The Routledge Handbook of Linguistics

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Biolinguistics

Publication details
https://www.routledgehandbooks.com/doi/10.4324/9781315718453.ch28
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Published online on: 20 Jul 2015

How to cite :- Cedric Boeckx. 20 Jul 2015, Biolinguistics from: The Routledge Handbook of Linguistics Routledge
Accessed on: 27 Oct 2023
https://www.routledgehandbooks.com/doi/10.4324/9781315718453.ch28

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Biolinguistics

Cedric Boeckx

28.1 Introduction

Simply put, biolinguistics refers to the branch of the cognitive biosciences that deals with the language capacity that receives its maximal expression in our species. Many scholars take this capacity to be a species-defining trait, and a key to understand what it means to be human. As such, findings in biolinguistics are not only relevant for the (mental) life sciences, but also for the humanities.

The roots of biolinguistics can be traced back to the cognitive revolution that took place in the 1950s, with the language sciences occupying pride of place thanks to the early efforts of Noam Chomsky, Morris Halle, George Miller and Eric Lenneberg. Such efforts culminated in the 1960s with the publications of Chomsky’s *Aspects of the Theory of Syntax* (1965) and Lenneberg’s *Biological Foundations of Language* (1967). Both documents quickly became classics in the field, and remain central today in defining its aims. (It is in *Aspects* that Chomsky offered his first substantial articulation of his biolinguistic commitments, expanding on remarks made in his 1959 review of Skinner’s *Verbal Behavior*.)

Biolinguistics characterizes itself by its supremely interdisciplinary agenda. That agenda was consciously modeled on that of ethology, whose clearest expression is found in Tinbergen (1963). Tinbergen put forth that the study of animal behavior be organized along the following dimensions:

- What stimulates the animal to respond with the behavior it displays, and what are the response mechanisms?
- How does an organism develop as the individual matures?
- Why is the behavior necessary for the animal’s success and how does evolution act on that behavior?
- How has a particular behavior evolved through time? Can we trace a common behavior of two species back to their common ancestor?

Years later Chomsky recommended that the study of the language faculty be guided by the following questions, which bear obvious parallels with those of Tinbergen.
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- What is knowledge of language?
- How does that knowledge develop in the individual?
- How is that knowledge put to use?
- How is that knowledge implemented in the brain?
- How did that knowledge evolve in the species?

Ontogeny, phylogeny and neural implementation are the central axes of research in biolinguistics. They were already the central theme of Lenneberg’s 1967 book, and figured prominently in Chomsky’s writings at the time. As a matter of fact, the agenda of biolinguistics quickly established itself, and led to a series of activities that culminated in the justly famous Royaumont encounter between Chomsky and Piaget in 1975. It is in fact during a preparatory meeting for Royaumont that Massimo Piattelli-Palmarini gave the term its modern meaning. Alongside Piattelli-Palmarini, Salvador Luria began to use the term in talks (advertising its promises in a 1976 American Association for the Advancement of Science keynote address), Lyle Jenkins was trying to launch a journal, and members of the MIT scientific community had formed a research group on biolinguistics (see Walker 1978).

Curiously, though, the decade that followed this flurry of activities saw the biolinguistic agenda go underground. It is not that the central questions listed above were found uninteresting, nor too hard to address. Rather, it seems, interdisciplinarity was not the order of the day. Attempts to teach human language to other species had failed (see Anderson 2004 for an overview), and within linguistics a new theoretical framework to deal with cross-linguistic variation met with undeniable success. This had the effect of marginalizing interdisciplinarity.

It is also true that some of the central challenges that animate current biolinguistic research, such as genomics or systems neuroscience, to which we will return, were still in an early stage of development and therefore could not have been contemplated at that time. It was still the early days of brain imaging techniques, and the genomic revolution still had not taken place.

All of this began to change in the late 1990s, which saw the return to explicit biolinguistic concerns. Generally speaking, such concerns are still very much the same as when it all began, but the range of specific questions, methodologies and perspectives has expanded, as a result of progress achieved in the intervening years. As is to be expected, it has also become clear that some of the early reflections on biolinguistics were quite naïve, and that complexity is very much the name of the game.

### 28.2 How we got here

So, what were the factors that led to the revival of biolinguistics?

There were four key developments that help us understand why scholars from various disciplines, not just from linguistics, decided to take on the biolinguistic challenge again.

The first development is the genomic revolution. Among numerous other findings, it led to the discovery of the implication of *FOXP2*, a gene that is implicated directly in a linguistic disorder. Shortly after its discovery, it became clear that *FOXP2* is, evolutionary speaking, a highly conserved gene. This fact has led to important investigations into its functioning of other species (especially vocal learners such as birds), and into the timing of and possible adaptive pressures behind the mutation that led to the variant found in modern human populations.
Needless to say, research in this area is still very much ongoing, and current results remain controversial. But inquiry into the nature of FOXP2 has had the merit of reinvigorating comparative studies – a must in the life sciences, from which linguistics had begun to isolate itself. It also had the merit of highlighting the distance and complex pathways between genotype and phenotype. While this should not come as a surprise, the study of FOXP2 and the genes it regulates (its interactome) has made it clear that linguistic properties are not encoded in the genome, and that (popular) characterization of notions like Universal Grammar as the ‘linguistic genotype’ are hopelessly naïve.

The second key factor is related to the first, though I like to keep it separate. It concerns the rise of bottom-up comparativism in psychology. Perhaps due to the identification of numerous deep homologies in the context of genetics, or perhaps due to a renewed appreciation for the compelling Darwinian logic of descent with modification as the celebrations of Darwin’s bicentenary were approaching (the year 2009 was the 200th anniversary of Darwin’s birth and the 150th anniversary of the publication of On the Origin of Species), an increased appreciation that the basic building blocks of cognition might be shared across a wide range of species became apparent among cognitive scientists (see De Waal and Ferrari 2010), and many of them began to explore seriously the possibility of constructing ‘cognitive phylogenies.’

In the domain of language, the rise of bottom-up comparativism was clearly felt, following the publication of Hauser et al. (2002). In an attempt to reconcile what makes the language faculty unique (human specific) and properly Darwinian descent-with-modification scenarios, which take our language faculty to be rooted in animal cognition, Hauser et al. outlined a program aimed ‘at uncovering both shared (homologous or analogous) and unique components of the faculty of language.’ To achieve this, they distinguished between the Faculty of Language in the Broad [FLB] sense and the Faculty of Language in the Narrow [FLN] sense. The recognition that a significant amount of the language faculty could be neither specific to language nor unique to humans (‘FLB’) marked a rather sharp departure from the standard position in the dominant biolinguistic paradigm in its early days.

The third factor I want to highlight is also related to progress in genetics. It is the rise of a new paradigm in biology, popularly known as ‘Evo-Devo’ (evolutionary development). For over fifty years, biology had been dominated by a genocentric, selectionist framework called the Modern Synthesis. The genomic revolution made the limits of genocentrism patently obvious, and gradually displaced selectionist considerations from the center to the periphery, opening up new lines of inquiry animated by a more eclectic, pluralistic agenda. This agenda is no longer a single-level model, with genes at its central causal force, but a much more interactionist perspective with equal weight placed on genes, the environment and development.

Evo-Devo marks a return to early rationalist concerns in biology that resonate with the Cartesian themes of early biolinguistics. It also marks a departure from the core assumptions adopted by evolutionary psychology that at one point threatened to dominate the field of evolutionary linguistics. As a result, more linguists found themselves in a more congenial setting in which to frame questions concerning the evolution of the language faculty.

The final development that I will discuss here pertains to what is called linguistic minimalism. Linguistic minimalism is an attempt to minimize the role of system-specific assumptions to account for properties of natural language grammars. It grew out of the recognition that the successful framework that had relegated biolinguistic concerns to the periphery in the 1980s led to an over-specified initial state of the language faculty (what has sometimes been called, not without reason, ‘exuberant nativism’). In addition to raising...
eyebrows concerning its biological plausibility, such an initial state gradually proved incapable of handling the amount of cross-linguistic diversity that it had in part contributed to uncovering. The early models of language acquisition based on it ran into problems and paradoxes that threatened the very foundations of the model.

Linguistic minimalism offers itself as an alternative to this earlier, over-specified vision of the language faculty. Over the years it has become clear that the success of this minimalist enterprise depends on several factors that mesh well with the other factors mentioned above. First, it must rely on – and therefore assume the existence of – a rich cognitive apparatus with which the (minimal) specifically linguistic apparatus interfaces to yield the substantive universals that previous linguistic research had somewhat naïvely attributed to a highly structured and specifically linguistic ‘Universal Grammar.’ Second, the set of operations that minimalists posit appears to be more in line with the sort of computation one may reasonably expect the brain to do (and the genes to eventually code for). Third, it is becoming clear that the success of the minimalist project will depend on recognizing that the emergence of many grammatical properties of natural languages is the product of social transmission and cultural evolution (‘grammaticalization’). This effectively means that the success of this ‘Chomskyan’ enterprise depends on the correctness of approaches that have (erroneously, in my opinion) traditionally been put in opposition with Chomskyan linguistics. It also means moving beyond the classical genocentric model that was often taken for granted in the early days of biolinguistics.

28.3 What lies ahead

In sum, the return of biolinguistic concerns since the turn of the millennium is the result of a convergence, a consilience among various disciplines. The task of current biolinguists is clear: it is to marry these various perspectives in a productive fashion, one that leads to the formulation of concrete, testable hypotheses concerning ontogeny, phylogeny and neural implementation.

As such, current biolinguistics can serve as a perfect illustration of the various challenges of interdisciplinarity. It seems clear that the bottom-up approach of comparative psychology and the bottom-up approach of minimalism (‘approaching Universal Grammar from below,’ as Chomsky often calls it) are made for one another. It also seems clear that a deflationary stance on grammatical computation has a better chance of being neurally implementable and genetically controlled (more on this below). And it is equally obvious that a pared down perspective on the initial state of the language faculty will have to rely on the reciprocal causality of the many factors recognized within the extended synthesis spearheaded by Evo-Devo. But for all this to truly happen, we need detailed linking hypotheses to act as bridges and allow the flow of information among disciplines.

Such a challenge is not new, but it has yet to be met. Quite often, in the early documents on biolinguistics, such as the Royaumont meeting, one has the feeling of people talking at cross-purposes.

Part of the problem concerns the training of the younger generation. As is patently obvious in the context of findings in the ‘paleo’-sciences (paleo-anthropology, paleo-genomics), where only indirect fossil evidence can be gathered concerning cognition, it takes more than a superficial acquaintance to be able to interpret findings in other fields, especially when media reports tend to bias interpretation and frequently overreach.

But in addition to training deficiencies, there is a real need to take results in linguistics seriously. This has not happened for at least two reasons, I think. The first one is the natural tendency among scientists to believe that they knew what language is, even if they have not
been scientifically trained to analyze it. Our familiarity with language can be quite misleading, as research on knowledge of language has revealed for the past fifty years.

The second reason lies more with the linguists, and their failure to prepare their results for fruitful interaction with experts in other disciplines. More often than not, linguists resort to opaque jargon and modular assumptions that alienate other scientists. It is perhaps for this reason that in recent years several language scientists have gone to the trouble of formulating desiderata for successful interdisciplinary talks. Here are two (the first from Tecumseh Fitch (2009:298), the second from David Poeppel (2005:3)) that I found particularly useful in my own research.

We need to distill what we know from linguistic theory into a set of computational primitives, and try to link them with models and specific principles of neural computation. Thus we need linguistic models that are explicit about the computational primitives (structures and operations) they require, and that attempt to define linguistic problems at a fine enough grain that one can discuss algorithmic and implementational approaches to their solution. We need a list of computations that linguistic theorists deem indispensable to solve their particular problem (e.g. in phonology, syntax or semantics).

Linguists and psycholinguists owe a decomposition (or fractionation) of the particular linguistic domain in question (e.g. syntax) into formal operations that are, ideally, elemental and generic. The types of computations one might entertain, for example, include concatenation, comparison or recursion. Generic formal operations at this level of abstraction can form the basis for more complex linguistic representation and computation.

The issue I have in mind is what Poeppel and Embick (2005) dubbed the ‘Granularity Mismatch Problem’: linguistic and neuroscientific studies of language operate with objects of different granularity. But it is worth bearing in mind that Poeppel and Embick also formulated a far more damaging ‘Ontological Incommensurability Problem’: the units of linguistic computation and the units of neurological computation may well be incommensurable. If incommensurability is true, then, the fields cannot be unified, and the promises of biolinguistics cannot be met. The questions on the biolinguistic agenda may be questions of the sort that ‘we will never answer’ (Lewontin 1998); they are not ‘problems,’ but ‘mysteries’ (Chomsky 1975).

Though real, this possibility should not be taken as proven, and it seems to me that more efforts should be devoted to bridging the ontological gap that is so evident. Today, the challenge seems to be taken seriously, and concrete steps are formulated to make it happen. A growing number of researchers realize that to marry Chomsky and Lenneberg, a multilevel perspective of the sort advocated by the late David Marr for vision (linking the computational and the implementational levels of analysis) may be the solution. The task will not be easy, but certain things are already very clear. As far as linguists are concerned, it is important to abandon claims that language features are directly rooted in the genome, that the very developmental process, which relies on non-genetic factors, needs to be taken into account, that talk of ‘language areas’ is obsolete and inadequate. Brain areas perform basic kinds of computations that are recruited for different, high-level cognitive functions. Linguists and their colleagues also need to realize that ‘mapping’ (say, mapping a particular linguistic property onto a brain area) is not ‘explaining.’ The ultimate goal is to understand how the brain does it, not where it does it.
It is also important to revisit the claim that all human beings (pathological instances aside) are endowed by the same, homogeneous faculty of language. There is mounting evidence suggesting that the human faculty for language is not actually (so) uniform within the species. Some of this is not new. For example, different linguistic modalities can coexist in the same subject, as bilingual people in oral and sign languages nicely exemplify. Moreover, psycholinguistic measures are varied across the normal (and the impaired) population. And, of course, one important piece of evidence is the very existence of language disorders, which plausibly represent different breakdowns of the faculty that are qualitatively diverse by nature. Moreover, developmental trajectories followed by language acquisition, while encompassing similar milestones, are yet diverse (particularly at the cognitive/neurobiological levels). Language ontogeny in pathological populations is even more diverse.

It is clear that similar cognitive profiles can rely on different brain architectures. It seems then that there can be many ways of implementing a (more or less) functional faculty of language at the term of growth. Additionally, major changes in the brain architecture and function usually take place across development. Modules are not born; they are made, although their basic wiring is achieved before birth, plausibly, genetically-guided.

A fruitful biolinguistics must take the following as its premises:

- genes are not blueprints;
- the innate cannot be conflated with the genetic;
- developmental processes also depend on non-genetic factors;
- there is always an indirect link between the genotype and the phenotype;
- developmental itineraries are constrained, but not fully predetermined (in other words, development is both plastic and canalized);
- only biological structures (performing specific activities) are the final output of developmental processes;
- functions (that is, forms of behavior) usually result from the interplay of different biological structures; at the same time, one biological structure can contribute to more than one function;
- biological structures (but not the functions they contribute to) are the real evolutionary loci;
- biological systems are both robust (i.e. resistant to change) and evolvable (i.e. prompted to change) because of their modular nature;
- evolution can be prompted by modifications in any of the factors that affect development (not only genes are involved!);
- phenotypic novelties are largely reorganizational rather than a product of innovative genes.

A fruitful biolinguistics will have to come to grips with the fact that the language faculty is a mosaic, composed of various components of possibly distant origins. It is also clear that language, though used to communicate, cannot be reduced to a system of communication. While it is common to say that no other animal succeeds in transforming thoughts into speech (or sign), this cannot be equated with our linguistic ability. Language also plays a significant role in constructing new thoughts (cross-modal concepts, as Elizabeth Spelke and Katherine Kinzler (2007) have argued at length), which need not be expressed. This, too, should find its place in a future biolinguistics.

It is true that in the past reflections on the nature of language in a biological context may have been reduced to evolutionary pressures (evolutionary psychology) or design...
considerations related to optimality (the early days of minimalism). I think that we have come to realize that these may not have been the most fruitful questions to start with. Instead of focusing on what Ernst Mayr (1997) called ‘ultimate’ questions in biology, it seems advisable, at least for now, to focus on ‘proximate’ questions. It is these that seem more testable, using all the tools from the various disciplines at our disposal.

### 28.4 Conclusion

Pursuing a biolinguistic approach to language in one sense means that the field of inquiry becomes broader. A successful biolinguist must know enough about the cognitive systems of other species and about the properties of non-linguistic cognitive domains in humans to be able to make reasonable inferences about what each of them contributes towards the shape of the modern language faculty. But in another sense, the central object of study becomes much smaller for theoretical linguists, certainly those of a Chomskyan persuasion, for many of the grammatical details that were often attributed to some rich innate component specifically dedicated to language (‘Universal Grammar’) are now to be understood in terms of cultural evolution.

### Further reading

Anderson (2004); Boeckx and Grohmann (2013); Di Sciullo and Boeckx (2011).

### References


