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BOOK REVIEW

Making sense of language in the light of evolution

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Inquiry into language evolution has been controversial, mainly because there is no consensus as to the nature of both 'evolution' and 'language.' Berwick and Chomsky make sense of the evolution of language by treating it as a biological phenomenon. In contrast to functional characterizations of language as 'communication' or 'speech,' the authors define it as, essentially, a mind-internal computational mechanism. Within their minimalist approach, hierarchical syntactic structure is achieved through the recursive application of a basic operation called '*Merge.*' The simplicity of the basic operation is consistent with archeological evidence suggesting an evolutionary recent origin of language.

KEYWORDS
biology, computational system, language evolution, *Merge*, minimalist program, recursion

This is a notable year for linguistics, as it is the anniversary of both Noam Chomsky's *Syntactic Structures* (1957) and Eric Lenneberg's *Biological Foundations of Language* (1967). These two seminal books have laid the foundation for an understanding of the faculty of language as part of human biology. Given that language is indeed a biological phenomenon, the question arises as to how it could have evolved. This has been the subject of much speculation recently and has proved to be quite controversial. The discussion about language evolution suffers from a lack of consensus as to the nature of both these concepts, evolution and language. I would argue that Berwick and Chomsky's (B&C) book is the first successful attempt at making sense of language in the light of evolution. I should add that I am somewhat biased, having worked with both authors on the very topic of language and evolution (Berwick, Friederici, Chomsky, & Bolhuis, 2013; Bolhuis, Tattersall, Chomsky, & Berwick, 2014). My work on the mechanisms of birdsong learning led to an interest in human speech and language (Bolhuis & Everaert, 2013). Trained as a biologist, I was enamored by the biological approach of Chomsky et al, and through a fortunate set of events, I came into contact with some of the leading linguists in the Generative Grammar tradition, including the authors of *Why Only Us?*

1 | THE NATURE OF LANGUAGE

Although there may not be general agreement about the precise nature of the human capacity for language (UG), most, if not all, linguists would agree that such a capacity with domain-specific and human-specific properties must exist. That is, there has to be a mechanism in the mind/brain that generates an unbounded array of hierarchically structured expressions. Amazingly, many of the authors who have published on the evolution of language seem to disagree. To them, language is not an autonomous computational cognitive mechanism but a means of communication (preferably by way of speech) that is somehow implemented by a combination of existing cognitive and sensorimotor capabilities. In fact, this point of view is repeated once more in a recent riposte to B&C (Corballis, 2017). It is as if for these authors, the faculty of language does not exist—to paraphrase Chomsky. Within this view of language, it would seem that the cognitive revolution of the 1950s never happened or as if there had been some kind of cognitive counterrevolution that wants to take us back to the days of behaviorism where language was regarded as merely "verbal behavior."

Arguably, the birth of modern linguistics coincided with what Chomsky has termed "the second cognitive revolution"—the first one being initiated by Descartes. The fact that Chomsky was a key figure in both of these more recent events makes this book all the more important and noteworthy. Our current understanding of language owes a great deal to him. B&C use a clear conception of language as a computational cognitive system that is rooted in the human biological endowment. Clearly, within this general linguistic framework, there are different points of view, and several of these are discussed in the present volume. However, I would argue that the generative grammar approach advocated by B&C is the most coherent view that is supported by ample evidence. The Generative Grammar approach is a dynamic one, where theories adapt to increasing empirical evidence and maturing theoretical insights. At the heart of the "generative enterprise" is a theory of the human genetic endowment that implies the infant's initial state of linguistic knowledge: Universal Grammar, or UG for short. Assuming that language is an evolutionary recent phenomenon (more about that later), and given that human infants can acquire language very rapidly with very little evidence (e.g., Yang, Crain, Berwick, Chomsky, & Bolhuis, 2017), it has become clear that UG has to be relatively simple. The alternative, "usage-based" view of language development (which, again, denies the existence of the faculty of language as an autonomous mind-internal computational system) is held by a large number of researchers—perhaps even the majority. This is surprising given the ever-increasing amount of evidence showing that human infants have syntactic abilities that they could not possibly have picked up from their linguistic environment (e.g., Crain, Koring, & Thornton, 2017; Yang et al., 2017).

Generative Grammar assumes a Basic Property of language, which provides the means for generating, in the mind, an unbounded array of hierarchically structured expressions that are systematically interpreted at two interfaces, a Conceptual–Intentional interface (CI) and a sensorimotor interface (SM), essentially concerned with meaning and externalization, respectively. Within Generative Grammar, major effort has gone into defining what constitutes UG and getting rid of unnecessarily complex syntactic rule systems, such as those in Phrase Structure Grammar or Transformational Generative Grammar, eventually arriving at what Chomsky has termed the Strong Minimalist Thesis or SMT. Within the SMT framework, hierarchical syntactic structure is achieved through the recursive application of a basic operation called *Merge.* For a biologist, this minimalist view of language brings to mind Darwin's famous phrase that "There is grandeur in this view of life (…)", when he summarized his "minimalist" view of evolution by means of natural selection. In fact, the rest of the passage from *The Origin of Species* almost sounds—*mutatis mutandis*—like an echo of Wilhelm von Humboldt's earlier characterization of language as the "infinite use of finite means," when Darwin continues: "(…) from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved."

B&C argue, quite convincingly in my view, that the Basic Property of language necessarily implies that language is not the same as communication or speech. Communication is one of the possible functions of language; as B&C argue convincingly, language is happening mostly 'between the ears', and communication is merely a by-product. Of course, biological (and cognitive) systems should be defined structurally (or causally in other words) and not functionally. Language did not evolve for communication just as the visual system did not evolve to enable us to watch television (as Chomsky once put it in a lecture). Communicative language requires externalization. Speech is of course only one possible way of externalizing language. B&C review the considerable evidence that interpretation of hierarchical structure by CI is direct. That is, language introduced hierarchical structure in human thought. Language is a powerful way of generating and expressing thought. Externalization, on the other hand, is a far less straightforward affair as it means the 'flattening' of internal hierarchical structure to serial strings of sounds or signs. This is simply a result of the nature of the sensory and motor systems; we cannot speak hierarchically. Thus, what reaches the mind is not what reaches the senses. As B&C demonstrate, this 'mapping asymmetry' (see Huybregts, 2017, for a recent discussion) is responsible for all kinds of linguistic problems, such as filler-gap problems and islands. Thus, as B&C argue, externalized language is actually a very inefficient means of communication. Whenever there is conflict between communicative efficiency and computational efficiency, the latter always wins 'hands down'. Clearly, language is not 'designed' for communication but for thought.

2 | THE NATURE OF EVOLUTION

Evolutionary analysis is essentially a historical science (Bolhuis et al., 2014; Bolhuis, Brown, Richardson, & Laland, 2011). That is, the study of evolution is about an attempt to reconstruct the history of biological traits—such as language—and more often than not, evolution moves in mysterious ways. There is no a priori reason to assume that a particular trait—such as the language faculty—has got here through common descent, or evolutionary convergence, or indeed exaptation. In addition, there is no reason to assume—as many scientists still do (see Corballis, 2017, for a recent example)—that evolution should proceed slowly, with small incremental changes and that our closest evolutionary relatives, the great apes, should be the most similar to us in terms of cognitive capacities. Yes, Darwin thought so, but that was 1871. And yes, he was a genius, but science has progressed since then. We now know that there have been substantial human genetic changes in the last 50,000 years, with as much as 10% of human genes affected, many of which are expressed in the brain (Bolhuis et al., 2011).

If evolution is to occur, three factors need to be involved, as we can illustrate using the simple (and simplified) example of the evolution of the giraffe's neck. How did these beasts get such a long neck? First, there has to be *variation.* So, at some stage, there must have been some kind of proto-giraffes with longish necks, short necks, and anything in between. Second, this variation has to be *heritable.* That is, if a male and female long-necked proto-giraffe mate, the probability of their offspring having a long neck would have to be great. Third, there is differential *adaptedness.* At a particular time in history, some variants find themselves better adapted to the environmental conditions at that time than other variants. For example, the leaves that the animals eat grow only on tall trees, so the ones with longish necks are at an advantage. Natural selection can take its course, and eventually, the proto-giraffes with the longer necks will survive. (This is actually not the correct interpretation of the evolution of giraffe neck length, but that is not relevant here.) Thus, natural selection is an important driving factor for evolutionary change, but it is not a causal factor for any trait. It is a causal factor for the process of evolution, but that is a truism (Bolhuis et al., 2011, 2014). Importantly, natural selection can only operate when there is variation. The question is how this variation comes about. More likely than not, that is achieved through the essentially random process of mutation. B&C argue that because language seems to have emerged very recently in evolutionary terms (around the time or shortly after the emergence of *Homo sapiens*, some 200 kya), UG is likely to have been the result of mutation. Although mutation must be a major cause for variation, the suggestion that mutation would have led to the emergence of language has met with considerable criticism. I find this quite puzzling.

As I indicated before, there have been major evolutionary changes in the human genome over the last 50 ky or so, and mutation is likely to have played a major role in this. For language, a counterargument that is often used is that complex systems cannot evolve quickly (e.g., Corballis, 2017). An example that is often presented is the eye: such a complex system must have evolved over millions of years. But as we have seen, within the minimalist program, the basic operation underlying language (*Merge*) is actually quite simple. Thus, it is quite conceivable that a mutation (or mutations) has led to a 'rewiring' of the brain that allowed the simple binary operation *Merge* and hierarchical structure building through its recursive implementation. Regarding the complex eye, following Gehring (2011), B&C argue that the "Basic Property" of vision (a light-sensitive and a pigment cell) is likely to have come about as the result of mutation. Of course, once this basic property was there, natural selection could take its course; different kinds of lenses evolved, and so on, but the essential property underlying vision is likely to have emerged suddenly. A similar mutational event could have led to the emergence of the Basic Property of language. Interestingly, in the latest installment of his autobiography, Dawkins (2015), one of the champions of slow incremental evolution by natural selection, agrees. On pp. 380–384 of his book, he discusses the idea of a single mutation at the origin of language. He calls this a "macro-mutation", that is, "a mutation of large effect" (p. 380). Dawkins then discusses ("the genius") Chomsky's theory of hierarchical syntactic structure and the "recursive subroutine" involved. He suggests that Chomsky may well be spot on with his suggestions regarding the recent and sudden emergence of language, suggestions that are elaborated in B&C.

Regarding language as being identical to either communication or speech obviously leads to a view of language's evolution as coinciding with either of these phenomena. As we have seen—and as B&C explain in detail—these interpretations of the nature of language are simply wrong, and like B&C, I will not discuss them further. But even if language is correctly viewed as an internal computational system, investigation of the evolution of language is fraught with difficulties. For a start, there is no evidence that there is anything like the human language syntactic system in nonhuman animals, whether it be in our closest relatives, chimpanzees, or in songbirds, which—unlike apes—have complex vocalizations that they acquire through auditory-vocal imitation learning (Bolhuis et al., 2014; Bolhuis & Everaert, 2013). That is the comparative method, the mainstay of evolutionary analysis, out of the window.

Despite the fact that for comparative linguistics, there is "nothing to compare" (Bolhuis et al., 2014), adherents of the "common descent" approach to evolution keep pushing nonhuman primates as model systems in the study of language evolution (see Snowdon, 2017, for a recent example). The trouble with these studies is often that language is confounded with speech. That is, language is equated with externalization (SM) rather than the mind-internal computational system that it is. Interestingly, if one does focus on externalization, there are interesting parallels, but these are not between humans and apes but between humans and songbirds (Bolhuis & Everaert, 2013). So, when it comes to externalization, it is not common descent but evolutionary convergence that seems to have happened. This is particularly clear when speech acquisition in human infants is compared to song learning in songbirds. Songbirds, like infants but unlike nonhuman primates, acquire their vocalizations through auditory-vocal imitation learning during a sensitive period. They both go through a transitional phase known as "babbling" in infants and "subsong" in juvenile songbirds. In addition, in humans and songbirds, there is a similar neural organization underlying this kind of learning. B&C discuss these parallels in some detail, including some very interesting recent findings (Pfenning et al., 2014) showing that the same genomic transcriptional profiles align across different vocal-learning species, such as humans, parrots, or songbirds, but not in vocal nonlearners such as chickens, doves, or macaque monkeys. Many of the genes that vocal learners share and that are activated in similar brain regions are transcription factors, that is, genes that regulate the expression of other genes. Thus, it appears that in the course of evolution, suites of genes can be recruited for a certain task—in this case auditory-vocal imitation learning. Similar solutions have evolved for similar problems, evolutionary convergence in a nutshell. It is important to stress, as B&C do, that this convergent evolution has to do with externalization. To date, there is no evidence for any kind of animal equivalent of human language syntax.

To make matters worse for an evolutionary analysis, there are no fossilized brains or thoughts. Thus, an evolutionary analysis of language has to make do with what Tattersall (2012) terms "proxies" of language: major changes in tool making and what B&C call "unambiguous symbolic artefacts" (p. 38), such as shell ornaments and the geometric carvings in the Blombos cave, dating back to 80 kya. That puts the origin of what one could call internal language (as opposed to "communicative language") somewhere between 200 and 80 kya. A recent analysis by Riny Huybregts (2017) allows us to be more precise regarding the evolutionary timing. Using some suggestive results from various disciplines, Huybregts seeks to account for the gap that must have existed between the emergence of internal language and its externalization. For this, he discusses the role of phonemic clicks, which are almost exclusively limited to the Khoisan languages in southern Africa. The author notes that the evolutionary split between San on the one hand and Yoruba and Bantu on the other occurred about 125 kya. These different kinds of externalization must have followed separation, which itself must have followed the possession of internal language (i.e., emergence of the Basic Property), which puts language's origin between 125 and 200 kya.

Analysts of cognitive evolution (e.g., evolutionary psychologists) generally assume that evolution proceeds slowly, over millions of years, with small incremental modifications, hence the focus on Stone Age hominids in Evolutionary Psychology and the interest in nonhuman primates in many researchers of language evolution. B&C employ a modern view of evolution where major evolutionary change can occur rapidly as a result of mutations. They plausibly suggest that language evolved quite recently, building on preexisting cognitive and sensorimotor systems, and, yes, only in us. This book is a milestone in the study of language in the light of evolution. It sets the standard for many years to come.

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