addability to a proto-grammar.

A definitive analysis of the removability of different components or principles of grammar requires that we know what these principles are. However, as noted by Edelman and Pedersen (2004):

> ...we have, as yet, no comprehensive, psychologically real and neurobiologically grounded process model for language, and with a descriptive model there is a distinct possibility that the features we believe to be important are in fact immaterial (p. 399).

The Chomskian paradigm, e.g. (1995), is one such descriptive model, popular with many linguists. But there are several competing theories of grammar that remain viable, both other generative grammars (e.g. Bresnan, 1982; Pollard & Sag, 1994) and e.g. functional-cognitive grammars (Van Valin & LaPolla, 1997; Givón, 1997; Halliday, 2004). Instead of assuming a specific theory of grammar, a slightly different perspective will be adopted here, focusing on a few features that modern human languages incontrovertibly possess, regardless of the details of grammatical theory, and seeing which of those features may be removable, and in which order.

Human languages are universally:

1. *Structured* in the sense that an utterance is not just a random juxtaposition of words, but in some way indicates the relations between words. The structure indicators may be linear order, or morphological markers, or whatever.

2. *Hierarchical* in the sense that there are levels of structures within structures.

3a. *Flexible* in the transformational sense that there are many different ways to express the 'same' meaning by moving around words and restructuring sentences according to certain rules.

3b. *Recursive* in the sense that the same rules and structures may recur at different levels in the hierarchy, so that a structure may contain a substructure that is another instantiation of the same structure, in theory repeated *ad infinitum*.

The features are listed with the most fundamental first, and the most easily removable at the end, as discussed below. *Flexible* and *Recursive* are independently removable, and are thus at the same level.

None of the other features of language requires the *Recursive* feature, whereas *Recursive* certainly requires both *Hierarchical* and *Structured*. It is quite possible to have a language with only partial recursivity, or even none at all, supported by e.g. the fact that some children with SLI (Specific Language Impairment) apparently lack recursivity (Bloom, 1999). Therefore, *Recursive* is a prime candidate for being a late evolutionary addition to human grammar, a possibility further discussed in the next section. Hauser & Chomsky & Fitch (2002) similarly places recursion as the final step in the emergence of language, in that recursion is the sole component of their FLN, i.e., the only component of the language faculty that is narrowly language-specific, with everything else being used also for non-linguistic purposes. Hurford (2003) likewise proposes that the earliest languages lacked subordinate clauses, and thus presumably lacked (at least non-trivial) recursion.

Flexible, like *Recursive*, appears to be an optional feature that can be removed without fatal effects. *Flexible* definitely requires *Structured* to be meaningful, and may require *Hierarchical*, but none of the other features require *Flexible*. Depending on the exact grammatical theory, there may be a lot of obligatory moving around of constituents in a sentence — but in modern human grammar there are also lots of optional movement possibilities, constituents that can be appear in different places at the discretion of the speaker (topicalization is one example; see e.g. Box 4 of Jackendoff (1999) for others). Language would be perfectly functional, if less rich and nuanced, without these discretionary movements. Thus, *Flexible* is also a candidate for being a late evolutionary addition to human grammar.

A *Hierarchical* language must be *Structured*, but need not be either *Recursive* or *Flexible*. The main breakthrough in achieving *Hierarchical* may be the grouping of words into headed units, and the application of structural rules to headed units as a whole, rather than to individual words (Jackendoff, 1999). It is possible to have a hierarchy of structures, without the same structure being allowed to recur in infinite recursive chains.

The *Structured* feature, finally, is fundamental — it makes little sense to talk about syntax at all for a non-structured language, and all the other features presup-

pose *Structured*. But it is perfectly possible to imagine a language that is *Structured* without possessing any of the other features — the two-word stage of child language may be an example, and some pidgin languages may be clearer examples. This means that *Structured* must be the first syntax feature to emerge. Given that alternative ways of indicating structure are typically the product of grammaticalization processes, requiring a pre-existing syntax, it may be argued that linear word order is most plausible as the original implementation of *Structured* (cf. Hurford, 2003).

This adds up to an allowed sequence of successive grammar elaboration, that may be a candidate evolutionary sequence:

1. One-word stage — basic semantics with no syntax
2. Two-word stage — *Structured*, but with none of the other features.
3. Hierarchical structure, much like a basic phrase structure grammar, but with no recursivity. This means a language without subordinate clauses and other forms of embedding.
4. Recursive syntax (alternatively, *Flexible* may be added before *Recursive*, since they are largely independent of each other).
5. Full modern human grammar.

Each step in this sequence corresponds to a functional communication system, if not as elaborate and rich as the modern human system. And none of the gaps that need to be bridged when going from one step to the next looks anything like the huge chasm commonly pictured between non-syntax and syntax. The steps roughly resemble the stages of child language acquisition, where both recursivity (Goldin-Meadow, 1982) and flexibility (Håkansson, 1994) are fairly late additions.

Jackendoff (1999) presents a similar sequence, with a similar number of syntactic steps (he has more steps in total, but many of them do not concern syntax, and are not covered here[a]). Jackendoff's syntactic steps are (i) Concatenation of symbols, (ii) Symbol position significant [i.e. *Structured*], (iii) Hierarchical structure, and (iv) Phrasal syntax conveying semantic relations. The main differences appear to be that Jackendoff concatenates symbols into longer strings than two words before adding *Structured*, and that he does not make a clear distinction between *Hierarchical* and *Recursive*.

4. More on recursion

Depending on exactly what the underlying grammar looks like, it is not inconceivable that some of these steps, notably *Recursive*, can be subdivided even further,

[a] See Johansson (2005) for a full discussion of other aspects of language origins.

with e.g., simple additive 'tail recursion' being added before central-embedding 'true recursion'.[b] Expressed in phrase structure rules:

$$S \rightarrow NP\,VP \tag{1}$$
$$NP \rightarrow Adj\;NP \tag{2}$$
$$NP \rightarrow NP\,Comp\,S \tag{3}$$

Both rule 2 and rule 3 are recursive. But rule 2, which adds very little complexity in either production or comprehension, may well be an earlier development than rule 3, which is much more difficult to handle even for adult modern humans.

Recursivity is plausible as a late addition in phylogeny as well as ontogeny, also because adults have trouble with it — comprehension is poor on sentences with multi-level recursion (Christiansen & Chater, 1999), such as the following sentence built by triple application of rule 3 above: *The rat the cat the dog the man hit chased caught squeaked.* In theory, such sentences are grammatical — but they are commonly judged as ungrammatical (Christiansen & Chater, 1999), are difficult and time-consuming to parse (Bates, Devescovi, & D'Amico, 1999), and are exceedingly rare in natural language. The central-embedding recursion discussed here appears to be the worst case for our language processing, which breaks down with no more than three or four nested levels (Marcus, 2004), but with a sufficient number of levels of embedding most people find other types of recursion non-trivial to parse as well, as soon as the recursion amounts to more than simple concatenation.

Recursion was invoked by Chomsky (1957) as a language feature that was impossible to learn without an innate grammar, which may be true for infinite recursion. However, as noted above, human language does not in practice allow recursion more than a few levels deep. And recursion to the same depth that humans can handle, has been 'learned' by a connectionist network (Christiansen & Chater, 1999).

In real language production, we often do not build recursive sentences top-down, as they are typically presented in formal grammars. Instead, recursion is more often a matter of embedding a central clause in more and more layers of predication, commonly as a result of social interactions (Harder, 2004):

1. *Mary to Jack:* George is impossible!
2. *Jack to Joe:* Mary thinks that George is impossible.
3. *Joe to Jack:* Are you sure that Mary thinks that George is impossible?

[b] The computational requirements for 'tail' and 'true' recursion are quite distinct (Pinker & Jackendoff, 2005).

4. etc...

In this way, recursion can emerge from our ability to handle predicate logic in social interactions. The 'viewpoint chain' of Langacker (2001) provides a very similar grounding of recursion, as may others of his 'paths of mental access', particularly causal chains. There are also other ways for recursion to be an emergent property of language without a language-specific biological basis of its own, e.g. through the semiotic constraints of Deacon (2003).

5. Discussion

The first step towards syntax, getting started on the sequence at all, might be thought the most difficult — but since we have compelling evidence that stage 1 and possibly stage 2 are within reach of enculturated non-human apes (e.g. Savage-Rumbaugh et al., 1993), that step involves nothing but activating already existing capabilities, which cannot be an insurmountable problem. It can also be noted in this context that Fitch and Hauser (2004) managed to train monkeys to master a simple structured grammar in a toy language, but failed with a recursive grammar.

The postulated social scripts of Worden (1996) and Aiello (1998) have the features *Structured* and *Hierarchical*, and even rudimentary recursivity. This is a consequence of the structure and complexity of observed social behavior, making it plausible that apes had a structured and hierarchical conceptual system available as a language exaptation. If the cognitive machinery of the social scripts was available and could be used for language, we would reach stage 3 in the evolutionary sequence above. Byrne (2000) postulates more general cognitive structures for dealing with structured, hierarchical problems, which would be eminently exaptable to syntax processing, whereas Bickerton (2000) invokes hierarchical semantic structures as an exaptation for syntax.

Pidgin languages, or 'The Basic Variety' (BV) of Jackendoff (1999), with their highly simplified grammatical structure, can also be invoked here, at the very least as examples of functional languages without all the features of full modern human grammar (McMahon, 1994), and possibly as a modern-day example of what an intermediate stage in the evolution of syntax might have looked like (Bickerton, 1995). Pidgins and BV commonly lack *Recursive*, and may lack *Hierarchical*, consisting of just a linear structure of words.

For the last stages of the origin of modern grammar, Hurford (2003) invokes the observed unidirectionality of grammaticalization processes. Since grammaticalization is a process of delexification, going from lexical stems to function words and inflections, it appears plausible that the earliest languages lacked function words and inflections. This would be a functional, if pidgin-like, language, that could then evolve into our present languages through normal processes of diachronic language change, without any further need for biological evolution.

This also means that morphology need not be an issue in discussions of language origins, since it is largely the product of grammaticalization. This "morphologization" may have occurred either before or after the emergence of recursivity.

In conclusion, the gradual evolution of modern human grammar through several functional intermediate stages, appears perfectly possible. The exact path of evolution is speculative, due to the dearth of data on the structure of actual proto-languages, but no insurmountable obstacles are visible. Some of the required transitions can actually be observed today, either in ontogeny, or in e.g., transitions from pidgin to creole language.

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