

# EVOLUTIONARY FRAMEWORK FOR THE LANGUAGE FACULTY<sup>†</sup>

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Due to the nature of the subject, the field of language evolution has to rely largely on theoretical considerations. A coherent fundamental framework for approaching language evolution has to relate principles of evolution of complex traits with those governing the organization of cognitive processes, communication and natural language architecture. We suggest that by treating the language faculty as a complex trait with predefined functional interfaces, it is possible to delineate the evolutionary forces that have led to the emergence of natural language. We analyze embedding and recursion in communication, and propose a conceptual prerequisite for natural language and fully symbolic reference: a hierarchical way of conceptualization termed 'conceptual embedding' (the ability to nest concepts within concepts). We go on to hypothesize that, initially, the selective force driving the development of the language faculty was towards enhanced conceptualization of reality. According to this scenario, the invention of linguistic communication was a secondary event, dependent on conceptual embedding which supports the sophisticated conceptual underpinnings of linguistic meaning.

## 1. Introduction

We will start by proposing a general evolutionary framework that establishes the language faculty's functional interfaces and asymmetric dependencies between them. We continue by considering the theoretical foundations of recursion,

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<sup>†</sup> In: Andrew D. M. Smith, Kenny Smith, Ramon Ferrer i Cancho (eds.). 2008. The Evolution of Language. Proceedings of the 7th International Conference (EVOLANG7), pp. 203-210. New Jersey etc: World Scientific.

followed by a discussion of relevant empirical data. Next, we propose the notion of conceptual embedding as a prerequisite for the invention of linguistic communication. A complex communication system cannot evolve until there is motivation to convey complex information (Bickerton, 2003; Nowak & Komarova, 2001). We hypothesize that such motivation requires the perception of reality in terms of independent, combinable concepts that can be embedded to form interdependent conceptual categories that provide the functional basis for the meaning of words. Accordingly, we suggest that the selective force that triggered the emergence of the language faculty's core components was towards an enhanced conceptualization of reality. We assume that formation and embedding of concepts belong to a hierarchical continuum of higher order associational processes performed by the nervous system.

## **2. Functional interfaces and functional dependencies**

We suggest that in order to create an evolutionary framework for a complex trait such as the faculty of language (FL), one has to start by defining its functional interfaces and their dependencies. Functional interfaces are defined as the functional outcomes of a complex trait that are most likely to contribute to the fitness of its bearer and thus motivate natural selection. Functional dependencies, on the other hand, are required to create a continuously evolvable hierarchical structure that can acquire new functions by building on and modifying the structures already present. In our opinion, functional interfaces of FL should include thought (complex conceptualization) and linguistic communication. Since highly differentiated conceptual structure is a prerequisite for the development of a complex communication system like natural language (NL), there is an asymmetric dependence between them. This is based on the observations that (1) NL is very much centered around human conceptual structure, (2) elaborate conceptual structure would increase fitness without NL by enabling conceptualization of principles of reality.

## **3. Recursion and embedding**

M.D. Hauser et al's paper posited FLN/FLB distinction<sup>1</sup> and hypothesized that "FLN comprises only the core computational mechanisms of recursion as they

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<sup>1</sup> The faculty of language in the narrow sense or FLN = unique aspects of the language faculty. The faculty of language in the broad sense or FLB = the whole language faculty, including the aspects shared with other species or faculties.

appear in narrow syntax and the mappings to the Sensory-Motor and Conceptual-Intentional interfaces" (Hauser et al., 2002, p. 1573). Lately, this hypothesis has been vigorously challenged (Jackendoff & Pinker, 2005; Parker, 2006; Pinker & Jackendoff, 2005). First, we will focus on the logical contingencies of embedding and recursion. Second, as the narrower claim of Hauser et al. that recursion is unique to our species has subsequently been questioned (Marcus, 2006; Okanoya, 2007; Watanabe & Huber, 2006), we will argue that recursion in non-human animal communication has so far not been attested.

### 3.1. *Recursion*

There is a confusion underlying the notion of recursion. In fact, there are two logically independent notions of recursion. In computer science and Chomsky's phrase structure grammar, recursion is a procedure or rule (Chomsky, 1956, 1964, 1975). For some other theorists, recursion is a type of structure: a situation where an instance of an item is embedded in another instance of the same item (Jackendoff & Pinker, 2005; Parker, 2006; Premack, 2004). For the sake of convenience, let us call the former procedural and the latter structural recursion. Procedural recursion implies infinity, whereas structural recursion does not. Thus, structural recursion does not imply procedural recursion, nor vice versa. For instance, the recursive center-embedding rule  $AB \rightarrow AAB B$  produces the strings AAB B, AAABBB etc. It is impossible to tell by looking at these strings if their production procedure was recursion or concatenation. Furthermore, the strings do not exhibit structural recursion. The reason for this is that they comply with serial mode of communication, whereas structural recursion requires parallel communication. Speech, for instance, is parallel communication as a sequence of vocalizations is matched with sequential interpretation. This is not to deny that its *interface* – a sequence of vocalizations – is serial (Pinker & Bloom, 1990). For speech, sequential interpretation is, of course, an understatement. Linguistic interpretation is sequential *and* compounding, merging smaller units that are per se meaningful in the code (Chomsky, 1995; Hauser et al., 2002; Studdert-Kennedy, 1998). As far as we know, linguistic code is unique among species in stipulating parallel interpretation (semantic compositionality)<sup>2</sup>. Cf. Parker (2006): "/---/ faced only with a string, and no pointer to its structure, we cannot distinguish tail recursion

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<sup>2</sup> Parallel interpretation may be closely related to multitasking (consciously managing two or more operations) – an ability admittedly unique to humans (Donald, 1998).

from simple iteration. Nested recursion, on the other hand, could be evidenced by a complex string alone". We maintain that this "complex string" must comply with parallel communication in order for nested recursion to be evident. The definition of structural recursion was "an instance of an item is embedded in another instance of the same item". In serial communication, the condition 'the same' proves fatal, as the only interpretation of it would be 'identical', and in given conditions (identical items in serial communication) it is impossible to differentiate an item and structural recursion of the same item.

### ***3.2. Embedding. Recursion in non-human communication?***

Embedding is a situation where an item is embedded in any item (with infinity not implied). According to Chomsky, 'embedding' is logically independent from procedural recursion (i.e. there can be one without the other). Structural recursion, however, is a proper subset of embedding. Unlike structural recursion, embedding is possible in serial communication (pattern within pattern sequences is an example). Songs of cetaceans and birds exhibit this property. The fact that embedding is hierarchical has frequently raised speculation about a putative underlying 'recursive' mechanism (or more unfortunately, resulted in confusing embedding with recursion). As Suzuki et al. correctly remark in discussing humpback whale song (in a paper that has attracted some misled attention as an evidence of recursion in non-human animals), "Hierarchical grammars may be efficiently represented using recursion, although recursion is not necessarily implied by hierarchy" (Suzuki, Buck, & Tyack, 2006, p. 1863). There have also been some claims as to the possibility of recursion in non-human communication in connection with Gentner et al's (2006) experiments with European starlings (Marcus, 2006; Okanoya, 2007; Watanabe & Huber, 2006) but, in this case, pattern recognition and/or counting are more simple and plausible explanations than learning a recursive rule. We submit two general points about attesting recursion in communication. First, it is much easier to attest structural than procedural recursion. Second, structural recursion can be attested in parallel communication systems only. This rules out species that, as far as we know, communicate serially (for instance, songbirds). To our knowledge, neither procedural nor structural recursion has been attested in non-human animal communication. This is in concordance with the observation by Fitch et al. (2005) that no non-human animal communication system known shows evidence of syntactic recursion.

#### **4. Conceptual embedding**

We propose another notion instead of syntactic recursion as an underlying feature of the many critical aspects of the language faculty. The notion is conceptual embedding – a type of embedding not to be confused with recursion. Conceptual embedding (CE) is a cognitive phenomenon directly related to conceptual structure. It is possible that CE (the capacity to nest concepts regardless of the presence of syntactic recursion in a language) is specific to humans. "If non-human animals know in some sense that things have parts that have subparts which have subparts, then again their mental representations, independent of language, have a recursive structure. It is not known whether animals are capable of such mental representations" (Hurford, 2004). We will generalize Hurford's point and submit that it is not known whether or to what extent non-human animals have CE. If they do then it is seemingly confined to limited aspects of reality. CE forms the basis of our capacity to operate on sets, construct categories and make categorical distinctions, and of our capacity to model possible worlds. The latter has been frequently cited as a uniquely human trait (Jacob, 1982).

It is useful to think of CE as a hierarchical way of conceptualization. We suggest that the ability to conceptualize any properly abstract category (e.g. cause, value, sign, thought, structure, function etc) is a fair indicator of the species' reliance on CE. Obviously, then, CE is an indispensable building block in the development of the language faculty. Although conceptual embedding per se does not imply syntactic embedding, this core syntactic feature of NL is implemented by CE.

##### **4.1. *Conceptual embedding in non-human species?***

Until recently, comparative studies have focused primarily on the species' ability to accomplish feats of increasing complexity while the nature of cognitive processes that lie behind these achievements has received less attention (see Hauser et al., 2007, for recent developments). We have reviewed experiments with grey parrots, bottlenose dolphins, bonobos, baboons and diana monkeys, and reanalyzed the results of these experiments with respect to the cognitive strategies used by the species. Only one example is presented below.

Since several properties characteristic of human language (e.g. representationality, hierarchical structure, open-endedness etc) are evident in nonhuman primates' social knowledge albeit on a rudimentary level, Cheney and Seyfarth (2005) hypothesize that "the internal representations of

language meaning in the human brain initially emerged from our pre-linguistic ancestors' knowledge of social relations. /---/ The demands of social life create selective pressures for just the kind of complex, abstract conceptual abilities that are likely to have preceded the earliest forms of linguistic communication" (p 153). In our opinion, the lack of attribution of mental states (the lack of theory of mind) is a dubious cause for not being able to form differentiated concepts of reality. Moreover, in order to attribute mental states the way humans do, one has to be aware that there are different *kinds* of mental states and that it is possible to link them to any individuals in the first place. We maintain that such process requires CE, as the concepts of mental states need to be embedded with the concepts of other living beings so that new meaning arises. Thus CE must predate the theory of mind. Since CE is also beneficial in situations not involving social relations, the hypothesis that social lifestyle created the selective pressure for the emergence of human-like conceptual structure might not be justified.

## **5. Conclusion**

In the present article, we have proposed an evolutionary framework for the language faculty. We suggest that by defining the common functional interfaces of neurobiological traits involved in language-associated processes it is possible to delineate the selective forces that have acted upon them. Namely, we hypothesize that the common functional interfaces of the language faculty are thought (a sophisticated form of conceptualization) and linguistic communication. We argue that humans possess a hierarchical way of conceptualization termed as conceptual embedding (the ability to nest concepts within concepts – see section 4 for details). More experiments are needed to prove or refute CE in non-humans but we hypothesize that CE may turn out to be a uniquely human trait. We suggest that CE is at the top of the hierarchical continuum of associative processes performed by the nervous system. As the nervous system evolved, increasingly higher-order associative processes became available which resulted in the emergence of CE in human ancestors. We go on to hypothesize that, initially, the selective force driving the development of the language faculty was towards enhanced conceptualization of reality that is functionally relevant in the absence of linguistic communication. According to this scenario, the invention of linguistic communication was a secondary event, dependent on CE which supports the sophisticated conceptual underpinnings of linguistic meaning.

## Abbreviations

CE conceptual embedding, FL the faculty of language, FLB the faculty of language in the broad sense, FLN the faculty of language in the narrow sense, NL natural language

## Acknowledgements

We thank Noam Chomsky for thorough and critical discussions, and Tim Gentner, Kate Arnold, Jaan Valsiner, Jüri Allik, and Haldur Õim for comments and suggestions.

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