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REVIEW

Calvin, William and Derek Bickerton. 2001. *Lingua ex Machina. Reconciling Darwin and Chomsky with the human brain.* Cambridge, MA: MIT Press. 298 pages. ISBN: 0-262-53198-4.

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Lingua ex Machina, by Calvin and Bickerton, is an important contribution to the growing body of literature on the evolution of language for a host of reasons. These include relative accessibility of the book to non-experts, the profiles of its authors and the interdisciplinary character of their collaboration, and weight of their proposals. William H. Calvin – a "theoretical neurophysiologist", as he dubs himself – and linguist Derek Bickerton do not restrict themselves just to providing a summary and synthesis of the current theorising on the evolution of language, but put forward a number of innovative, though at times speculative, hypotheses of considerable value.

Rather than being aimed at a purely academic audience, *Lingua ex Machina* is clearly intended as a popular scientific book carefully designed to be appealing to a wider public. The authors opt for the convention of a friendly and relaxed conversation, with Bill [Calvin] explaining to Derek the workings of neuronal mechanisms, and Derek introducing linguistic considerations. Consequently, although each of the main chapters is written by one of the authors, it usually features contributions from the other, ranging from questions to comments, even to exclamations of approval. The book is complemented by a (somewhat harder to digest) "linguistics appendix", a useful glossary of terms, and endnotes consisting mostly of bibliographical references that would probably look too daunting in the running text of a popular book.

Despite all these efforts, and the fact that *Lingua...* does read relatively well, it needs to be made clear that, at a minimum, the appendix and some of Calvin's neurological considerations (again, in spite of a few very graphic metaphors) will remain inaccessible to readers lacking the appropriate background. Similarly, it must be admitted that the book, though not devoid of an occasional witticism, is still no match the natural ease and humour of Pinker's *Language instinct*.

Both William Calvin and Derek Bickerton are researchers of impeccable academic credentials, who have already managed to make their names in their respective disciplines. Equally importantly, both of them have manifested more than a passing interest in the evolution of hominids, especially in relation to the origins of language. Calvin is known as an advocate of throwing as a crucial activator of the general cognitive advance in the hominid lineage leading to *Homo sapiens* – an idea pursued in *Lingua ex Machina*. Bickerton, in turn, has become one of the most frequently quoted authors in

the context of evolution of language; his work on the creolisation of pidgin languages remains about the only strictly linguistic finding of paramount importance to gain universal acknowledgement within this very broad field. (Interestingly enough – though the significance of the phenomenon of transferring of a pidgin into a grammatically complex creole is recognised and quoted by almost everyone writing on the origin of language – the interpretations of its possible implications for the evolution of language form a most diverse spectrum.)

The authors set off by reviewing the necessary rudiments of the organisation and operation of both language and the brain, which is followed by some more advanced (and speculative) cerebral theorising from Calvin; after that, it is Bickerton's turn to hypothesise on the origins of the first words, and then, argument structure and full syntax. Calvin takes over again to describe the possible role of throwing in hominid evolution, and to develop some of his earlier themes concerning the brain; then Bickerton concludes by summing up the argument and providing a supplementary and more technical linguistic chapter.

I shall now very briefly outline some of the authors' key points as they are advanced chapter by chapter; this summary will be followed by a critical commentary, where I shall address their propositions in more detail.

Chapter 1 is a stage-setter, introducing the problem of the evolutionary emergence of language and, more importantly, aptly exposing some variants of what I call a "biological reification fallacy". There appears to exist a strong popular tendency of perceiving phenomena that have names on the behavioural level as equally real on other levels of organisation: "if we have a name for it (smell, aggression, language), it is associated with a single and unique selective pressure, specific and exclusive gene, as well as a specific and exclusive brain area". Here, as further on in the text, Calvin makes a good job of dispelling this persistent illusion.

Chapters 2 and 3 (Bickerton) discuss the nature of words, their dependence on underlying conceptual representations, and the importance of their capacity of being combined. Calvin's subsidiary comments are essential, explaining why words are unlike animal calls, and why human linguistic communication is totally dissociable from any kind of animal communication, both in the sense of present day functioning and evolutionary continuity. However, Bickerton makes his credo clear: it is human potential for syntax, and not for words themselves, that truly separates our species from all the rest.[1] In Chapter 4, he describes the structural developments responsible for the major qualitative advance from the hypothesised level of protolanguage (where combining words is unprincipled and inefficient) to a fully-fledged syntax; these are phrases and clauses.

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[1] Contrary to what is stated in an Amazon.com review by the journalist Gregory McNamee, who was unlucky enough to pick up perhaps the only sentence in the whole book suggesting the opposite: "[...I]t's words, not sentences that dramatically distinguish our species from the others" (p. 23) is in fact meant to recapitulate Terrence Deacon's position, criticised by Bickerton.
(http://www.amazon.com/exec/obidos/tg/detail/-/0262032732/104-6917742-6511117?vi=reviews)

In Chapters 5 and 6, Calvin takes over to introduce the reader to the basic principles of the cerebral foundations of language and memory, partly as a supplement to his comments earlier in the text. The subsequent two chapters, however, comprise a set of more original and challenging ideas. What is really at stake here seems to be nothing less than an implementation mechanism for, *inter alia*, concepts in the brain. Calvin suggests that it is specific sequences of synchronised activations of large neuronal assemblies, producing a kind of distinct firing patterns, or 'tunes' ("plainchant choruses"), that function as the "online" (not necessarily long-term memory) representations of concepts on the neuronal level. Rather than a highly localised activity of an individual cell or group of cells, this would mean a common cerebral code for a concept, universal to all brain areas. For example, a characteristic tune (i.e. a specific spatiotemporal order of coordinated neuronal firings) for 'apple' would propagate throughout the cortex, evoking responses from the sensory and motor cortical areas that would contribute, respectively, the image, smell, taste, etc. of apples, as well as motor programs for the pronunciation of the word 'apple', and countless other associations. Furthermore, according to Calvin, such patterns display the six traits indicative of a Darwin Machine ("Darwinian quality improvement process")[2] – a mechanism for generating structure out of chaos, by multiplying alternatives and selecting the most viable of them.

The next three chapters (Bickerton) sketch a hypothetical evolutionary route from ape level cognition to a fully developed human language. The authors downplay the early importance of within-society selective pressures; instead, they focus on challenges faced by hominids living as extractive foragers in savannah environments, with particular emphasis placed on hunting as a possible cognitive "prime mover". According to the authors, however, social interactions became of crucial importance at a subsequent stage (after arriving at protolanguage ca. 2 million years ago), when social calculus was exapted as a basis of argument structure. Memory for individuals and their roles in events – keeping record of "who did what to whom" – requires the sort of conceptualisations exactly like those underlying thematic roles, and can form the necessary substrate for the emergence of the latter. At this stage, selective pressures for the efficiency of communication itself would have come into play, with syntax enhancing its own further development through a Baldwinian mechanism.

Finally, Calvin's task is to find a successful cerebral implementation for developing syntax, as well as the kinds of pressures that would have been responsible for its emergence. The key concept is that of throwing as a nonstandardised ballistic movement. In the execution of throwing, proprioceptive feedback is too slow for corrections to the movement to be introduced "online", hence, the whole complex action has to be planned in advance. An elaborate structure must be devised, where each step is embed-

[2] "1. a characteristic pattern [...] that can 2. be copied, with 3. occasional variations (A′) or compounding, where 4. populations of A and A′ compete for a limited territory, their relative success being biased by 5. a multifaceted environment [...] and where 6. the next round of variants is primarily based on the more successful of the current generation [...]" (p. 83).

ded in the matrix of all of the previous steps, e.g. the activity of one's fingertips is adjusted in relation to the motion of the wrist, elbow, shoulder, and upper body. Selection for efficient throwing could thus have had impact on other cognitive functions that require precise temporal sequencing; among other things, on speech. At the end of Chapter 14, Calvin envisages an evolutionary scenario featuring selection funnels or (as he terms them) "bottlenecks" – resulting from climatic changes bringing severe droughts about 3 million years ago – that would have made viable some degree of group selection (foodsharing leading to reciprocal altruism), as well as emphasising the value of hunting (hence, the utility of efficient throwing).

Chapter 15, by Bickerton, offers a summary of the argument gilded with a bunch of rather lofty statements concerning "the long awaited marriage of Darwin and Chomsky". The linguistics appendix that follows reviews a number of syntactic phenomena that are fundamental and universal across languages, trying to ground them in just four basic principles that could have been exapted directly from social calculus in an ancestral hominid society.

Unfortunately, problems with the argumentation developed in *Lingua...* are quite numerous. I will sidestep the potentially most controversial issue in the book, expressed by its subtitle: the alleged tension between Chomskyan and Darwinian perspective on (the emergence of) language. As noted by another reviewer (Jenkins 2002), it is not at all clear that this tension really obtains. Admittedly, in several points Chomsky's opinions might seem puzzling, and have sparked criticism even within broadly understood generative tradition (e.g. Jackendoff 2002; Newmeyer 1998). At any rate, his recently co-authored text (Hauser et al. 2002), if distrustful of fully selectionist explanations, would certainly not qualify as antiadaptationist.

And yet, paradoxically, Calvin and Bickerton seem to share with Chomsky one of the most fundamental theoretical tenets. In *Lingua...* language is taken to be virtually coextensive with syntax. It is the emergence of a capacity for systematic, hierarchically structured, recursive combination of lexical units that is deemed both the most significant and evolutionarily problematic; the preceding achievement of symbolisation is thoroughly neglected. Bickerton dismisses the idea of symbol use as a watershed in just two paragraphs, making use of one argument, to the effect of "it's easy – even Kanzi the bonobo can do it" (p. 23).[3]

It is thus hardly surprising that Chapter 9 is the weakest part of *Lingua ex Machina*. Envisaging evolutionary scenarios is always risky and likely to fall as soon as new empirical evidence becomes available. This should not mean, however, that imagination has no limits. Bickerton's stories are mildly amusing, but his reference to a classic text by Gould and Lewontin (1979) solely to borrow the name ("just-so stories") is perplexing – since the article's content was disregarded, no reference at all would have been better. But the actual problem is more serious. According to Bickerton (p. 116), the first

[3] Calvin's statement (p. 181) counting vervet calls as symbol use in the wild is utterly mistaken at worst, or, at best, extremely controversial.

words might have been: "something like 'Mammoth! Mammoth!' (which could have been the noise the beast made, or miming a trunk, or anything that worked) plus 'Come on!', which might have been repeated arm movements in the direction of the circling vultures" or "something like 'Leopard!' (however that was rendered)" ("presumably, by miming a claw" – an unkind commentator might observe). The above passage is teeming with covert assumptions. As to the latter "proto-word" ("leopard!"), if we are after a specific communicative sign rigidly coupled with a specific behavioural response, this is precisely what vervets have (and, less famously, other animal species including non-primates like suricates [Manser et al. 2002]). But if not, difficulties begin to amass. For "mammoth!", a multielement, temporally extended plan must be devised, integrating the mental representations of the cue (vultures), the imagined, but not immediately accessible goal (distant carcass), and other members of the group. This in turn requires an advanced theory of mind, with regarding others in the group as independent agents, representing their states of knowledge and desires, and predicting their behaviours. On top of that, there is no way in which miming a trunk could be iconic of a mammoth (as it is for us) unless a sound concept of MAMMOTH, spatiotemporally stable and invariant across contexts, is already in place.

Equally distressing is the authors' all-out attack on theories favouring social intelligence as a crucial factor in the cognitive advance of early hominids, and their advocacy of the role of hunting. Contra Bickerton, there are many ways in which, for example, an arms race for reading the others' minds while manipulating their beliefs concerning oneself might have led to the development of more refined mental representations that could underlie early words.[4] Bickerton's opting for extractive foraging over within-society pressures flies in the face of contemporary mainstream anthropological theory and appears to be rather poorly vindicated by arguments like: "[i]n the real world, food comes first, socializing second" (p. 199) or "[a]fter all, the only animals other than ourselves to have anything that can transmit variable factual information, as language can, are bees, and bees, like our ancestors, are extractive foragers and use their language to help their extractive foraging" (p. 200).

The authors' insistence on the specific importance of hunting puts them in an even more awkward position where, for lack of arguments, they must resort to ridicule: "there's the exquisite throwing accuracy of modern humans compared to that of apes. (Would paleoanthropologists prefer prehistoric baseball to hunting, as an evolutionary explanation for accuracy? [...]) [...] There's that half-million-year-old wooden spear that Derek mentioned (Would they prefer prehistoric javelin contests to hunting?)" (p. 120). However, we do not seem to need any "evolutionary explanations" for the inconceivable mastery of motor control demonstrated by – of all sportsmen – a number of top snooker players (nor do we expect snooker tables to appear in fossil record); and the

[4] For example, by the increased neocortex (whose area parallels group size in primates) being reappropriated for the performance of other abstract cognitive functions; or by stable "mental labels" for individuals priming the development of detached (context independent) representations of spatial objects.

spear, presumably the one found in Schoningen, might even be conclusive, but the age of 400,000 years BP, to which it was dated is, far too recent to establish hunting as the "prime mover".

Most other problems with *Lingua...* have evolutionary-theoretic sources. Some are the inevitable consequence of the inconclusive nature of the topic. One might, for example, wonder to what degree throwing, considered as a major milestone, is actually qualitatively different from brachiation, which shares most of the former's constitutive "ballistic" characteristics, and yet has been perfected by our ape cousins. At other points, the authors are flagrantly at odds with evolutionary theory, as when suggesting that brain size increase might depend on competition at the level of species (p. 205): "[...] and working memory too might expand (and brain size with it) if, for instance, we came into contact with an alien species roughly equal to ourselves in computational power. Without that, or something like that, there's no selective pressure on working memory to expand". Although nothing of import hinges on the above proposition, this and a few similar statements detract from the book's overall soundness.

By contrast, Calvin's chapters on the cerebral code are what I am inclined to view as the most valuable parts of the book. Calvin's theory has prima facie validity, is consistent, and its basics are lucidly presented – though admittedly, its details remain somewhat hazy. Of course, as a non-professional, I cannot undertake to evaluate Calvin's neuroscientific propositions, but if I read them correctly, they provide a potential implementation mechanism for a wide range of higher mental functions. If confirmed, this would undoubtedly be a truly groundbreaking discovery. Nevertheless, as the co-author himself notes, much of the material "has the status of a theoretical prediction based on neuroanatomy, not physiological data" (p. 80).

Unfortunately, in the context of this book, this hedge has a vital corollary. Neurological mechanisms described by Calvin are intended as responding to the requirements of running syntactic operations described by Bickerton. The hypothetical rather than factual status of this basic component means that the book's theoretical construction is built on shaky ground. In addition, and more importantly, Calvin's story and Bickerton's story do not tie in seamlessly. In more than one place the authors seize on mere surface similarities in each other's accounts: for example, in suggesting an analogy between throwing and syntax, Calvin fails to receive full endorsement even from his co-author (p. 167).

In summary, *Lingua ex Machina* can be described as a daring, yet largely successful interdisciplinary enterprise. Admittedly, the book is not free from shortcomings, some of which are more serious than others (I am convinced Christian Huygens *would* mind being called a Dane – p. 81); in particular, taking shortcuts through evolutionary theory in several places appears to have led the authors up the garden path. No match for either the more academic Deacon's *The symbolic species* or the more popular Pinker's *The language instinct*, *Lingua...* is still a book that is worth recommending to everyone interested in the current controversy regarding the origins of language.

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