Language, from a Biological Point of View

Language, from a Biological Point of View: Current Issues in Biolinguistics

Edited by

Cedric Boeckx, María del Carmen Horno-Chéliz
and José-Luis Mendívil-Giró

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TABLE OF CONTENTS

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This book originated as a series of lectures organized in 2009 by M.C. Horno-Chéliz and J.L. Mendívil-Giró, as part of the summer course offerings of the University of Zaragoza in its summer headquarters in Jaca.

The event, *Language, brain and genes: lectures in Biolinguistics*, brought together several authors of this volume (Benítez-Burraco, Boeckx, Cuetos, Laka, Lorenzo), as well as others, such as Andrea Moro, who unfortunately could not contribute to this volume. The success of the event among students led us to start thinking of a volume covering the topics of the lectures, as well as addressing issues for which the intensive, 3-day summer course had not left any room. The editors of the present volume invited Bridget Samuels to turn her poster presentation in Jaca into a chapter, and welcomed V. Longa, C. Baus, and M. Carreiras to the project.

The editors also asked S. Balari, T. Martín and J. Rosselló, founding members of the Biolinguistics Group in Barcelona, to write introductions for two of the parts of the book. The editors would like to thank all the authors for their collaboration, and their patience during the editing process.

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INTRODUCTION

INTEGRATING LINGUISTICS AND BIOLOGY

CEDRIC BOECKX,
MARÍA DEL CARMEN HORNO-CHÉLIZ
AND JOSÉ-LUIS MENDÍVIL-GIRÓ

The present volume offers a collection of essays covering a broad range of areas where currently a *rapprochement* between linguistics and biology is actively being sought. Following a certain tradition we call this attempt at a synthesis *biolinguistics.*

The goal of this introductory chapter is to examine, all too briefly, the nature of biolinguistics, a term that is encountered with increased frequency in linguistic, and more generally, cognitive science circles these days, and to offer an overview of the chapters to come.

The term *biolinguistics* is not new (its first appearance dates back to 1950), but recently, it has figured prominently in the titles of articles, books, book series, journals, courses, conferences, symposia, grant proposals, research interests on CVs, and research groups. In the following pages, we want to focus on two issues: (i) why this resurgent interest in biolinguistics? and (ii) the opportunities and challenges that this implies for linguists, which are treated in more detail in the chapters that follow.

1. Why Now?: Factors that led to the return of biolinguistic concerns

One can rarely, if ever, predict the course of events, in science or elsewhere, but with the benefit of hindsight, one can recognize several factors that contributed to the renaissance of biolinguistics. We say renaissance because there was a brief period during the 1970s where the term enjoyed a certain popularity. As mentioned above, the term

biolinguistics appeared for the first time in a 1950 publication (Meader and Muysken 1950), but seemingly attracted no interest,[1] and was recoined by Massimo Piattelli-Palmarini (displacing its early competitor "bioanthropology") during events that led to the famous Chomsky-Piaget debate at Royaumont (Piattelli-Palmarini 1980). Alongside Piattelli-Palmarini, Salvador Luria was using the term in talks (advertising its promises), 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).[2] All these activities were building on the research program initiated by Noam Chomsky, with its rejection of behaviorism and its embracement of ethology (Chomsky 1959), and the specific proposals made by Eric Lenneberg concerning the biological foundations of language (Lenneberg 1967). The climate at the time, well reflected at Royaumont, was supremely interdisciplinary.

All of this is strongly reminiscent of what is happening now in the context of "biolinguistic" activities.[3] The two periods are not identical, of course, but they share the same research focus, which is well captured in terms of Tinbergen's (1963) foundational questions for ethology, adapted to language (cf. Chomsky 1986, 1988):

I. What constitutes linguistic competence in humans?
II. How does this competence develop in the individual?
III. How is this competence put to use?
IV. How is this competence implemented in brain structures?
V. How did this competence evolve in the human species?

These are still the questions that dominate the current biolinguistic research panorama, but current biolinguistics benefits from recent advances in various areas of linguistics and biology that promise to overcome obstacles that may have proven too big to overcome the first time around (in the 1970s), leading to its temporary eclipse.

Let us, all too briefly, sketch some of these advances.

[1] Lenneberg mentions the term biolinguistics, and refers to this 1950 in the preface to his 1967 book, but does not use the term, given that what it referred to in 1950 was not the object of study Lenneberg (or Chomsky) had in mind.

[2] For quotes and other supporting documents, see Boeckx and Grohmann (2007), the introductory chapter in Di Sciullo and Boeckx (2011), and Jenkins (2000).

[3] Not by chance, many see aspects of the original Royaumont meeting being replayed at recent meetings; see Hornstein and Drummond's (to appear) review on the San Sebastián meeting (Piattelli-Palmarini, Uriagereka, and Salaburu 2009).

In mediatic terms, perhaps the major advance in biolinguistics has been the discovery of the *FOXP2* gene and, subsequently, its interactome.[4] It is clear to everyone that *FOXP2* is not "the" language gene, but it is also clear that *FOXP2* and the genes it interacts with provide a concrete example of the long-anticipated genetic basis of language (cf. Lenneberg 1967).[5] It thus allows for a connection with the intense genomic research line (the "omics") in biology. Moreover, the fact that *FOXP2* appears to be so well-conserved a gene allows for experiments with other species (mice, birds, bats, etc.)[6] that could not be possible with humans, if only for ethical reasons. Research on the bird variant of *FOXP2* (*foxp2*) has led to a renewed appreciation of the many parallelisms between human speech (the externalization aspect of human language) and birdsong at various levels (genetic, neuronal, functional), parallelisms that many now believe will vindicate the productivity of Darwin's remarks concerning human speech and birdsong in *The Descent of Man* (1871). In addition, the *FOXP2* discovery promises to shed light on the nature of various linguistic disorders and deficits, which for linguists and biologists alike, have always been phenomena of choice to shed light on the nature of normal biological functions (cf. the logic of monsters, as Alberch 1989 called it). It is to be hoped that such improved understanding will not only advance basic research but also lead to improved therapeutic strategies in a medical context.

Equally central to the reemergence of biolinguistic concerns has been the shift of perspective in comparative psychology, extremely well captured in the following passage from de Waal and Ferrari (2010):

> Over the last few decades, comparative cognitive research has focused on the pinnacles of mental evolution, asking all-or-nothing questions such as

[4] Fisher *et al*. (1998), Lai *et al*. (2001), MacDermot *et al*. (2005), Vernes *et al*. (2007, 2008), Spiteri *et al*. (2007), and Konopka *et al*. (2009). For a comprehensive treatment, see Benítez-Burraco (2009), and for a linguistics-oriented overview, see Piattelli-Palmarini and Uriagereka (2011); for other overviews, see Fisher, Lai, and Monaco (2003), Marcus and Fisher (2003), Vargha-Khadem *et al*. (2005), Fisher (2006), Ramus (2006), and Fisher and Scharff (2009).

[5] On Lenneberg's position concerning this genetic basis, see Boeckx and Longa in press.

[6] Enard *et al*. (2009), Shu *et al*. (2005), Haesler *et al*. (2004, 2007), Teramitsu *et al*. (2004), Webb and Zhang (2005), Scharff and Haesler (2009), Teramitsu and White (2006), Li *et al*. (2007), and Bolhuis, Okanoya and Scharff (2010). For studies concentrating on FOXP2 in the *homo* lineage, see Krause *et al*. (2007). On the evolution of FOXP2, see Enard *et al*. (2002), and Berwick (2011).

> which animals (if any) possess a theory of mind, culture, linguistic abilities, future planning, and so on. Research programs adopting this top-down perspective have often pitted one taxon against another, resulting in sharp dividing lines. Insight into the underlying mechanisms has lagged behind. A dramatic change in focus now seems to be under way, however, with increased appreciation that the basic building blocks of cognition might be shared across a wide range of species. We argue that this bottom-up perspective, which focuses on the constituent capacities underlying larger cognitive phenomena, is more in line with both neuroscience and evolutionary biology.

It is of great significance for current biolinguistics that an influential article advocating this shift of perspective, this new call for meaningful, descent-oriented, properly Darwinian comparative psychology, was co-authored by Noam Chomsky. We are here referring to Hauser, Chomsky, and Fitch (2002), where it is proposed that investigations into the nature of human language may prove more fruitful if one distinguishes between a faculty of the language in the narrow sense (FLN), that which is unique to language, and a faculty of language in the broad sense (FLB), that which is not. Although much attention was devoted to what Hauser, Chomsky and Fitch suggest may be in FLN—suggesting a residue of the old top-down approach discussed by de Waal and Ferrari,[7] it is perhaps the research on FLB that has so far proven far more productive.[8]

Also of great importance has been the emergence of (calls for) a new, expanded synthesis in biology (Pigliucci and Mueller 2010; Gould 2002), one that emphasizes the severe limitations of naive adaptationism and genocentrism (Gould and Lewontin 1978), and the need for a more pluralist, internalist, structuralist, generative (Webster and Goodwin 1996) biology.[9] This internalism resonates strongly with the anti-behaviorist,

[7] Witness the debate between Pinker and Jackendoff (2005), Fitch, Hauser and Chomsky (2005), and Jackendoff and Pinker (2005); and the attention to the negative results of Fitch and Hauser (2004) regarding the inability of certain primates to learn recursive structures, and to the positive results of Gentner *et al*. 2006 regarding the ability of certain birds to do so. For sobering notes regarding these results see Liberman (2006), Hochmann, Azadpour and Mehler (2008), and van Heijningen *et al*. (2009).

[8] Endress *et al*. (2007, 2009, 2010), Endress and Hauser (2010, 2011), Endress and Mehler (2009, 2010), Endress, Nespor and Mehler (2009), Gervain and Mehler (2010), Berwick, Okanoya, Beckers and Bolhuis (2011), Abe and Watanabe (2011), and Bloomfield, Gentner and Margoliash (2011).

[9] The term "Evo-devo" is perhaps the most popular term to characterize this new synthesis in biology, but I prefer the term "expanded thesis", as the best-known

innatist stance in Chomskyan linguistics (see Boeckx 2011c, Fodor and Piattelli-Palmarini 2010), and at once allows linguists to move beyond the meaningless "Chomsky vs. Darwin" discussions that plagued biolinguistics when evolutionary psychology advertised itself as the only road towards biocognition (see Dennett 1995, Pinker 1994, Pinker and Bloom 1990).

A fourth factor that facilitated the return of biolinguistics is the recognition of a central problem of interdisciplinarity in the context of language, particularly salient in the context of neurolinguistics (linking mind and brain). The problem has been most clearly articulated by David Poeppel (Poeppel 2005; see also Poeppel and Embick 2005), who notes that quite apart from the seemingly inherent locationist/phrenologist tendencies in cognitive neuroscience, interactions between neuroscientists and linguists have led to impasses (Poeppel calls it "interdisciplinary cross-sterilization") because of a granularity mismatch: currently, there is a lack of a common level of representation at which the two disciplines investigate processes and the fundamental elements used. This consequently prevents the formulation of theoretically motivated, biologically grounded and computationally explicit descriptions of language processes in the brain.

To better relate to neuroscience, Poeppel says that

> Linguists and psycholinguists owe a decomposition (or fractionation) of the particular linguistic domain in question (e.g. syntax) into formal operations that are, ideally [from the perspective of neuroscience], 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.

Fitch reinforces this point when he says in his "Prolegomena to a science of biolinguistics" (2009b) that

> [w]e 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

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strand of evo-devo remains strongly geno-centric (see, e.g., Carroll 2005). For an excellent discussion of the many meanings of evo-devo, and what this implies for linguistics, see Benítez-Burraco and Longa (2010).

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).

We say that the recognition of this central interdisciplinary problem is a key factor in the return of biolinguistics because, as is well known, recognizing the problem and articulating it in detail is often half its solution.

In addition, the idea that "the linking hypotheses between language and brain are most likely to bear fruit if they make use of computational analyses that appeal to generic computational subroutines" (D. Poeppel) directly relates to the fifth, and most specifically linguistics-internal, factor that led to the renaissance of biolinguistics: the formulation of a minimalist program in theoretical linguistics.

This is not the place to provide a comprehensive overview of the minimalist program for linguistic theory first formulated in Chomsky 1993.[10] Suffice it to say that it consists in approaching the content of Universal Grammar (the grammatical basis for the human language capacity that is hypothesized to be part of our biological endowment) from below. In the words of Chomsky (2007):

> At the time [pretty much throughout the history of generative grammar], it seemed that FL must be rich, highly structured, and substantially unique. [...] Throughout the modern history of generative grammar, the problem of determining the character of FL has been approached "from top down": How much must be attributed to UG to account for language acquisition? The M[inimalist] P[rogram] seeks to approach the problem "from bottom up": How little can be attributed to UG while still accounting for the variety of I-languages attained.

As several linguists have pointed out (see Boeckx 2006: chap 4, Hornstein 2009, among others),[11] it is clear that, although independently formulated, the minimalist program, rigorously pursued, addresses Poeppel's concerns regarding the granularity mismatch (a granularity mismatch which, by the way, need not stop at the neuronal level, as it also applies in

[10] See Boeckx (2006, 2010a, 2011b) for overviews.

[11] Jackendoff (2011) takes issue with the minimalist program in the context of biolinguistics, but we think that his conception of what minimalism is is much narrower than what the literature warrants. Moreover, a careful reading of his paper (for which we don't have room in this introduction, but see Boeckx 2011c) suggests that his vision of biolinguistics is much closer to that of proponents of minimalism than he acknowledges.

full force at the level of genetics, and the relation between genes and cognitive functions). It also resonates strongly with themes like optimization, specificity, laws of form that are at the heart of the new biology (see the material and references of part I of Fodor and Piattelli-Palmarini 2010, especially chapter 5); like the new comparative psychology, it adopts a bottom up approach to cognitive faculties, welcoming the evidence of powerful computational resources in other species/domains of cognition, since it allows for a more deflated characterization of Universal Grammar, and more plausible descent scenarios (Longa, Lorenzo and Uriagereka 2011, Chomsky 2007, 2010b). Furthermore, one of the running themes in minimalism in recent years is that there is a basic asymmetry between the way syntax subserves the sound and the meaning components it interfaces with (Chomsky 2007, 2008; Berwick and Chomsky 2011), being more optimized for the latter. This fits rather well with the research in birdsong that indicates that the basic apparatus for externalization (speech/sound) can be found in the absence of meaning (Berwick, Okanoya, Beckers, and Bolhuis 2011; Samuels 2009a, 2011; Samuels, Hauser and Boeckx, To appear; Bloomfield, Gentner and Margoliash 2011).

As Eric Reuland (2011) put it, the linguistic principles formulated before the advent of the minimalist program were too good to be false (they accounted for a surprisingly wide range of data, and formed the basis of the success of modern theoretical linguistics), they were nevertheless too "language" specific to be true: this is the granularity mismatch problem again. The pre-minimalist linguistic principles, not being decomposed into their elementary components, looked like nothing else in cognition and biology: as such (i.e., undecomposed), they were not biologically plausible (only the existence of some biological components responsible for language development was). The highly-specific, strongly modular nature of these principles required an evolutionary miracle for their emergence, which is why no alternative to the adaptationist scenario could reasonably be offered until the advent of minimalism (witness Piattelli-Palmarini 1989).

In sum, the minimalist program formulated within the confines of linguistic theory converges with the other forces that favored the return of biolinguistic concerns. Minimalist ideas, if pursued rigorously, can help put an end to the still dominant isolationism in theoretical linguistics, where the emphasis is on how language is distinct from other cognitive domains, and in so doing, minimalism promises to stop the "alienation" of linguistics from other branches of cognitive (and biological) sciences diagnosed by many at the turn of the century (see, e.g., Jackendoff 2002).

But the key (or the catch) here is in the phrase "(minimalism,) *if rigorously pursued*". It should be clear that linguists have a central role to play in biolinguistics: they are the ones to provide the elements that researchers from other fields must look for at the neural and genetic levels, and whose evolutionary origins must be traced back. But this is only feasible to the extent that linguists are willing to engage in this interdisciplinary dialogue; that is, it's only feasibly if linguists are willing to become genuine biolinguists. What the opportunities and challenges of this change are is the topic of this book.

2. A wonderful window of opportunity, *if linguists are really willing to take advantage of it*

The linguists who read thus far are likely to point out that biological concerns have been present in theoretical linguistic studies for over 50 years, and that, as far as they are concerned, they have always been biolinguists. After all, already back in the 1970s, Chomsky was saying that linguistics is biology at a suitable level of abstraction.

All of this is true, but the emphasis in theoretical linguistics has all too often been (and continues to be) on the modification "at a suitable level of abstraction". The safe distance of abstraction, we fear, has become a license to posit entities and processes whose biological (neural, genetic, etc.) foundations are, at best, unclear. When this is pointed out to them, linguists often say that we know so little about the brain, about how genes relate to cognition, that it is best not to speculate. Again, this is not incorrect; we indeed have a lot more to learn about mind and brain, genes and cognition, but the fact that we know little in these areas does not mean we know nothing, and it does not mean that we should not engage with the relevant literature in adjacent fields. Too often theoretical linguists adopt an imperialist attitude, assuming that it is the task of others to find biological correlates of theoretical entities, not questioning whether these entities have the right "format" suitable for biological integration.

Put differently, linguists all too often ignore Marr's 1982 vision that a truly productive cognitive science must relate description at the computational level to description at the levels of mechanisms (what Marr calls the algorithmic level) and at the level of brain implementation (what Marr calls the implementational level).

It is with this stance in mind that we decided to assemble this volume. We asked (mostly, theoretically-trained, mostly 'Chomskyan') linguists to show how a genuine engagement with the existing literature in biology could redirect linguistic inquiry.

The volume is organized into three parts (I. *Language and Cognition*, II. *Language and the Brain*, III. *Language and the Species*), each with their own introduction.

The first part (*Language and Cognition*) includes three chapters that deal with issues traditionally associated with linguistic theory, such as the architecture of the language faculty (*The I-language Mosaic*, by C Boeckx), the process of language development and acquisition (*Theoretical linguistics meets development*, by V. Longa and G. Lorenzo), and the problem of the unity and diversity of languages and the nature of linguistic change (*The Myth of Language diversity*, by J.L. Mendívil-Giró).

The second part (*Language and the Brain*) consists of three chapters that introduce the reader to what is known and is currently being investigated in the area of brain processes relating to language. The first one of these chapters (*The role of aphasic disorders in the study of the brain-language relationship*, by F. Cuetos) presents the analysis of different aphasias as a way of addressing the study of language-brain relations; the second one (*Word Processing* by C. Baus and M. Carreiras) introduces the study of language use in real time, focusing on comprehension and production of words, both in oral languages as in sign languages. The third chapter (*More than one language in the brain*, by I. Laka), focuses on multilingualism and its brain basis.

The third part of the book (*Language and the Species*) addresses issues ranging from the molecular and genetic basis of language (*The "Language Genes"* by A. Benitez-Burraco), to the problem of unravelling the evolution of the human faculty of language (*The evolution of the Faculty of Language*, by G. Lorenzo), and to the comparison of the capabilities required for human language with those found in other species (*Animal minds and the roots of Human language*, by B. Samuels).

Taken together, these nine chapters offer a comprehensive overview of issues at the forefront of biolinguistic research. Each contribution highlights exciting prospects for the field, but they also point to significant obstacles along the way.

Perhaps the biggest challenge for linguists will be that of open-mindedness. The field of language acquisition, and the field of biology at large, offers strong reasons to adopt a stance of theoretical pluralism. Instead of viewing different theoretical proposals as competing with one another (the traditional stance in linguistics, where Chomskyan and non-Chomskyan, formalist and functionalist approaches are often contrasted), it is becoming increasingly clear that ingredients from each one of these theoretical perspectives will help shed light on the complexity of the

human language faculty. Adopting a pluralist stance should not only enable us to make faster progress, it would also give the field a more united look and feel, a welcome feature at the time of recruiting students. But this, of course, will have to come at a price: each one of us will have to recognize that we've been wrong. Much like there is likely to be some truth to each one of our theoretical proposals, there is also likely to be quite a few things that are wrong, not in detail, but in terms of the big picture. The age of theoretical exclusivity (necessarily leading to unfortunate exclusion), much like the age of theoretical specificity (leading to isolation), will have to end if interdisciplinarity is to reign and if biolinguistics is to flourish.

For students and teachers alike, the prospects of interdisciplinarity will require a shift of emphasis with respect to the material being covered. Instead of focusing on the descriptive tools that today constitute the main (exclusive?) focus of courses, more fundamental and foundational aspects of our field will have to be taught (aspects that too many students and teachers today only master imperfectly). For example, Gallistel and King (2009) make a strong case for the relevance of foundational results of the earliest days of generative grammar and mathematical linguistics in guiding computational neuroscience (Fitch 2010b makes a similar point in the context of comparative cognition; witness O'Donnell, Hauser, and Fitch 2005, and Berwick, Okanoya, Beckers and Bolhuis 2011). Paradoxially, such foundational results are only covered in detail in one introductory syntax textbook (Lasnik 2000), and (admittedly only briefly) in one general text about linguistics as cognitive science (Boeckx 2009b).

Students in the language sciences should also expect their next jobs to be outside of the humanities, if biolinguistics is to become productive. This gradual displacement already took place with psychology, and there is no reason to think that linguistics will be an exception. True, this will require other departments to open their door to linguists, but we are confident that if linguists succeed in demonstrating the relevance of their results to experts in adjacent fields, this should be possible, particularly as deans lay emphasis on interdisciplinary enterprises. Importantly, linguists should expect to work on things that prima facie look nothing like human language, such as bird song or bat echolocation, ant navigation or chimpanzee tool use, baboon social structure or vervet monkey call system, but this fact was already predicted by Darwin when he wrote at the end of *Origin of Species* (Darwin 1859) that if he was right about evolution (and who now doubts this these days?), psychology would be based on a new foundation. Following Darwin, biologists have come to learn about essential components of higher-order organisms like humans

by experimenting with model organisms that seemingly display none of these essential components.[12] Once decomposed, though, these apparently irreducibly complex, atomic, and unique properties yield to the logic of descent with modification and tinkering.

[12] Consider the fact that it has become standard to explore mental retardation in children by studying specific mutants in drosophila, to look for the roots of autism in rats, and so on (see the bottom-up research program outlined in Manolio *et al*. (2009).

PART I

LANGUAGE AND COGNITION

INTRODUCTION TO PART I

FOR AN APPROACH TO LANGUAGE WITH BIOCOGNITIVE IMPORT: THE DISMISSAL OF SPECIFICITY AND OTHER ISSUES

JOANA ROSSELLÓ AND TXUSS MARTÍN

Under current circumstances, any field of research can easily be split up into two kinds of people and/or activities: those that are representative of the normal practice and those that are one step beyond, usually concerned with possibly unsettled questions and potentially conflicting conceptual issues in the domain of study. Sometimes when clear progress is made in the more conceptual side, conflicts arise with the everyday endeavors in the field. When such thing occurs, not a bad thing in itself, it is normally time to rationally assess what the appropriate next step is and then act accordingly. Otherwise, the risk of enlarging the gap between both perspectives can jeopardize the whole domain.

In the field of Chomskian generative linguistics (CGL), we are now likely in such a crossroad. Time is ripe to dedicate efforts to study the origin and evolution of language, but a plausible approach in this area is at odds with what is still proposed for language acquisition. Conflicts also come up when comparing the standard apparatus used to explain the content of an I-language and what is seen as feasible at the level of its neural implementation. Thus, it seems to us that it is more than appropriate to confront the challenge. CGL will keep being considered relevant within the multidisciplinary ally that focus on the human mind only if it addresses the faculty of language in a sound biological sense. That means that we have to enhance the biocognitive import in our approach to language even in normal practice as theoretical linguists. Language, the most distinctly human hallmark in our otherwise almost unremarkable primate mind, will then reveal its secrets to us.

The three following chapters show us that there are linguists with proposals that aim at bridging the gap between common practice, remotely imbued with biology at most–biolinguistics in the weak sense–, and an elaborated and strongly biological view coming from sources like evolutionary developmental biology (evo-devo) which are now penetrating the otherwise also stagnant standard genocentric biology–biolinguistics in the strong sense (Boeckx & Grohmann 2007).

Among the topics running through the three chapters in this section, the issue of specificity stands out because of its being in the middle of the current crossroad. Wherever you look at, the question arises on whether it is or not correct to assume that X is a specifically linguistic property. And the pronouncements lead us to affirm that the lack of specificity is in order in all those aspects with a prominent biological dimension. Put it otherwise, to find linguistic specificity you have to recluse in history, in the sociocultural dimension of language, much wider than usually acknowledged (see Koster 2009). Another possibility, but not a very interesting one, is to attribute specificity not to basic properties but to the global outcome of some basic not specifically linguistic traits. In a sense, emergence will be at stake in such a case. But before dealing with emergent properties, let us see how specificity lost terrain, with some detail.

As Boeckx reminds us in his chapter, minimalism is since its birth an invitation for the generative enterprise to go in search of minimal design specifications for language. It also invites to go "beyond explanatory adequacy" (Chomsky 2001a) and recommends that Universal Grammar (UG) be "approached from below", i.e. minimally (Chomsky 2007). That being so, we could confidently conclude that minimalism goes beyond Occam's razor as a methodological precept: the minimalist program is not only that, which could hardly count as a novelty in CGL, but rather a strong hint in favor of a minimal design for language in the narrow sense (Hauser, Chomsky & Fitch 2002) and, therefore, a strong hint in favor of unspecific mechanisms in general.

Boeckx suggests that this overall change happened when in the nineties "Chomsky got the impression that the overall approach was well-established and that it was time to take the next step". For us, this sounds too optimistic. We think that at the root of the change there were the conflicting views emerging from the common practice in the different arenas (investigation of steady, normal I-languages, and their acquisition and abnormal deficits) and the combination of a rigorous conceptual analysis with a serious consideration of the evolutionary dimension of language. How can we otherwise understand the incompatibility between

the high degree of specificity that is posited for language acquisition by the majority of its practitioners and what is required for a plausible proposal in the evolutionary side, namely an as much unspecific apparatus as possible?

If the allegedly Chomskian optimism was true, the field of language acquisition wouldn't need to be rethought as we, with Longa and Lorenzo (L&L), think it does. Moreover, it is not only because of the evolutionary demands that the innate contribution to the steady linguistic state of knowledge (I-language) has to be recast. As L&L show in chapter 2, it's also because of neural implementation demands that the necessity of an integral redesign of language acquisition becomes indisputable. In other words, as we see it, the responsibility for the changes we are witnessing lies in the pressure brought to bear on explanatory adequacy (language acquisition) not only from evolutionary adequacy, since especially the programmatic paper by Hauser, Chomsky and Fitch (2002), but also from neural adequacy—if we can use this, to our knowledge, new term. Equivalently, one could say that the imperative approach to Darwin and Broca's problems have paved the way for a new approach to the older Plato's problem.

A strong biolinguistic view of language requires, indeed, a convergent solution to the different problems at stake. What if in a given moment the solutions are divergent? How to know the right direction? For concreteness, couldn't it be that the lack of specificity was the wrong hint in the case of language? Our answer is negative for empirical, methodological and conceptual reasons. Let us illustrate each of these three sides.

On the empirical facet, recent findings in paleogenetics–think of *FOXP2*, for instance, and see footnote 4 in Boeckx's chapter–and the archeological record suggest that the language faculty is only 200,000 years old at most. Language is, then, a very recent achievement in evolutionary terms. This circumstance makes implausible any attempt to naturalize all the complexities that, for this reason, could not have philogenetically evolved, and should rather be the outcome of cultural processes.

The methodological reasons that favor unspecific rather than specific mechanisms have to do with the "granularity mismatch" (Poeppel and Embick 2005) easily at hand in neurolinguistics (Broca's problem). Independently of the ultimate nature of the linguistic operations in the brain, it is clear that the level of abstractness and specificity at which the principles of grammar are currently formulated makes them unmanageable at the brain level. The interaction, then, becomes, in Poeppel's words,

"cross-sterilization". To avoid this annoying situation, in fact the current one, it would be better to recast linguistic formulations in more basic and unspecific terms. That would not preclude that at the same time one had to keep installed at a more abstract level in order to meaningfully capture the linguistic workings of the system.

Finally, there is a point to be made on a rather conceptual issue. It is, simply, that it is easier to add than subtract. Take for instance Universal Grammar (UG) under the orthodox view of the Principles and Parameters framework. What could we subtract from this artifact? Of course, any part you took away from such an intertwined and specific top-down system would take it to pieces. All in all, the only possible real alternative would be starting it anew from scratch, building a UG from below. According to this strategy, we could even expect there to be no mechanism specific to the faculty of language and, then, no UG. However, Chomsky, the very proponent of it, would insist on maintaining UG even in the case that recursive Merge, which is present in other systems (arithmetic, music, etc,), was its only ingredient. One way to obviate such an apparent blatant inconsistency would be to vindicate the linguistic primacy of Merge, which would appear only derivatively in arithmetic, music and the like. This is, in fact, Mukherji's (2010) approach. However, Chomsky would posit UG even in the case of a truly unspecific Merge by saying that "there still must be a genetic instruction to use Merge to form structured linguistic expressions satisfying the interface conditions" (Chomsky 2007: 7). This doesn't seem convincing to L&L, who overtly criticize this move, but it could be sustained by Mendívil-Giró who in his chapter assumes a more lax view which equates UG with the initial state of the language faculty. Be that as it may, with or without (a minimal) UG, the demise of specificity is nowadays beyond dispute.

All this, of course, doesn't invalidate either the tautologic claim that he faculty of language as a whole (FLB, in the sense of Hauser, Chomsky & Fitch 2002) is a specifically linguistic outcome or the obvious statement that the faculty of language is specifically human in the sense that it is unique to our species. As said before, this is almost uninformative by itself. However it suffices to combine the first claim with our previous stand in favor of unspecific properties to see that what ensues from it is the conception of the faculty of language as an emergent property and this is, by contrast, a very interesting issue.

This concept of emergent property is one of the fundamental blocks of the multidisciplinary research paradigm known under the umbrella term of Complex Systems Theory. This research paradigm, inspired by figures like D'Arcy Thompson or Alan Turing, has produced some of the most

exciting ideas of current science with people like Ilya Prigogine, Brian Goodwin, Stuart Kauffman, or Ricard Solé, among many others. In many of these works, the center of the explanatory stage is occupied by concepts such as emergence, chaos, self-organization, and dynamics. The main issue there explores the conditions under which novel and coherent structures, patterns and properties emerge during the process of self-organization in complex systems out of their parts, parts where you don't find those properties. To put it in the words of Kauffman quoted in Mendívil-Giró's chapter, life is not to be found as the property of any single molecule of a living being, but rather as the collective emergent property of the whole those molecules create: "The collective system is alive. Its parts are just chemicals". A more systematic definition of this concept is offered by Jeffrey Goldstein in the inaugural issue of the journal Emergence (Goldstein 1999). This author considers the minimal common characteristics of emergent properties to be the following: (1) radical novelty (features not previously observed in the system); (2) coherence or correlation, meaning integrated wholes that maintain themselves over some period of time; (3) a global or macro "level", i.e. there is some property of "wholeness"; (4) it is the product of a dynamical process, that it to say it evolves; and (5) it is "ostensive"—it can be perceived (Goldstein 1999, apud Corning 2002).

If we stick to Goldstein's proposal, language can be considered an emergent property, as it fits with each one of the five properties Goldstein 1999 proposes for this kind of system: (1) radical novelty: none of the component parts of FL in a broad sense (FLB, in the terminology of Hauser, Chomsky, & Fitch 2002) is in itself linguistic; (2) coherence or correlation: language can be seen as a integrated system, something that sometimes turns out to be equivocal, as language should be seen as a complex system formed by many different parts; this is indeed the rationale for (3) seeing language as a global or macro "level" where we find some property of "wholeness"; (4) language is also the product of a dynamical process, that it to say it evolved in the Homo genus and appeared, probably abruptly 200,000 years ago with the emergence of Homo sapiens; and finally (5) it is an "ostensive" system that can be perceived.

This view is fully coherent with the one advocated for by L&L in their chapter, where they want to reduce the role of genocentrism, the pre-specified endowment, in favor of epigenetism, where from a rather underspecified initial state, a cascade of epigenetic biophysical phenomena make language appear in our species. Such a process of emergence, the authors claim (see also Lorenzo & Longa 2003), should be the same at

both the ontogenetic and the phylogenetic level. That is, FL emerged in the species for the same reason it emerges once and again in every normal human individual: as an effect of the interaction of a minimum linguistic initial state of the system with two independently evolved performance systems, via general laws of biophysical efficiency (epigenesis).

In any case, and contrary to what Mendívil-Giró calls the functional-cognitivist paradigm (FCP), that is the approaches to language that attribute the properties of language to its communicative and social functions, CGL remains committed to an internal and biological view of language, to the primarily individual and internal nature of the human faculty of language. In this perspective, language is a natural, rather than a cultural object. That is to say, in CGL, as opposed to the FCP, the object of study is not external languages, English, or Swahili, the scientific status of which is at least fuzzy, The object rather are the restrictions on possible human languages imposed by the computational system of language. That is to say, CGL focuses, on the internal computational system, the FL, which is common for the whole of the species. That emphasis on what all human languages share is opposed to the endeavors of the FCP, which focuses on how different particular languages are.

Summary of Part I Chapters

The I-Language mosaic (Cedric Boeckx).

Boeckx presents a programmatic contribution to the biolinguistic enterprise understood in its strong sense. In order to measure it against the still predominant view in the generative enterprise, which is of weaker biologic concern, he first summarizes Lasnik's authorized state of the art, 'Grammars, Levels and Biology' representative of the standard practice. Next he substantiates the drastic change of perspective and attributes a great deal of responsibility in it to Chomsky's ideas as expressed in his last linguistic essays. Following that, Boeckx goes on to give a specific articulation of the faculty of language that, in contrast with that advocated in Lasnik's essay, can make true sense biologically, namely ontogenetically and phylogenetically.

With this goal in mind, he effectuates a decomposition—hence "mosaic" in the nice title—where the relevant "levels" cease to be determined by cross-linguistic differences but by more psychologically sound considerations instead. Thus, syntax (narrow syntax), seen as the only purely biological level of language where recursion lies, consists of two alternating and, hence, symmetry breaking operations: one, "densely recursive", is merge (external and internal), and the other, "sparsely

recursive", is a process of partial transfer. Syntax, reduced in this way, becomes the only level of the faculty of language that is completely language-free. This reduction paves the way for an easy enough (antiadaptive) evolutionary scenario in which syntax is the biophysical outcome of a self-organization process once a neural complexity threshold was attained. To complete the very inside of an I-language, two more levels have to be added, a (post-syntactic) lexicon and a grammar, which stabilizes the syntactic machine through a grammaticalization process encoding external properties and developing in a great part inductively. Finally, with respect to the syntax-meaning interface, Boeckx, in line with Pietroski, assumes a linguistic semantics relatively empoverished and embraces the view that syntax and semantics are isomorphic. Regarding the syntax-sound (or gesture) interface instead, a much more kludged adjustment is posited.

Implicit in the previous account of Boeckx's proposal is the demise of specificity and the related mandate to approach language from below or, in other words, to proceed according to truly minimalist premisses.

Theoretical linguistics meets development. Explaining FL from an epigeneticist point of view (Víctor M. Longa and Guillermo Lorenzo).

Longa and Lorenzo argue that genocentrism is preformationist and preformationism is wrong because it neglects the role of development. After a thoroughly criticism of rampant genocentrism and the ensuing defense of epigenetism, Longa and Lorenzo make a comprehensive review of chomskian nativist stance. They go on to demonstrate that it is mainly genocentric although Chomsky himself didn't explicitely embrace this particular form of innateness until the eighties. Grammatical geneticism with its preformationist view of Universal Grammar (UG), however, is not the only way to sort out the poverty of linguistic stimulus. An alternative nativist and developmentalist (epigenetic) account is in order also for language as they neatly show shedding a renewed light on the structure-dependent character of linguistic rules.

Surprisingly enough however, their case study on the structure dependence can hardly be more classical since they deal with the fronting of the (main) auxiliar verb in polar questions in English, surely the oldest and most discussed case in the hot debate around linguistic nativism, since Chomsky attracted attention to it.

The novelty of the two steps approach they undertake resides in two characteristics. The first one, deployed thoroughly, is the overt resort to a "data-driven" learning usually banned in orthodox nativist accounts. In the first approximation, this data-driven learning is combined with and based

on an "innate-primed" and specifically linguistic procedure that refrains the child to entertain any rule not being structure-dependent. The second new characteristic, which appears in the second and final proposal, is the denial of any linguistic specificity in the structural principle at work. They substantiate their claim by appealing to the cortical growth that underlies an enhanced work memory, which in turn enables the structural processing of a sequential stimulus. The dismissal of any specificity in the structural basis of linguistic rules in favor of a view where merge/structure-dependence is seen as a mere by-product of cortical growth amounts to neglect the necessity of UG, namely of a specifically linguistic factor causally entering the state of knowledge finally attained. Were this approach generalized, UG would only be the limit space for linguistic variation. In this way, the divorce between the theory of linguistic variation and the theory of the acquisition of language will be ratified. By contrast, we will be able to aptly envisage a convergent solution for the origin of language in the individual and in the species.

The myth of language diversity (José-Luis Mendívil-Giró).

Mendívil-Giró explores the myth of language diversity by discussing "The Myth of Language Universals", a target paper by Nicholas Evans and Stephen Levinson (Evans & Levinson 2009; E&L henceforth). E&L represents to a good extent the general standpoint of the FCP, and defends the idea that the diversity of languages must be the essential topic of the study of language from a biological point of view. For those authors, the idea of a Universal Grammar is nothing but a myth invented by Chomskyan linguists and constitutes in fact an obstacle to the progress of cognitive science in general. This view, rooted in neo-Darwinism, entails an externalist, functionalist, and adaptationist conception of languages as historical objects created by its development through successive adaptive changes. However, Mendívil-Giró argues that such a view can easily lead to linguistic relativism, which he vigorously rejects. If languages are external objects, and languages and brains coevolve, then different types of languages might have ended up yielding different types of brains, and as a result a particular language would drastically determine the cognition of its speakers. As a corollary, there might be languages (and therefore cognitions) in different stages of evolution, i.e. more primitives than others. Against that view, Mendívil subscribes to the so-called *Language Uniformity Hypothesis*, according to which all languages have the same degree of development or evolution, and hence there are no primitive languages. As a result, the study of the individual faculty of language, uniform for all humans, and probably the most defining trait of the

biological species *Homo sapiens*, is a crucial part of the study of the biology of language. This is indeed opposed to limiting that biology of language to the study of language diversity, the claim by E& L.