TOWARDS A COMPARATIVE APPROACH TO (SYNTACTIC) HIERARCHY

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It is a well known fact that the human language syntax has a hierarchical nature (Chomsky 1957; see also Berwick & Chomsky 2016). The process of combining words into phrases and sentences proceeds in a recursive, non-Markovian fashion, instead of forming a string. Given that this is one of the most striking properties of the human language syntax as many researchers claim (see Fitch & Hauser, 2004; Fitch, 2010 among many others), the mechanism underlying this property should be treated as an *explanandum*. Generative grammarians claim that "Merge," an elementary combinatoric syntactic operation, neatly captures this property. The definition of Merge is shown in (1) below (see Chomsky, 2010; Berwick & Chomsky, 2016 among others).

(1) Merge (X, Y) = {X, Y} = K

That is, Merge takes two discrete items and produces a set out of them, which itself can be an input to further Merge operation as a single item (K). Obviously, the procedure defined in this way can describe the hierarchical nature of syntax. However, what evolutionary linguists should crave is not a way of *defining* this hierarchical nature but a specific *explanation* of it. Succinctly put, a definition is not an explanation. This suggests that defining the syntactic process in this way is very harmful for evolutionary investigations of language as it sweeps one of the most important *explananda* under the rug: i.e., the hierarchical nature.

Based on this observation, I propose a decompositional approach to this procedure. Specifically, the syntactic process can be segmented into four parts: (i) Select process that maps inputs to the next process onto its workspace, (ii) Set-forming process that successively combines the materials mapped via (i), (iii) Transfer process that sends old inputs to the process (ii) to a stack, and (iv) Pushdown Stacking process that stores at most two Transferred outputs of (ii) (Chesi, 2015), making them accessible to (i). I show that all these processes

cowork in a cyclic and self-organizational manner to yield a hierarchical structure; it roughly proceeds in the following fashion: (i)→(ii)→(iii)→(iv)→(i)→(ii)… The reason for the self-organization of this model is that the process (iii) makes its inputs inaccessible to the process (ii), necessarily restricting the accessible/active materials to the process (ii) (see already Boeckx, 2014). In other words, (i) gives the inputs to the process (ii), which in turn successively combines the Selected items, and (iii) makes it possible for (ii) to pay attention only to specific materials, putting all other items inside (iv). Also, the output of the series of processes (iv) →(i)→(ii) is also necessarily hierarchical since both the materials inside (iv) and the outputs of (ii) are independent/discrete chunks, neither of which inner materials are accessible to (ii). This said, my model *explains* the mechanism of the hierarchical nature of the human language syntax without defining the syntactic process in such a way that it can *capture* it. Succinctly put, my aim is to provide a principled explanation (crucially, not a definition) of the hierarchical nature of syntax and elucidate the necessary components for it.

What is more, due to its decompositionalist spirit, this model makes it possible to establish an experimentally feasible and evolutionarily plausible theory, as it provides neuroscientists, ethologists and many others with more specific questions (e.g., do animals have (iv)? how about (i)?) than before; it offers the opportunities to further narrow down the missing link(s) between "us and them." Put another way, this model fosters the comparative research more than the standard "complex-Merge" model does because the former gives empirically testable predictions while the latter shuts out the comparative/experimental feasibility, a necessary requirement for evolutionary studies.

Additionally, I claim that chimpanzees' cup-nesting observed by Greenfield (1991, 1998) sheds light on the evolution of the human language syntax. Specifically, due to the absence of the processes (iii) and (iv), their action grammar is a string-formation. In contrast, in humans, due to the expansion of the working memory along with the enlargement of the Broca's area, they acquired a giant working memory (initially had nothing to do with language) with the pushdown stack, which plays a crucial role in the generation of hierarchy (see Tomason et al., 2009 and Carruthers, 2013 for the evolution of working memory). Independently, Fujita (2009, 2014) also argues based on Greenfield's observation that this action grammar is the precursor to the syntactic computation. What my model differs from his one is that while he assumes that the process (ii) evolved into the composite operation (ii) + (iv), I dissociate these two processes since the process (iii) is necessary in order for (iv) to be active; materials cannot be stacked separately from the active chunk(s) unless they are "forgotten" by the process. As Fujita remains agnostic to this "forgetting" process, I claim that my model is conceptually more plausible than Fujita's one. And I also argue that the process (iii) is a syntactic instantiation of what Pylyshyn (2007) calls "FINST," an elementary, domain-general procedure which segments its input from others.

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