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On how "early syntax" came about

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1. Introduction

Modern humans are biologically predisposed to the ability to create symbolic elements and to combine them systematically to share feelings, thoughts, or beliefs. In considering paleoanthropological evidence, we hypothesize that this particular innate ability emerged in early members of the Homo group but evolved from (nonhuman) primates. Here, we identify four, closely interconnected evolutionary stages that may have brought about an extended syntax: (a) binary signal binding, (b) symbolic signs, (c) pragmatic grammar and (d) extended syntax. Basic signal binding can be occasionally observed in primates. Various cortical changes in the early hominin lineage enabled the creation of symbolic signs (words) and a *pragmatic grammar* consisting of two or three words. At this stage, cognitive strategies (e.g., AGENT-first) may have mimicked perceived event-structures and determined asymmetry between these words. Finally, lexical grouping, syntactic frames, argument structures, semantic roles and morphological markers are the outcome of an accumulative cultural process that resulted in an extended syntax. We conclude that the origin of syntax is deeply conceptually rooted and emerged along with an increase of cognitive control, rehearsal and global workspace capacity (Baars et al., 2013; Aboitiz, 2018a,b; Corballis, 2019).

Our evolutionary syntax approach is in sharp contrast to the minimalist program which claims that syntactic recursion is an innate property of a universal grammar (e.g., Chomsky, 1965; Hauser et al., 2002; Berwick and Chomsky, 2016). Although we do not argue against the idea of a universal grammar, we do not consider syntactic recursion, which iteratively merges syntactic objects of the lexicon to create bottom-up larger phrases in a binary fashion (Kayne, 1984), as crucial for defining the human language capacity. For example, *hit* has the feature "uninterpretable noun" and *ball* "object noun," which projects *hit* as being prominent compared to *ball* (Chomsky, 2001, 2004). Merge, which can be infinitely recursively applied to its own output, continuous after this initial step with a bottom-up binary operation. In the case of a simple declarative sentence, such as *Bill hit the ball*, labeling will be projected by the head (the prominent word of the respective set), and 6x binary hierarchical branching of {x{xx}}is required. The generated tree structure is relatively complex for a short declarative phrase but it is considered as minimal because the same computation applies iteratively.

More recent evidence favor user-based computational accounts, such as construction, unification grammar, or simpler syntax because they cover many syntactic patterns, including syntactic frames and various degrees of lexical freedom, not covered by the generative approach (e.g., Culicover and Jackendoff, 2005; Goldberg, 2005). Thus, the generative approach complements a computational syntax model. Construction-based models, for example, do not rely on a single binary operation but emphasize multiple branching (Shieber, 1986). They consider in particular, the idiomaticity, fixedness, and scheme-like structure of an expression or phrase (e.g., Fillmore et al., 1988; Goldberg and Suttle, 2010; Hoffmann, 2022). English examples are semi-fixed expressions (e.g., *weapons of mass destruction* or *look the answer up*) that must be part of the mental lexicon (Jackendoff and Wittenberg, 2014, 2017). Phrasal idiomaticity and fixedness are a matter of degree and affect all sentence types. Such phrasal frame constructions are, for example, "the X-er the Y-er" (comparative correlates), "X causes Y to move Z" (caused-motion frames), "the more X, the less Y," "X was V-ed by Y" (passive sentence). Other examples are syntactic nuts, such as the grammar of geographic names (*the River of X or *the X River) or number systems (Jackendoff, 1997, 1999, 2011; Jackendoff and Wittenberg, 2017). Syntactic frames with different grades of flexibility defined by variables are not a peripheral linguistic typology but a core property of all languages.

Construction-based and Merge accounts do not exclude each other. Merge is a specific structural construction that may be particularly useful in novel formats, for which the speaker did not acquire a scheme. Both approaches are, however, of great significance for discussing the origin of lexical grouping and syntax.

2. Signal binding in primates

Two claims were made in association with the emergence of Merge (Chomsky, 2010; Berwick and Chomsky, 2019; Tattersall, 2019). First, language is the result of a single Merge operation. That is, syntax did not evolve as no intermediate gradual steps are possible: a species has or has no access to Merge. The argument is that the syntactic capacity should be exclusively linked to *Homo sapiens* since significant archeological finds that may represent symbolic behavior would not be older than 100 k years (Henshilwood et al., 2018). Thus, the claim is that a sudden mutation occurred during this period in some individuals of *Homo sapiens*. These genetic changes would have led to brain rewiring for the capacity to generate Merge.

Initial Merge can be traced back to various precursor stages, which does not favor but diminishes the claim of a sudden mutation causing brain rewiring in early modern humans. Some favor a structured protosystem that would have been integrated into an extended syntax system (e.g., Di Sciullo, 2013; Miyagawa et al., 2013; Nóbrega and Miyagawa, 2015). However, it remains unclear how the protosystem became ready for integration. It is a *post-hoc* argument: the properties of a precursor stage do not necessarily reflect properties of the succeeding stage. Moreover, the evolution of brain structures in the human lineage supports an incremental increase of cognitive capacities, including the creation of symbols and lexical grouping (e.g., Pinker and Bloom, 1990; Bickerton, 1998; McBrearty and Brooks, 2000; Johansson, 2005; Kinsella, 2009; Progovac, 2010; Fitch, 2014; Tallerman, 2014, 2017; Hillert, 2015, 2021; Martins and Boeckx, 2019). The all-or-nothing Merge account reminds us of the hopeful monster hypothesis stating that small-scaled mutations cannot produce new species (Goldschmidt, 1940). The botanist Hugo de Vries was one of the most prominent defenders of such a saltation model at the turn of the 19th century (De Vries, 1901–03). Still, his evidence refers to plants rather than to cortical evolution (Zuberbühler, 2019).

If initial grouping is defined as a binary set requiring a label, it can be decomposed into different subcomponents. Based on observations with monkeys and chimpanzees, this may include the production of discrete vocal signals or *binary vocal signal binding*. The latter structure is in most cases asymmetric. The positional structure is typically fixed rather than free and is perceptually driven (e.g., AGENT-first). Studies with encultured and wild great apes show that signed or vocalized binary binding is the main combinatory operation to express pragmatic needs (e.g., Greenfield and Savage-Rumbaugh, 1991; Crockford and Boesch, 2005; Spillmann et al., 2010; Clay and Zuberbühler, 2011; Hedwig et al., 2015; Schlenker et al., 2016; Girard-Buttoz et al., 2022). The order of the elements is, in principle, free but seems to follow mostly pragmatic strategies. The workspace capacity of monkeys and great apes restricts emittance to small sequences (Pasternak and Greenlee, 2005; Read et al., 2022). It is most significant that great apes never start to develop a symbolic system on their own to communicate beyond their immediate needs. Further studies are required to suggest that they vocalize about events in the past and future.

3. Acquisition of extended syntax

Typically developing children produce at around 18–24 months largely two-word utterances, such as *want-juice* or *car-go*. Inflections or function words are rarely produced during this two-word stage (Bloom, 1993). If the language acquisition process is delayed, the child still goes through this stage. Two deaf children who were not exposed to sign language until the age of 6 years showed the same acquisition pattern (Berk and Lillo-Martin, 2012). Bigrams are also the basic syntactic layer of particular sign languages. The first generation of deaf children of the "Idioma de Señas de Nicaragua" combined signs to bigrams such as AGENT-EVENT, and the next generation elaborated on these structures (e.g., Senghas et al., 2004). Similarly, adult speakers, who learn a second language without explicit instructions, acquire first bigrams before they learn more extended syntactic structures (Klein and Perdue, 1997). The trend is to acquire first content words without inflections and to rely on a pragmatic word-order strategy. For example, the AGENT-first strategy is sufficient in interpreting the free-ordered sequence *hit girl boy* as *The girl hit the boy*.

Again, headless phrases are common in the Malayan dialect "Riau Indonesian" (Gil, 2005). An often-quoted example is the word pair comprising *makan* (chicken) and *ayam* (eat). The free-positioned word pairs *makan ayam* or *ayam makan* are open to the same readings and unmarked for grammatical roles. The speaker's semantic network consist not only of lexical relations but may also include situational attributes. An asymmetry is not syntactically marked but mentally represented (e.g., *X eat chicken* may be a more frequent reading than *Chicken eat Y*). Generally, the range of language typologies, which primarily displays grammar by inflections (polysynthetic) or word order (analytic), varies strongly concerning lexical grouping and dependencies. Although the basic syntactic layer of human language and great apes appears to be quite similar regarding the use of bigrams, there is a critical difference: at an early age, the human child already has access to a large number of words which they can freely combine without any boundaries, a mental property great apes lack.

4. Discussion

The literature discusses numerous factors on how syntax might have emerged from basic signal binding in nonhuman great apes. Without discussing specific socioecological conditions, most critical is the evolution of full bipedalism, the expansion and rewiring of cortical structures, along with the evolution of workspace systems, control circuits, and structure-building capacities for self-organization and planning (Aboitiz, 1995, 2018b; Murphy and Benítez-Burraco, 2018; Murphy, 2019). About 3.4 mya *Australopithecus africanus* (Stw 505 Sterkfontein), whose brain was not larger than that of chimpanzees, had a posterior placement of the lunate sulcus (Holloway et al., 2004). It implies that the temporal lobe (TL) increased. In modern humans, this structure has various language-related functions, amongst other the anterior TL is involved in semantic and the posterior TL in syntactic processing (e.g., Levy et al., 2004; Matar et al., 2021).

The hominin evolution had a significant breakthrough after the appearance of *Homo erectus*, about 1.8 mya. Their brain size increased to 950–1,230 cc (Rightmire, 2013), reaching almost the size of modern humans with 1,350 cc. Moreover, they had human-like prefrontal and temporoparietal regions, including a Broca's cap morphology (Rilling et al., 2008; Holloway, 2015; Nishimura, 2018; Ponce de León et al., 2021). *Homo erectus* was a *Homo faber*. He developed and refined the Acheulian tool industry, used fire, had a hunter-gatherer culture, traveled to East China and Java, and even produced symbol-like objects indicated by engraved Trinil shells (Dubois, 1894; Joordens et al., 2015; Rizal et al., 2020). Most traces suggest that this species developed a premodern language system to coordinate their activities and increase the chance of survival in challenging conditions. However, what kind of language system did our ancestors create?

Considering that structure-building is a piecemeal sociological process, we assume that this species developed a symbol system and a *pragmatic grammar* consisting of two to three symbolic elements. The development of event-based discrete iconic and then symbolic signs must have followed emotional signals used by primates, whereas we assume that vocal signs gradually replaced gestures due to an increasing demand for manual actions, such as tool development. Along with the development of words, they were pairwise combined according to recurrent perceived event-structures. Then, an unspecified binary and a ternary mental scheme were created through unspecified set formations, whereas context provides information about prominence. Finally, a head is assigned and provides an asymmetric structure, extendable to a partly flat structure, such as *catch-fish-spear*: [ACTION [OBJECT, ACTION]] + [TOOL]. These schemes, basic syntactic branching, such as treelets or flat structures, may have been applied to other semantic categories defined today in linguistic theories as argument structures. It is a starting point for diverse syntactic branching and various degrees of lexical freedom that is semantically rooted in our evolutionary ancestry. We conclude that *H. erectus*' brain was language-ready and extended syntax results from cultural refinements of a pragmatic grammar.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author DH declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Publisher's note

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