Cartesian Biolinguistics*

Cedric Boeckx
Institutió Catalana de Recerca i Estudis Avançats (ICREA)
&
Universitat Autònoma de Barcelona (UAB)
cedric.boeckx@gmail.com

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Abstract

When Chomsky wrote *Cartesian Linguistics* in 1966, he was concerned with showing that his own arguments against behaviorism emphasized certain basic properties of language, such as the creative aspect of language use, or the innate basis of knowledge, that Descartes, Leibniz and other Rationalists of the 17^th and 18^th centuries had already identified. Chomsky wanted to stress how much would be lost if these insights were obscured by pseudo-scientific approaches to language such as behaviorism, and how much would be gained by trying to shed further light on the issues that, say, Neo-Platonists brought up in the context of meaning and the nature of concepts. Furthermore, he wanted to demonstrate that certain intuitions in the technical works of Port-Royal grammarians matched pretty closely (or could easily be reinterpreted in terms of) what was being done at the time in generative grammar. At the same time, Chomsky was stressing how recent advances in modern mathematics, once applied to language as he had done in *Syntactic Structures* could sharpen some intuitions about the nature of language such as Humboldt's aphorism about language making infinite use of finite means.

Today I think that another aspect of rationalist thought could be said to animate modern (bio-)linguistics, under the impetus of the minimalist program. This aspect pertains to the rationalist conception of life, the sort of conception that was advocated by Geoffrey St Hilaire, Goethe, Owen, and

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more recently, D'Arcy Thompson, and Turing — those that are sometimes referred to as the rationalist morphologists. I explore some of the features of this "rationalist-romantic" conception of life in the present work, and highlight parallelisms between the emergence of the minimalist program in linguistics, and a re-emergence of rationalism in some corners of biology. The overall conclusion is that whereas *Cartesian Linguistics* offered historico-conceptual arguments in favor of a specific psychology in the study of the language faculty, current biolinguistics, animated by minimalist concerns, militates in favor of a specific biology to accommodate the human language faculty.

1 Preamble

I would like to begin with a few preliminary remarks regarding the nature of the talk I am about to give. First, and foremost, I would like to thank the organizers of this event for inviting me and especially my student Hiroki Narita for selecting a topic — "Cartesian Linguistics" — that is dear to my (and Jim McGilvray's) heart. Second, let me state right away that there will not be any data of the familiar kind in my presentation, but this does not mean that the talk will be devoid of empirical considerations. I have the impression that many linguists (even those of a generative persuasion) quickly become ill at ease when a talk does not contain examples from English, Japanese, or Navajo, and all too easily dismiss the content of the talk, deeming it "too conceptual," not empirical enough ("not (real) linguistics"). This is very unfortunate, in my opinion. Generative linguistics, or Cartesian linguistics for that matter, is an empirical science, but the object of study is not the examples from English, Japanese, and so on; it's the human language faculty, which can be approached from the perspective of specific examples from various languages, but in other ways as well. Generative grammar is (emphatically) not formal philology. Today I have decided to approach this subject matter from a 'philosophical' standpoint, putting the biolinguistic agenda in philosophical focus. Let me stress that I do not have a ready-made definition of 'philosophical' (a few centuries ago, philosophical means scientific, that's why Galileo insisted on having the title philosopher attached to his name), but you can say that the approach will be conceptual, speculative, reflective. In this sense it will be part of the ongoing minimalist program for linguistic theory, which is trying to be philosophical in the sense made clear in the following quote, from Whitehead (1925):

> If science is not to degenerate into a medley of *ad hoc* hypotheses, it must become philosophical and must enter upon a thorough criticism of its own foundations

Incidentally, Chomsky's *Cartesian Linguistics* (CL; 1966) also starts with a quote from Whitehead. My aim today is in fact to go back to Chomsky's 1966 seminal study (thankfully made available anew in an excellent format a few months ago, thanks to Jim McGilvray's efforts). The subtitle of *CL* is "a chapter in the history of rationalist thought." My modest aim is to make here a few remarks that could become material for a new section, or an appendix to this chapter in the history of rationalist thought. These remarks will focus on the relation between themes discussed by Chomsky in *CL* and the emerging discipline of Biolinguistics. Hence my title "Cartesian Biolinguistics" for today.

2 The growth of biolinguistic thought

It's perhaps appropriate to start with a brief discussion of what Biolinguistics actually is, and of why one comes across the term more often these days than, say, when I was a graduate student (not so long ago).

First, when I said that Biolinguistics was an emerging discipline, I should have been more accurate and said, 're-emerging discipline.' Biolinguistics is not a term a few of us invented a few years ago. The term is currently enjoying a new lease of life, and the interdisciplinary research program behind it, renewed appreciation, but the term itself is in fact older than the generative enterprise. The first mention of the term (Meader and Muyskens (1950)) went largely unnoticed, as far as I have been able to determined from the vanishingly few references to it in the literature. It wasnt until the early 1970s that the term caught on. It was used in the title of a conference "A debate on Bio-linguistics" organized by Massimo Piattelli-Palmarini in 1974 in the Boston area (a sort of warm-up session for the much better known Chomsky-Piaget debate (Piattelli-Palmarini (1980)), and it figures prominently in an address at the annual meeting of the Amercian Association for the Advancement of Science made by Salvador Luria in 1976. After that, the term went under ground, and only reappeared at the turn of the millennium, as the title of a book by Lyle Jenkins (Jenkins (2000)). Since then it has figured prominently in titles of talks, courses, articles, books, workshops and conferences; it even became the title of a new journal and is the rallying call behind the formation of various research initiative in Montréal (the Biolinguistic International Network), Barcelona (the Biolinguistic Initiative), and, I hope, elsewhere.

'Biolinguistics' expresses more transparently than any other term I know of what defines modern linguistics since the 'cognitive revolution' of the 1950s. Back then, under the impetus of Noam Chomsky, Eric Lenneberg, and Morris Halle, the field of

linguistics abandoned its focus on external behavior, and followed a path that was more decidedly cognitive, indeed biological, as it turned its attention to the organism that makes language possible. Chomsky's devastating review of Skinner's *Verbal Behavior* in 1959 quickly became a landmark, and, combined with the analysis of English verbal morphology in Syntactic Structures (Chomsky (1957)), laid the foundations of generative grammar masterfully articulated in the introductory chapter of *Aspects of the theory of Syntax* (1965) (where one can find themes more fully developed in *CL*). At the same time Eric Lenneberg was working on his *Biological foundations of language* (1967), where he stressed the need to study "language as a natural phenomenon—an aspect of [man's] biological nature, to be studied in the same manner as, for instance, his anatomy."

Lenneberg's book was a seminal, ground-breaking work that anticipated many of the issues in the agenda of contemporary research programs concerned with the biology of language. Even just a cursory look over the table of contents of the monograph shows that the book discusses or at least foreshadows such topics as the genetics of language, the biological (physiological) correlates of language, the growth of language in the individual (i.e. the progress of language acquisition), the interplay of brain processes (e.g., lateralization) with the growth of language, the neurological aspects of speech and language, the neural mechanism supporting language, and the evolution of language in the species. It also contains an appendix, written by Noam Chomsky, on formal aspects of grammar, and another by Otto Marx on the history of this research program (very much in line with *CL*). Each of these topics has spawned many areas of research that are currently being intensely explored anew in a necessarily interdisciplinary framework.

I believe that the renewed appreciation for biolinguistic research questions is due to a variety of factors: First, the decidedly interdisciplinary perspective adopted in introductory texts such as Jenkins (2000) and Uriagereka (1998) no doubt led many linguists to reopen the dialog with their colleagues in adjacent disciplines. Both Jenkins and Uriagereka stress the importance of addressing head-on the 'logical problem of language evolution' (how could such an object as the human language faculty have emerged in the species?) from a multi-disciplinary perspective, to avoid the facile adaptationist, just-so-story traps that are all-too-familiar (cf. Pinker and Bloom (1990)). Interestingly, the same message in favor of a pluralist, less genocentric/adaptationist approach to central issues in biology: the rise of the Evo-Devo paradigm (see, among many others, Carroll (2005)) that (bio)linguists are now appealing to on a regular basis. (Incidentally, Jenkins and Uriagereka's messages are not without antecedent. Both refer to Piattelli-Palmarini's (1989) compelling rejection of adaptationist scenarios in the context of language evolution (the article that

sparked Pinker and Bloom's 1990 response), and both point out that Chomsky has voiced the same concerns on numerous occasions since his earliest writings. For an excellent collection of relevant passage from the Chomsky corpus, see Otero (1990).)

At roughly the same time, geneticists in Europe made the breakthrough discovery of a link between the language deficit manifested by the now famous KE family members and a specific gene (FOXP2). Though long suspected, the genetic basis of language received a tremendous publicity boost from this (still ongoing) research. Although it is crystal-clear that FOXP2 is not the language gene, investigations into the role of this gene brought linguists, cognitive scientists, neurologists, and biologists to ask questions to one another, and learn from each other's fields to interpret the data, and it would be our second force behind the renewal of interest in biolinguistics. This process requires temporarily abandoning, and at least moving beyond the jargon of one's field to articulate linking hypotheses. The need to adopt concepts that would be commensurable across disciplines has been stressed for several years by neurolinguists such as David Poeppel in an attempt to circumvent the sterile interactions among subfields of linguistics and adjacent disciplines that so far have led many to express skepticism about the very feasibility of biolinguistics. Fortunately these calls to develop a lingua franca for biolinguistic investigations have been taking place at a time when theoretical linguists themselves, under Chomsky's impetus, decided (for largely independent reasons) to revisit the very foundations of their field, and explore the plausibility of a 'minimalist' program for linguistic theory—the third force, in my opinion, behind the re-emergence of biolinguistics.

I assume that the audience is familiar with the minimalist program, so I will not go into this much (for background, see Boeckx (2006, In pressb)). Suffice it to say that strategically speaking, the minimalist program forces linguists to reformulate previous findings in terms of elementary units, operations, and interface conditions. Many of these, minimalists anticipate, will have such a generic flavor to them (combine, map onto a linear sequence, etc.) that they are plausibly not specific to the language faculty. This should be very good news to researchers in other areas, as the concepts articulated by minimalists may find an equivalent in their own field, or be more readily testable using familiar techniques. At the same time, these generic operations make it more plausible to entertain 'descent with modification' scenarios concerning the evolution of language.

Put differently, linguistic minimalism contributes to the end of what I would like to call linguistic isolationism—an inevitable period of over-modularization in generative grammar during which the language faculty as a whole was studied *sui generis*, as an autonomous system bearing little or no resemblance to other cognitive modules in humans, or other species. I realize that by placing the minimalist program

at the center of the revived field of biolinguistics I am formulating a controversial hypothesis — at the very least one that runs the risk of alienating those who view the theoretical aspects of 'Chomskyan' linguistics with skepticism (not to say contempt), but still see language as a biological object, to be studied 'biolinguistically.' Let me be clear. Biolinguistics is a fairly broad research program, and allows for the exploration of many avenues of research: formalist; functionalist; nativist and insisting on the uniqueness of the language faculty; nativist about general (human) cognition, but not about language per se; etc. From Chomsky to Givon, from Lenneberg to Tomasello — all of this is biolinguistics. In practice, though, it is fair to say that the term biolinguistics is more narrrowly construed as a more transparent label for generative-oriented studies (but see Givon (2002) for an important exception). This narrower characterization is perhaps in part due to the fact that the term biolinguistics was first used with the generative enterprise in mind (Piattelli-Palmarini 1974, Luira 1976, Jenkins 2000). But we think that it also reflects the fact that despite much criticism, the basic tenets of the generative approach to the language faculty remain the very best bet we have to carry the biolinguistic program forward. One should bear in mind that the latest instantiation of the generative enterprise, the minimalist program, is just as broad and 'theory-neutral' as biolinguistics itself. As Chomsky himself has remarked (2007:4),

> Recent inquiry into these questions in the case of language has come to be called the minimalist program, but there has been so much misunderstanding, even within professional circles, that it is perhaps worth reiterating that it is a program, not a theory, and a program that is both traditional in its general flavor and pretty much theory-neutral, insofar as the biolinguistic framework is adopted. (...) And whatever one's beliefs about design of language may be, the questions of the research program arise. It may also be wroth mentioning that the program can only be pursued, whatever theoretical framework one adopts, insofar as some descriptive account of the phenomena to be explained is reasonably unproblematic, often not the case of course, as expected with any system of at least apparent intricacy.

In other words, there are many alternative minimalist visions one can entertain. As soon as one begins to ask 'Why is the language faculty that way?', like it or not, one in minimalist territory as well as in biolinguistic territory. (This is also to say that minimalism is more, much more than finding a way of making sure that some feature is being checked in the most economical way in each of the examples one is looking at. This is also to say that I do not understand why Fitch et al. (2005) dissociate

their (2002) statement from the minimalist program.)

In addition to the broad vs. narrow construal of the term 'biolinguistics,' there is an additional contrast that I would like to draw the readers attention to. Boeckx and Grohmann, in the inaugural issue of the Open-Access journal Biolinguistics (2007), point out that there is both a weak and a strong sense to the term 'biolinguistics.' The weak sense of the term refers to 'business as usual' for theoretical linguists, so to speak, to the extent they are seriously engaged in discovering the properties of grammar from a mentalist stance, in effect carrying out the research program Chomsky initiated in *LSLT*.

The strong sense of the term 'biolinguistics' refers to attempts to provide explicit answers to questions that necessarily require the combination of linguistic insights and insights from related disciplines (evolutionary biology, genetics, neurology, psychology, etc.): which aspects of the language faculty are unique to language?; which are unique to human cognition?; what are the factors that influence language development and the ways language is put to use?; what are the neural substrates of linguistic concepts; what are the origins of this or that aspect of the language faculty? etc.

As Boeckx and Grohmann did, I would like to stress that the term 'weak sense' is not meant to indicate that we regard work focusing narrowly on properties of the grammar as inferior to interdisciplinary work. Indeed I think that such work is not only necessary, but has very often proven to be the basis for more interdisciplinary studies.

I regard Eric Lenneberg's book, *Biological Foundations of Language*, published forty years ago, as the best example of research in biolinguistics in this strong sense. I feel that with the advent of the minimalist program and its emphasis on interfaces and primitive operations, it has become harder to formulate 'purely' theoretical proposals without any regard to interdisciplinary issues. It has certainly become more common to see theoretical linguists speculate at some of the biolinguistic (in the strong sense) implications of their proposals, or even motivate their premises on biolinguistic grounds (again in the strong sense). Thus it is more and more common to find introductory statements such as this (taken from Yang (In press)):

> How much should we ask of Universal Grammar? Not too little, for there must be a place for our unique ability to acquire a language along with its intricacies and curiosities. But asking for too much won't do either. A theory of Universal Grammar is a statement of human biology, and one needs to be mindful of the limited structural modication that would have been plausible under the extremely brief history of Homo sapiens evolution.

This is what Chomsky has in recent years called "Approaching UG from Below." This is also the subject matter of Hauser, Chomsky, and Fitch (2002) (incidentally, the first paper co-authored by Chomsky and non-linguists after a gap of 30 years, the very period during which the term 'biolinguistics' had virtually disappeared — these two facts are not unrelated in my opinion.) To pursue this kind of research program seriously, you need to do more than pay lip-service to biology. You need to ask not only: What is language such that it could fall within the purview of Biology? (that's the subject matter of *CL*); but also, What is biology such that it could capture the properties of language? So, not only what kind of linguistics is needed, but also what kind of biology. It is in this context that I would like to approach themes in 'Cartesian Biolinguistics.' (For the Cartesian roots of Biolinguistics in the weak sense, turn to *CL*.) As we will see, it's not only the linguistics part of Biolinguistics that has Cartesian roots, the biology part does too. Put another way, the sort of biology you need to marry it to theoretical (Cartesian) linguistics is what one might call Cartesian Biology. Do I mean that theoretical linguistics needs a special kind of biology? Yes, I do. This is, by the way, what I like to call the biolinguist's predicament: biolinguistics is neither what you think language/linguistics is, nor what you think biology is.

3 Cartesian Biology

What could I possibly mean by 'Cartesian Biology'? Perhaps the first thing to get clear about is the meaning behind 'Cartesian.' The term refers to a research program, a *Weltanschauung* in fact, that is more or less synonymous with modern science, which finds its roots in the reflections found in René Descartes' works (especially his scientific works). But there is no intention here, or in *CL*, to claim that Descartes thought all of this out. I must insist that 'Cartesian' is a research program (and a very broad one at that, since it arguably includes 'empiricists' like David Hume, to which Fodor (2003) rightly ascribes a thorough-going "Cartesian naturalism"). There can be little discussion about Descartes' influence on modernity (see Israel (2001)), so in this sense the term 'Cartesian' is justified, but a more transparent term would be the one suggested by Jim McGilvray in his introduction to the 2^{nd} and 3^{rd} editions of *CL*: "Rationalist-Romantic". Less catchy perhaps, but more accurate, and less controversail. 'Rationalist-Romantic' captures the two big figures at the heart of *CL*: Descartes and Humboldt. It will also encompass the nature of the contributions of the two major figures I would like to bring to bear on the theme of Cartesian Biolinguistics: Spinoza and Goethe. There is, as far as I am aware, no serious discussion of Spinoza's work in the Chomsky corpus, which is a bit surprising,

considering the undeniable role Spinoza played in the rationalist movement (see again Israel (2001)), and the role he may play in guiding inquiry in cognitive neuroscience (a role that is discussed in Damasio (2003)) — Spinoza was, after all, the first to say that the mind is the idea of the brain, a definition echoed in Pinker's 1997 definition of the mind as what the brain does. As for Goethe, Chomsky mentions him in *CL*. The passage is worth quoting in full, since unfortunately *CL* is rarely read, and much less well known than other works of Chomsky's.

> The parallel between Humboldt's notion of "organic form" in language and Goethe's much earlier theory of "Urform" in biology is also quite striking. The concept of "Urform" was intended as a new dimension beyond the "static" concept of form of Linneaus and Cuvier, for example (namely, the concept of form as structure and organization). But, at least at one stage of his thought, Goethe took this dimension to be one of logical rather than temporal order. In a letter to Herder, in 1787, Goethe writes:
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> The primordial plant is the most marvelous created thing in the world, and nature herself should envy me it. With this model and its key one is able thereby to invent other plants *ad infinitum*, which must be consistent with the model. That is, even if these invented plants do not exist, they *could* exist. They are not, for example, pictorial or poetic shadows of illusions; they rather have an inner truth and necessity. The same law applies to all other living beings.
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> Thus, the Urform is a kind of generative principle that determined the class of physically possible organisms; and, in elaborating this notion, Goethe tried to formulate principles of coherence and unity which characterize this class and which can be identified as a constant and unvarying factor beneath all the superficial modifications determined by variation in environmental conditions. (. . .) In a similar way, Humboldt's "linguistic form" constrains all individual acts of speech production or perception in a particular language, and, more generally, the universal aspects of grammatical form determine the class of possible languages. (pp. 72–73 in the 3^{rd} edition)

Now, I hope you see that we are in the midst of Cartesian Biolinguistics, or at least, you begin to see the possible connection between Humboldt's proto-concept of Universal Grammar and Goethe's "Urform." Chomsky is right in bringing up Goethe's works in the context of his discussion of Humboldt, for Goethe had an enormous influence on Humboldt and the (German) romantics that figure in *CL*, especially Schelling. Goethe is the main character in Robert Richards' excellent 2002 book *The Romantic Conception of Life*, a conception of life that is rooted in Spinoza's

philosophy (which Goethe admired), and that Richards sees as an oft-ignored, but non-negligible influence on Darwin's own view of life (see also Richards (1992)).[1] It certainly had a strong influence on the view of life of the German Darwin, Ernst Haeckel, who began each chapter of his textbook on evolution *Generelle Morphologie der Organismen* with a quote from Goethe's work, and who founded the journal *The Monist*, a direct reference to Spinoza's own monism. Although Haeckel is often maligned in the literature on evolutionary biology (for reasons that are not completely fair, as Richards notes in his brilliant intellecutal biography (2008)), a growing number of researchers in Evo-Devo (yes, that brand of biology that biolinguists tend to refer to a lot) sees him (and through him Goethe) as a precursor of some of their leading ideas. In fact, every time you come across the term Morphology (in the biological sense), you should think of Goethe, who not only coined the term, but gave it a definition that is essential in the context of Cartesian Biology (and Biolinguistics). My overall point, to be developed more fully in what follows, is that various subfields in biology, Evo-Devo, Systems Biology, Theoretical Morphology, Complexity Theory, Theoretical Biology, and generative linguistics (i.e., Biolinguistics as practiced along generative lines) are all sister disciplines. They share the same Rationalist-Romantic roots and commitments, which, at bottom, means that they are trying to discover laws that could explain life, including mental life; and they tend to do that by emphasizing Form and internal properties of organism, at the expense of Function, and the environment.

You all know that this is a controversial research program within linguistics, even within biolinguistics (see Givon (2002)). But you may not realize that is is just as controversial in biology, and this is what I want to address now.

3.1 A *science* of life?

Many of the early proponents of Theoretical Biology,[2] those that biolinguists cite a lot (D'Arcy Thompson, Turing, even Gould) are regularly tagged as heretics. They, like Wallace, dared to question what became like a credo for neo-(ultra-)Darwinians (Dawkins, Dennett, Pinker, etc.). Modern (evolutionary) biology, at least the one that gets a lot of press, the one at the heart of Dobzhansky's well-known statement "nothing in biology makes sense except in the light of evolution", the one that Gould and Lewontin called "vulgar Darwinism", is not too different from behaviorism in

[1] It's undeniable that Alexander von Humboldt, the brother of Wilhelm, that key figure of *CL*, had an enormous influence on the young Charles Darwin.

[2] A term coined by Uexküll, who also coined the term *Umwelt*, and was a forefather of ethology. You will find references to his work in Chomsky's and Lenneberg's writings.

its extreme reliance on the role of the environment, its lack of interest in internal factors, and (I would say) its lack of explanatory value. (If you don't believe me, read Fodor (2008), or look for Fodor and Piattelli-Palmarini (2009), or turn to Skinner's own writings, where you will find a lot of explicit analogies between reinforcement and natural selection.)

What I am touching on here is an old theme is biology.[3] Kant had already said that "there will never be a Newton of the grass blade." By that he meant that there would never be a science of biology in the same sense that there was already then a science of physics. Biology was doomed to be a special science, "unique", as Ernst Mayr, the Darwin of the 20^{th} century, put it. Of course, biology is a science, but it's not (at least, not in the way it's practiced most of the time) a Galilean science, or a science with Galilean ambitions. The Galilean style, with which I am assuming you are familiar, is all about idealizing in the quest for explanatory depth. But as Keller (2002) has made abundantly clear, biologists are not sympathetic to idealization, seeing it as a "weakness", a lack of "satisfying explanation" (p. 74), always requiring "more measurement and less theory" (p. 87).[4] Biological entities are messy, klugy.[5] As Francis Crick says (1990:138), "while Occams razor is a useful tool in physics, it can be a very dangerous implement in biology." Here is what Mayr (2004:28, 93) has

[3]I first discussed this theme in Boeckx (2006, chap. 4).

[4]Chomsky himself, already in the early Principles-and-Parameters days, was aware of the conflicting outlooks, as he wrote in the introduction to *Lectures on Government and Binding* (in a way that highlights once again how latent minimalism was in his earlier writings):

> This approach [which Chomsky does not name, but he clearly has the Galilean style in mind—CB], ... is based on a guiding intuition about the structure of grammar that might well be questioned: namely, that the theory of core grammar, at least, is based on fundamental principles that are natural and simple, and that our task is to discover them, clearing away the debris that faces us when we explored the varied phenomena of language and reducing the apparent complexity to a system that goes well beyond empirical generalization and that satisfies intellectual or even esthetic standards. ... But it might be that this guiding intuition is mistaken. Biological systems — and the faculty of language is surely one — often exhibit redundancy and other forms of complexity for quite intelligible reasons, relating both to functional utility and evolutionary accident. (Chomsky, 1981, 14)

[5]It is for this reason that although the generative enterprise is firmly grounded in biology, the perspective advocated by minimalists has been deemed "biologically implausible" by many linguists and cognitive scientists alike (see Marcus (2008), Kinsella (To appear), Pinker and Jackendoff (2005)). Jackendoff (1997, 20) nicely sums it up when he says: "it is characteristic of evolution to invent or discover "gadgets." (...) The result is not 'perfection'." Jackendoff goes on to say that he would "expect the design of language to involve a lot of Good Tricks (...) that make language more or less good enough. (...) But nonredundant perfection? I doubt it."

to say:

> Laws certainly play a rather small role in theory construction in biology, . . . because evolutionary regularities do not deal with the basics of matter as do the laws of physics. They are invariably restricted in space and time, and they usually have numerous exceptions.

As C. H. Waddington famously said, "the whole real guts of evolution — which is, how do you come to have horses and tigers, and things — is outside the mathematical theory."

Gould (1995, 36) makes a similar point when he writes:

> Apply all the conventional 'laws of nature' type of explanations you wish; add to this panoply all that we will learn when we grasp the laws and principles of higher levels, greater magnitudes and longer times, and we will still be missing a fundamental piece of 'what is life?' The events of our complex natural world may be divided into two broad realms — repeatable and predictable incidents of sufficient generality to be explained as consequences of natural law, and uniquely contingent events that occur, in a world of full chaos, and genuine ontological randomness as well, because complex historical narratives happened to unfurl along the pathway actually followed, rather than along any of the myriad equally plausible alternatives. (. . .) Contingency's domain embraces questions of the common form: 'why this, and not any one of a thousand something else?'

In a similar vein, Gould (2002, 85, 1028) notes:

> The contingent and phyletically bound histories of particular complex lineages . . . constitute the "bread and butter" of macroevolution; . . . Validation in natural history rarely follows the criterion of "never in principle for this would violate nature's laws," as favored in some constructions of the so-called exact sciences, but rather the standard of "conceivable in principle, but not occurring often enough to matter."

Finally, Lewontin (2000, 93) reinforces Gould's and Mayr's points when he states that:

> The problem for biology is that the model of physics, held up as the paradigm of science, is not applicable because the analogues of mass, velocity, and distance do not exist for organisms. Organisms are of intermediate size and take odd shapes. As a result, it is not the first book of

> Newton's Principia, which deals with idealized systems in vacuums, but the second, which discusses friction, buoyancy, and the movement of real objects in real media, that is most relevant to them.

If you subscribe to a Rationalist-Romantic conception of life, you have to question these statements, and let me stress that it's not easy because the authors of these statements are not biologists-wanna-be philosophers or psychologists, or pop-science writers. You are likely to be accused of being a philosopher of the worst kind, i.e. a disciple of Plato (a *very* bad thing in Ernst Mayr's book), or a poet like Goethe, or a mystic like Spinoza, or a fraud like Haeckel; in any event, not a "real biologist." (The great S. J. Gould was often on the receiving end of such accusations; see, e.g. Maynard Smith (1995).)

So, let me once again point out that I know that Cartesian Biology is not popular these days. Fortunately, something that's controversial need not be seen as wrong-headed. (As a matter of fact, if you think about it, it's only things that are potentially interesting, and right that are controversial; otherwise, people would not even bother trying to discredit them.) And there are signs that the tide is slowly changing.

3.2 Calls for an "extended," "expanded" modern synthesis

It is customary to allude to Theodor Dobzhansky's well-known dictum that "nothing makes sense in biology except in the light of evolution" whenever questions of origin are raised (Dobzhansky (1973)). The exquisite complexity of organisms can only be accounted for, so it seems, by means of natural selection. As Dawkins (1996, 202) puts it, "[w]henever in nature there is a sufficiently powerful illusion of good design for some purpose, natural selection is the only known mechanism that can account for it." Questions of origin pertaining to the mind, the 'Citadel itself,' as Darwin called it, are no exception. Indeed, the assumption that natural selection is the "universal acid" (Dennett (1995)) is perhaps nowhere as strong as in the study of mental faculties, being the motto (credo?) of evolutionary psychology (witness ?Marcus (2008)). But the simplicity of Dobzhansky's assertion conceals layers of necessary refinements that cannot be ignored. Its meaning very much depends on what it means to make sense of life (including mental life), and what we understand by (Darwinian) evolution.

As Fox-Keller has made clear in her book *Making sense of life* (Keller (2002)), the notion of explanation, of 'making sense of life,' cannot be uniformly defined across the life sciences.[6] As for Darwinian evolution, Gould, more than anyone else, has

[6]Mayr (2004) says nothing different when he calls our attention to two fields of biology, with radically different methodological assumptions: functional biology (biochemistry) and evolutionary

stressed the richness and complexity of evolutionary theory (see Gould (2002)), and stressed the limitations of ultra-Darwinism and its narrowly adaptationist vision. One can, and must preface any study of origin by 'ever since Darwin,' not, I think, by 'ever since Dawkins.' And one must bear in mind that Darwin himself was explicit about the fact that "natural selection is . . . not [the] exclusive means of modification" (Darwin (1859, 6))

The promises of genome sequencing, and of the selfish gene, have not been met, and a growing number of biologists side with Lynch's 2007 opinion that "many (and probably most) aspects of genomic biology that superficially appear to have adapative roots . . . are almost certainly also products of non-adaptive processes." Speaking for all evo-devo adherents, Carroll 2005 points out that the modern synthesis has not given us a theory of form. A theory of form is at the leart of what Kirschner and Gerhart call "Darwin's Dilemma."

When Darwin proposed his theory of evolution, he crucially relied on two ingredients: variation and selection. Although he could explain selection, he couldn't explain variation. The forms on which selection operated were taken for granted. The problem of the origin of species, Darwin's problem as Goodwin (2009) calls it in a volume celebrating the 150^{th} anniversary of *Origin of Species* is still with us. Since *The Origin of Species*, at repeated intervals, and with accelerated pace in recent years, it has been suggested that several factors giving direction to evolution (facilitating variation, biasing selection, etc.) must be taken into account.

As Gould (2002, 347) clearly states,

> simple descent does not solve all problems of "clumping" in phenotypic space; we still want to know why certain forms "attract" such big clumps of diversity, and why such large empty spaces exist in conceivable, and not obviously malfunctional, regions of potential morphospace. The functionalist and adaptationist perspective ties this clumping to available environments, and to shaping by natural selection. Structuralists and formalists wonder if some clumping might not record broader principles, at least partly separate from a simple history of descent with adaptation principles of genetics, of development, or of physical laws transcending biological organization.

In this respect Gould (2002, 21) calls for a renewed appreciation for "the enormous importance of structural, historical, and developmental constraints in channeling the pathways of evolution, often in highly positive ways, adding that "the pure functionalism of a strictly Darwinian (and externalist) approach to adaptation no longer

biology.

suffices to explain the channeling of phyletic directions, and the clumping and inhomogenous population of organic morphospace."

Echoing Gould, Pigliucci (2007) writes that biology is in need of a new research program, one that stresses the fact that natural selection may not be the only organizing principle available to explain the complexity of biological systems. Its not just all tinkering; there is design too.[7] Pigliucci reviews numerous works that provide empirical evidence for non-trivial expansions of the modern synthesis, with such concepts as modularity, evolvability, robustness, epigenetic inheritance, and phenotypic plasticity as key components.

Amundson (2005) points out correctly that many of the themes at the heart of the expanded modern synthesis (a more enlightened version of Darwinian evolution) arch back to all the major theorists of life before Darwin, especially those that are often called the Rationalist Morphologists. All major theories of life before Darwin followed a tradition reaching back to Plato in presenting a fundamentally 'internalist' account, based upon intrinsic and predictable patterns set by the nature of living systems for development through time, as the term 'evolution' (*evolutio*, 'unfolding') reveals.[8] As one of the foremost exponents of such internalist accounts, Goethe writes (second essay on plant metamorphosis, written in 1790):

> In my opinion, the chief concept underlying all observation of life one from which we must not deviate is that a creature is self-sufficient, that its parts are inevitably interrelated, and that nothing mechanical, as it were, is built up or produced from without, although it is true that the parts affect their environment and are in turn affected by it.

By analogy with Chomsky's distinction between I(nternalist)-linguistics and E(xternalist)-linguistics introduced in Chomsky (1986), we could call the modern synthesis E-biology and the return to pre-Darwinian concerns I-biology. As a common thread, internalist accounts deny exclusivity to natural selection as the agent of creativity, viewing "adaptation as secondary tinkering rather than primary structuring" (Gould (2002, 290)). Internalists claim a high relative frequency of control by internal factors, emphasizing notions like "Form", "Unity of Type" and "Correlation of growth." As Goodwin and Trainor (1983) write (in a passage that could be lifted from Chomsky's writings), "... the historical sequence of forms emerging during evolution is logically

[7] As for Jacob's point that nature recycles as she modifies, may I suggest we replace the tinkering metaphor and replace with 'nature as a topologist'?

[8] This dynamic character of evolution was at the heart of the romantic conception of life (Richards, 2002), which in some ways anticipates recent developments in dynamic/complex systems and chaos theory.

secondary to an understanding of the generative principles defining the potential set of forms and their transformations."

At the heart of internalist frustrations is the linkage between natural selection and contingency. In the words of Kauffman (1993, 26):

> We have come to think of selection as essentially the only source of order in the biological world ... It follows that, in our current view, organisms are largely ad hoc solutions to design problems cobbled together by selection. It follows that most properties which are widespread in organisms are widespread by virtue of common descent from a tinkered-together ancestor, with selective maintenance of useful tinkerings. It follows that we see organisms as overwhelmingly contingent historical accidents, abetted by design.
>
> My own aim is not so much to challenge as to broaden the neo-Darwinian tradition. For, despite its resilience, that tradition has surely grown without attempting to integrate the ways in which simple and complex systems may spontaneously exhibit order.

Despite the fact that various biologists have complained that phrases like "adaptation to the edge of chaos," and "order for free," repeatedly used by Stuart Kauffman, Brian Goodwin, and other proponents of "neo-rationalism" in biology, lack clear scientific definition and operational utility, Gould (2002, 1213) argues that Kauffman *et al.* are groping towards something important, a necessary enrichment or broadening of biology, with important implications.

Of great significance is the fact that the concerns that animate the return to the insights of the Rationalist Morphologists are the very same concerns that animate research in (Cartesian) biolinguistics. By using Cartesian Biolinguistics I intend to point to an important distinction within those who conceive of linguistics as a branch of biology (at a suitable level of abstraction). I suspect that most biolinguists make the very same 'bet' that Dawkins does,[9] and privilege adapation as the sole source or order and complexity. Let us call them neo-Darwinian biolinguists (see Givon (2002), Marcus (2008)). By contrast, those that I would call Cartesian (or rationalist-romantic) Biolinguists follow Chomsky in (i) favoring internalist explanations, (ii) seeing design and topology where others would see tinkering, and (iii) focusing on Form over Function. Once the complexity of biology as a whole, and evolutionary biology, or 'Darwinism' in particular is clear, any perceived conflict between 'Chomsky and Darwin' (Dennett (1995)), or any need to 'reconcile' them (Calvin and Bickerton (2000)), quickly evaporates. The clash is with Dawkins, not

[9]On Dawkins' bet, and how it contrasts with the one made by Gould, see Sterelny (2007).

Darwin. As a matter of fact, once the richness of evolutionary biology is taken into consideration, it seems to me that the prospects for biolinguistics become brighter, even more so if the minimalist program is pursued. As I remarked in Boeckx (2006), the hopelessness of neo-Darwinian accounts of language origin has been clear for a while now (Piattelli-Palmarini (1989), but see already Chomsky (1965, 59), Chomsky (1972, 85)[10]). But it is fair to say that the alternative, neo-rationalist scenario was hard to entertain until the advent of the minimalist program in linguistic theory. As I discussed in Boeckx (2006, chap. 4), the standard Principles-and-Parameters model of FL focused on the specificities of the language organ, and made it very unlikely that central linguistic concepts such as c-command, government, empty categories and cyclicity, just to name a few, may have emerged from any sufficiently general theory of form. The standard Principles-and-Parameters architecture, with its richly modular structure, offered a picture of the language faculty that was too complex for structural constraints (of the sort explored by D'Arcy Thompson) to realistically account for its emergence. (Quite plausibly one of the reasons why Chomsky didn't pursue his discussion of Goethe's *Urform* in *CL*, the same way he didn't pursue the minimalist themes found in his early writings (cf. Freidin and Vergnaud (2001), Boeckx (2006).)

Put differently, the idea that the language faculty was not shaped by adaptive demands, but by physical constraints ("Turings thesis," as Chomsky sometimes calls it) —a recurring theme in Chomskys writings didn't fit snugly in past frameworks. It found its niche only recently, as part of the minimalist program for linguistic theory, in the same way that the pre-Darwinians' speculations about a general theory of biological form seem to be finding their niche in the extended modern synthesis advocated by a growing number of bioligists. Just like Humboldt's thesis needed Turing, Post, and Chomsky to become concrete, Turing's thesis need minimalist constructs, as well as constructs involving networks, dissapative systems, etc.

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[10]Chomsky is very explicit in this passage:

> It does seem very hard to believe that the specific character of organisms can be accounted for purely in terms of random mutation and selectional controls. I would imagine that biology of 100 years from now is going to deal with evolution of organisms the way it deals with evolution of amino acids, assuming that there is just a fairly small space of physically possible systems that can realize complicated structures. (Chomsky, 1982, 23)

Citing the work of D'Arcy Thompson, Chomsky points out that "many properties of organisms, like symmetry, for example, do not really have anything to do with a specific selection but just with the ways in which things can exist in the physical world."

4 The best of all possible language faculties? Steps towards a 'logodicy'

In the heydays of the rationalist period, philosophers/scientists like Leibniz asked themselves questions like: How does God act? With what faculties and capacities is he endowed? To what extent is his behavior, like ours, amenable to rational understanding? Why is there something rather than nothing? Why is the world as it is, not just physically but morally as well? Why do bad things happen to good people? How can we make sense of suffering and human evil that often seem beyond comprehension? Behind all these questions was the fundamental question of how to represent the nature of God and of his agency. With such questions, Leibniz was trying to make sense of God and the world. He was trying to develop a theodicy (*theos*, God and *diké*, justice), a term Leibniz coined for the rational justification or vindication of God's ways. With the advent of the minimalist program, linguists can be said to have tried to develop what one might call a 'logodicy.' What I find particularly interesting is that the sort of reasoning and research strategy that one finds in minimalism can also be found among those developing a theodicy. Nadler (2008) has shown that philosophers pursued this quest in two ways: (i) we will never know (Arnaud, and to some extent Descartes); or (ii) they appealed to variational principles, such as 'the best of all possible worlds'. In the latter case, the strategy was to find a way to make this world 'perfect.' (NB: 'perection' in the 17^{th} century had a descriptive/onotological sense, not the normaltive sense it has today; in those days, 'perfect' meant 'full of positive reality, richer in being'). The name of the game was to show that the actual world contains the highest degree of perfection, that it realizes the maximum level of created being or reality. God faced in creation a problem of engineering, according to leibniz; he must find a way to produce the maxumum amount of perfection, or reality possible. For Leibniz, the best possible world is populated by the greatest number of beings that can possibly co-occupt a world over time without contridaction, and exhibits the greatest possible variety of kinds of beings. The best possible world is the one with the most fecund laws; the simplest in hypotheses and the richest in phenomena. In somewhat more mundane terms, the goal was to find the best arrangement of the greatest amount, a bit like Kepler's conjecture concerning optimal packing of canon balls.

Leibniz believed that the imperfections of this world are only apparent. By contrast, Malebranche, another 'super'-rationalist, concedes that the imperfections are real. For him, the laws of the universe are of maximum simplicity. That is, the laws of this world are the simplest laws imaginable. There could be better worlds, with fewer imperfections, but these world would require more complex laws. Even more

than Leibniz, Malebranche sought to uncover the simplicity of the world. For him, this world was not the best of all possible worlds, but the best one could have, given his axiom of simplicity.

Clearly, some of this reminds one of Chomsky's (2000) discussion of the nature of imperfection in language, and what to do in the face of it. It is also reminiscent of Chomsky's (2004) claim that internal merge is not an imperfection.

Nadler (2008) shows in his work that many philosophers agreed that the theodicy-project was worth a try, but they disagreed on which justification was more adequate, just like linguists disagree on what the best way is to articulate minimalist guidelines. The point of any theodicy, though, is to view god as a rational being who does things for an intelligible and objective purpose; it is to show that its creation is amenable to rational inquiry. Does the universe exist by *ratio*? Can there be a science of it? That too is the point of the strong minimalist thesis. And just like the strong minimalist thesis requires a certain view of the language faculty (P&P architecture as starter), Nadler is correct in stressing that a theodicy requires a portrait of God. It's a portrait for which Leibniz, Malebranche and other theodicy-practioners were criticized (chiefly by Arnaud), for by trying to naturalize the supernatural and his modus operandi, they suggested constraints on the choice of God. (God was not free to create the world; it had to create the best of all possible worlds). For Descartes, God's actions were absolutely free and arbitrary. Not so for Leibniz or Malebranche.

Spinoza took another approach. For him, there was no choice on the part of God. There is only one world, fully determined. According to Spinoza it is not the case that God tries to balance two values to produce the best outcome overall; for him, this world cannot not exist. It's not the best, it's the only possible world. It's not the result of choice, it's the result of being. This is an extreme version of Descartes' position (this is why Spinoza is often said to be a radical Cartesian), it's taking descartes philosophy and its metaphysics to its ultimate logical conclsion, making the universe devoid of value, though fully knowable/intelligible, because law-governed (determinism).

Spinoza's position anticipates the fate of variational principles such as the principle of Least Action (see Ekeland (2006); see also Born (1969)), and the fate of economy principles in the minimalist literature. As inquiry deepens, terms like 'best' or 'least x', or 'most x' are replaced by such things as the stationary path principle or Feynman's sum over histories. There is no quantity of action or the like that is being minimized.

5 The seat of humaniqueness

In this section I would like to turn to the process of lexicalization, the key event in the evolution of FLN in my opinion (Boeckx (In pressc,I)), and suggest that it may be the source of Man's unique abilities ('humaniqueness,' as Hauser felicitously dubbed it), that 'Great Leap Forward' that gave us our niche, and that was the focus of Cartesian reflections.

It is commonly assumed that the key evolutionary step that gave us our distinctness is cognitive in nature.[11] Accordingly, the quest for humaniqueness amounts to identifying the factor (or factors) that make(s) human cognition special. In the words of Hauser (2008),

> [a]nimals share many of the building blocks that comprise human thought, but paradoxically, there is a great cognitive gap between humans and animals. By looking at key differences in cognitive abilities, [we hope to] find the elements of human cognition that are uniquely human. The challenge is to identify which systems animals and human share, which are unique, and how these systems interact and interface with one another.

The program can be seen as an extension of Hauser et al. (2002), from FLN to HCN (Human Cognition in the Narrow sense; that which is specific and unique to human cognition), or (building on Fodor (1975)), LOTN (Language of Thought Narrow).

Hauser presents four evolved mechanisms of human thought that give us access to a wide range of information and the ability to find creative solutions to new problems based on access to this information:

1. the ability to combine and recombine different types of information and knowledge in order to gain new understanding;

2. to apply the same rule or solution to one problem to a different and new situation;

3. to create and easily understand symbolic representations of computation and sensory input; and

4. to detach modes of thought from raw sensory and perceptual input.

[11] Needless to say, it is perfectly possible that our special cognitive features are the result of more basic anatomical changes. Tattersall (1998) even suggests that the emergence of language was the result of epigenetic processes.

Details of formulation aside, Hauser's hypothesis is a very familiar one. The essence of Hauser's claim really goes back to the Descartes' fascination with human cognitive flexibility, its fluidity, its detachment from perception, and its unbounded character—in short, its creative character. This is what led the Cartesians to claim that Man has no instinct, by which they meant that Man's cognitive faculties rise above the *hic and nunc*. This too was clear to Konrad Lorenz, who said that "man is a specialist in not being specialized." (Lorenz (1959)) As Marc Hauser likes to put it, while other animals display laser-beam-like intelligence (highly precise specificity), humans intelligence is floodlight-like (generalized specificity) in character. Tattersall (1998, 197) calls it "the human noncondition," and writes:

> ... [O]ver millenia now, philosophers and theologians have made something of an industry of debating the human condition. Even if inevitable, it is rather ironic that the very species that apparently so much enjoys agonizing over its own condition is, in fact, the only species that doesn't have one—or at any rate, whose condition, if any, is most difficult to define. Whatever condition is, it is surely a lot easier to specify it in the case of an amoeba, or a lizard, or a shrew, or even a chimpanzee, than it is in our own.

Elsewhere (p. 207), Tattersall notes that in our case, "natural selection has gone for "flexibility" instead of specificity in behavior" (something which one may attempt to relate to Gould's 1977 discussion of 'neoteny').

To be sure, scientists have found that some animals think in ways that were once considered unique to humans. For example, some animals have episodic memory, or non-linguistic mathematical ability, or the capacity to navigate using landmarks. In sum, animals have a rich mental life, full of modules or what Liz Spelke calls 'core knowledge systems.' What Man seems to have in addition is the ability to systematically transcend the boundaries of modular thought and engage in cross-modular concept formation.

I would like to claim that this ability of building bridges across modules is directly related to language, specifically the ability to lexicalize concepts (uprooting them from their modules) and combine them freely via Merge.

I am by no means the first to speculate along these lines. Spelke (2003), Carruthers (2006), Pietroski (2007), Tattersall (1998), Chomsky (2005), and, to some extent, Mithen (1996), all agree with Descartes that language plays a significant role in human cognition. Darwin himself appears to be in agreement when he writes in *The Descent of Man*,

> If it could be proved that certain high mental powers, such as the forma-

> tion of general concepts, self-consciousness, etc., were absolutely peculiar to man, which seems extremely doubtful, it is not improbable that these qualities are merely the incidental results of other highly-advanced intellectual faculties; and these again mainly the result of the continued use of a perfect language. (p. 126)

The emergence of lexical items was the sort of perfect storm that gave Man his niche. Once concepts are dissociated from their conceptual sources by means of a lexical envelope, the mind truly becomes algebraic, and stimulus-free.

The creation of the human lexicon, which, if I am correct, goes hand in hand with Merge, is what lies behind the creative aspect of our thought process, which fascinated both Descartes and Chomsky. Edge features are the set of humaniqueness.

With language, creativity emerged, understood (as did Arthur Koestler) as "the sudden, interlocking of two previously unrelated skills or matrices of thought," an almost limitless capacity for imagination, metaphorical extension, etc.[12] Note that one need not follow Hauser (2008) in positing four distinct mechanisms to account for humaniqueness. One key event (the emergence of edge features) suffices. Going back to Hauser's four ingredients for human specificity listed above, we can now claim that by means of lexical envelopes, humans are able to "detach modes of thought from raw sensory and perceptual input," and lexicalize at will ("create and easily understand symbolic representations of computation and sensory input"). Via Merge, humans have "the ability to combine and recombine different types of information and knowledge in order to gain new understanding, and apply the same rule or solution to one problem to a different and new situation."

With edge features and Merge, the human mind became capable of true swiss-army-knife style cognition. Before that the tools at the animal's disposal were exquisitely tuned to their tasks, but too isolated. Their effects could only be combined sequentially; they could not be seamlessly and smoothly integrated with one another. With language, the human mind developed into a key ring, where all keys (concepts) can be combined and available at once, thanks to the hole (edge feature) that they all share.

One could say that the ability to endow a concept with an edge feature was, to paraphrase Armstrong, a relatively small step for a man, but a giant leap for mind-kind (and mankind). As Dennett (1996, 17) puts it (in agreement with the intuition

[12]It may be interesting to note that Mithen's 1996 characterization of the evolution of mind in three stages—primitive general intelligence, specialized intelligence (modules), and cross-modular intelligence—mirrors Fitch's 2008 three stages of consciousness. Perhaps one may attempt to make precise the link between language and consciousness that Jackendoff (1987, 2007) has tried to establish.

behind Cartesian dualism), "perhaps the kind of mind you get when you add language to it is so different from the kind of mind you can have without language that calling them both minds is a mistake."
Merge/edge features gave Man a truly general language of thought, a *lingua franca*, where before there were only modular mutually incomprehensible dialects/(proto-)languages of thoughts. It significantly altered Man's conceptual structures—how humans think the world. By merging lexicalized concepts, Man was able to hold in mind concepts of concepts, representations of representations, and associations of associations. *Homo* became *Homo combinans*.

The result of the emergence of FLN was a creative, cultural explosion well attested in the archeological record (art, symbol, music, notation, feelings of mystery, mastery of diverse materials, true innovation in toolmaking, sheer cleverness), a "quantum leap," as Tattersall (1998) calls it.

I agree with Tattersall (1998, 171) that "it is very hard to avoid the conclusion that articulate language is quite intimately tied up with all the other mysterious and often unfathomable aspects of modern human behavior."[13] Tattersall (1998, 186, 228) notes further,

> Almost all of the unique cognitive attributes that so strongly characterize modern humans—and that undoubtedly also distinguished our fellow *Homo sapiens* who eliminated the Neanderthals—are tied up in some way with language. Language both permits and requires an ability to produce symbol in the mind, which can be reshuffled and organized by the generative capacity that seems to be unique to our species. Thought as we know it depends on the mental manipulation of such symbols, which are arbitrary representations of features belonging to both the internal and outside world.
>
> . . . virtually any component of our ratiocinative capacities you can name—from our sense of humor to our ability to entertain apocalyptic visions—is based on those same mental abilities that permit us to generate language

Through Merge/edge features, we became the symbolic species—a transformative experience that is directly reflected in the archeological records. As Camps (2006) have noted, aspects of *Homo sapiens*'s toolmaking seem to require the kind of mental

[13]Tattersall is quite careful, as is Chomsky (see Chomsky (2008)) to distinguish between language [FLN] and speech, which he regards as an "adjunct" (p. 186) to language. It is quite possible that this adjunction was a recruitment of old circuits specialized in externalization of the sort we find in songbirds. For relevant discussion, see Piattelli-Palmarini and Uriagereka (To appear) on the possible role of FoxP2 in this respect.

computation that are distinctive of FLN (the discussion in Mithen (1996, 76) can also be interpreted in this way).

Monboddo—one of the forefathers of evolutionary thought—was clearly correct in his belief that language is "necessarily connected with an[y] inquiry into the original nature of Man." As Tattersall (1998, 58) writes, "universal among modern humans, language is the most evident of all our uniqueness." Tattersall goes on to note (p. 68) that our closest relatives "do not display "generativity," the capacity that allows us to assemble words into statements or ideas into products." It seems to me that edge features are a good candidate for the source of this very generativity, and humaniqueness.

6 Concluding remarks

One of the overarching themes of *CL* is to motivate innateness (plenty of it) in the context of language. I think that today the point of biolinguistics should be to move beyond nativism (taking it for granted), and asks which nativism is needed? And this is where we could learn from the rationalist morphologists, who like D'Arcy Thompson were highly suspicious of geno-centric explanations. Rationalist-romantic morphology favors the sort of "non-genomic nativism" (to use Chris Cherniak's apt phrase) that is gathering adherents in some corners of biology.

If the point of *CL* was to situate linguistics within psychology, the point of modern biolinguistics should be to situate linguistics within biology. As Amundson (2005) recounts in his masterful revisionist history of biological thought, the Rationalist tradition in biology was obscured not so much by Darwin himself, but by all the architects of the modern evolutionary synthesis. Rationalist morphologists had as their main ambition to develop a science of form. They saw development (in both ontogenic and phylogenetic senses) to be governed by laws, revealing a certain unity (of type). They focused on form, and treated function as secondary. They de-emphasized the role of what we would now call adaptation and the power of the environment to shape the organism, and favored internalist explanations according to which development (again, in both its ontogenic and phylogenetic senses) was channeled by physical constraints. Quite correctly, they saw this as the only research strategy to attain a truly explanatory theory of form, a true science of biology. Not surprisingly, they saw it as necessary to resort to idealization and abstraction to reveal underlying commonalities (such as Owen's archetype).

In contrast to all of this, neo-Darwinians, led by Ernst Mayr, focused on function, adaptation, change and the exuberant variety of life. They were empiricists, as is the majority of working (evolutionary) biologists today. But as Piattelli-Palmarini

(2006) points out, laws of form are making a come-back.

The study of biological networks (systems biology) reveals special features that give hope that [such] networks are structures that human beings can understand (Alon 2003:1867). Biology is finally yielding to intelligibility. Elsewhere (Alon 2007), Alon writes that biological networks of interactions are simpler than they might have been (or might have been expected to be). Alon clearly states that cells often seem to economize, relying as they do on only a few types of patterns called network motifs that capture the essential dynamics of the system. Alon stresses that approaches that seek to reveal such motifs must rely on abstract representations, focus on the essential aspects, and suppress details in good Galilean style. Alon is right to conclude his article on simplicity in biology by saying that simplicity in biology must be emphasized so as to encourage the point of view that general principles can be discovered. For without such principles, it is difficult to imagine how we might ever make sense of biology on the level of an entire cell, tissue, or organism (Alon 2007: 497). Such approaches (awkwardly falling under the rubric of "Complex Systems") suggest that simplicity, not complexity, pervades biology.

It is my honest feeling that linguistics, in its minimalist quest, has much to offer to this kind of biology. As Chomsky (2004, 124) remarks, "insofar as [minimalism makes progress in capturing properties of FL], the conclusions will be of significance, not only for the study of language itself." If simplicity and efficiency of design are found at the level of the cell and at the level of FL, it is not implausible to expect the same sort of simplicity everywhere in between these two relatively extreme realms of biological structures. Perhaps, then, minimalist pursuits will provide biologists with another model organism in their quest for a science of form. Perhaps linguistics can be part of tomorrow's science of life, much like it became a key component of the new cognitive science 50 years ago.

Waddignton (1968–1972) had this to say in the early 1970s:

> To a biologist, therefore, a language is a set of symbols, organized by some sort of generative grammar ... And it is language in this sense that I suggest may become a paradigm for the theory of General Biology.

I think we live once again in exciting times. And this is why philosophical reflections are needed. Linguistics, even more so than biology, is a very young science. And while it is too easy to forget some of its roots, it is also too easy to forget how truly remarkable it is that already now we can formulate a few minimalist concerns with some precision. Like biology, linguistics is a very interdisciplinary field, with lots of perspectives to integrate. In general, from its early inception in the 1970s, Evo-Devo as a field has sought the contract of both historians and philosophers of

biology. This has arguably been a most productive relationship. One of the reasons why scientists have found this contact profitable lies precisely in the integrative and interdisciplinary nature of Evo-Devo, which benefits from the kind of conceptual analyses that characterize philosophy. Linguists should do the same. Proponents of Evo-Devo are keen to point out that Evo Devo is as much a conceptual project as an experimental one. Accomplishing integration of varios research traditions is not easy. By delineating the various foundational theoretical assumptions behind such approaches, one can hope to provide a useful roadmap for future discussions.

References

Amundson, R. 2005. *The changing role of the embryo in evolutionary thought: Roots of evo-devo*. Cambridge: Cambridge University Press.

Boeckx, C. 2006. *Linguistic Minimalism: Origins, Concepts, Methods, and Aims*. Oxford: Oxford University Press.

Boeckx, C. In pressa. The emergence of language, from a biolinguistic point of view. In *The Oxford Handbook of Language Evolution*, ed. M. Tallerman and K. Gibson. Oxford: Oxford University Press.

Boeckx, C. In pressb. Linguistic minimalism. In *Oxford handbook of linguistic analysis*, ed. B. Heine and H. Narrog. Oxford: Oxford University Press.

Boeckx, C. In pressc. Some reflections on Darwin's Problem in the context of Cartesian Biolinguistics. In *The biolinguistic enterprise: New perspectives on the evolution and nature of the human language faculty*, ed. A.-M. Di Sciullo and C. Boeckx. Oxford: Oxford University Press.

Boeckx, C., and K.K. Grohmann. 2007. The Biolinguistics manifesto. *Biolinguistics* 1:1–8.

Born, M. 1969. *Physics in my generation*. New York: Springer.

Calvin, W.H., and D. Bickerton. 2000. *Lingua Ex Machina: Reconciling Darwin and Chomsky With the Human Brain*. Cambridge, Mass.: MIT Press.

Camps, J., M. & Uriagereka. 2006. The gordian knot of linguistic fossils. In *The biolinguistic turn*, ed. J. Rossello & J. Martin, 34–65. Barcelona: PPU.

Carroll, S.B. 2005. *Endless forms most beautiful: The new science of evo-devo and the making of the animal kingdom*. New York: Norton.

Carruthers, P. 2006. *The Architecture of the Mind*. Oxford: Oxford University Press.

Chomsky, N. 1957. *Syntactic structures*. The Hague: Mouton.

Chomsky, N. 1959. Verbal behavior. *Language* 35:26–58.

Chomsky, N. 1965. *Aspects of the theory of syntax*. Cambridge, Mass.: MIT Press.

Chomsky, N. 1966. *Cartesian linguistics*. New York: Harper & Row. [Third edition, with introduction by James McGilvray, 2009, Cambridge University Press.].
Chomsky, N. 1972. *Language and mind*. New York: Harcourt Brace Jovanovich.
Chomsky, N. 1981. *Lectures on government and binding*. Foris: Dordrecht.
Chomsky, N. 1982. *On the generative enterprise: a discussion with Riny Huybregts and Henk van Riemsdijk*. Dordrecht: Foris.
Chomsky, N. 1986. *Knowledge of language*. New York: Praeger.
Chomsky, N. 2000. Minimalist inquiries: the framework. In *Step by step: Essays on minimalist syntax in honor of Howard Lasnik*, ed. R. Martin, D. Michaels, and J. Uriagereka, 89–155. Cambridge, Mass.: MIT Press.
Chomsky, N. 2004. Beyond explanatory adequacy. In *Structures and beyond*, ed. A. Belletti, 104–131. New York: Oxford University Press.
Chomsky, N. 2005. Three factors in the language design. *Linguistic Inquiry* 36:1–22.
Chomsky, N. 2007. Approaching UG from below. In *Interfaces + recursion = language? Chomsky's minimalism and the view from semantics*, ed. U. Sauerland and H.-M. Gärtner, 1–30. Mouton de Gruyter.
Chomsky, N. 2008. On phases. In *Foundational issues in linguistics*, ed. C. Otero, R. Freidin, and M.-L. Zubizarreta, 133–166. Cambridge, Mass.: MIT Press.
Crick, F. 1990. *What mad pursuit: A personal view of scientific discovery*. New York: Basic Books.
Damasio, A.R. 2003. *Looking for Spinoza: Joy, sorrow, and the feeling brain*. New York: Harcourt.
Darwin, C. 1859. *On the Origin of Species by Natural Selection*. London: Murray.
Dawkins, R. 1996. *Climbing Mount Improbable*. New York: Norton.
Dennett, D. 1995. *Darwin's dangerous idea: evolution and the meanings of life*. New York: Simon & Schuster.
Dennett, D. 1996. *Kinds of Minds*. New York: Basic Books.
Dobzhansky, T. 1973. Nothing in biology makes sense except in the light of evolution. *American Biology Teacher* 35:125–129.
Ekeland, I. 2006. *The best of all possible worlds: mathematics and destiny*. Chicago: University of Chicago Press.
Fitch, W. T., M. D. Hauser, and N. Chomsky. 2005. The evolution of the language faculty: Clarifications and implications. *Cognition* 97:179–210.
Fitch, W.T. 2008. Nano-intentionality: a defense of intrinsic intentionality. *Biology and Philosophy* 23:157–177.
Fodor, J., and M. Piattelli-Palmarini. 2009. What Darwin Got Wrong. Ms., Rutgers University and University of Arizona.
Fodor, J.A. 1975. *The language of thought*. Cambridge, Mass.: Harvard University

Press.
Fodor, J.A. 2003. *Hume Variations*. Oxford: Oxford University Press.
Fodor, J.A. 2008. Against Darwinism. *Mind & Language* 23:1–24.
Freidin, R., and J.R. Vergnaud. 2001. Exquisite connections: some remarks on the evolution of linguistic theory. *Lingua* 111:639–666.
Givon, T. 2002. *Bio-Linguistics: The Santa Barbara Lectures*. Amsterdam: John Benjamins.
Goodwin, B. 2009. Beyond the Darwinian paradigm: Understanding biological forms. In *Evolution: The First Four Billion Years*, ed. M. Ruse and J. Travis, 299–312. Cambridge, Mass.: Harvard University Press.
Goodwin, B., and L. E. Trainor. 1983. The ontogeny and phylogeny of the pentadactyl limb. In *Development and evolution*, ed. C. C. Wylie B. Goodwin, N. Holder, 75–98. Cambridge University Press.
Gould, S.J. 1977. *Ontogeny and phylogeny*. Cambridge, Mass.: Harvard University Press.
Gould, S.J. 1995. 'What is life?' as a problem of history. In *What is life? the next fifty years: speculations on the future of biology*, ed. M.P. Murphy and L.A.J. O'Neill, 25–40. Cambridge: Cambridge University Press.
Gould, S.J. 2002. *The Structure of Evolutionary Theory*. Cambridge, Mass.: Harvard University Press.
Hauser, M. D., N. Chomsky, and W. T. Fitch. 2002. The Faculty of Language: What is it, who has it, and how did it evolve? *Science* 298:1569–1579.
Hauser, M.D. 2008. Humaniqueness. Talk given at AAAS 2008, Boston. A version to appear in *Nature* as "Mind the gap!".
Israel, J.I. 2001. *Radical enlightenment: philosophy and the making of modernity, 1650-1750*. Oxford: Oxford University Press.
Jackendoff, R. 1987. *Consciousness and the computational mind*. Cambridge, Mass.: MIT Press.
Jackendoff, R. 1997. *The architecture of the language faculty*. Cambridge, Mass.: Mit Press.
Jackendoff, R. 2007. *Language, Consciousness, Culture: Essays on Mental Structure*. Cambridge, Mass.: MIT Press.
Jenkins, L. 2000. *Biolinguistics: Exploring the Biology of Language*. Cambridge: Cambridge University Press.
Kauffman, S.A. 1993. *The origins of order: Self-organization and selection in evolution*. Oxford: Oxford University Press.
Keller, E.F. 2002. *Making sense of life: Explaining biological development with models, metaphors, and machines*. Cambridge, Mass.: Harvard University Press.

Kinsella, A.R. To appear. *Language evolution and syntactic theory*. Cambridge: Cambridge University Press.

Lenneberg, E.H. 1967. *Biological foundations of language*, volume 1. New York: Wiley.

Lewontin, R.C. 2000. *The Triple Helix: Gene, Organism, and Environment*. Cambridge, Mass.: Harvard University Press.

Lorenz, K. 1959. Psychologie und Stammesgeschichte. In *Evolution der organismen*, ed. G. Heberer, 131–170. Stuttgart: Fischer.

Lynch, M. 2007. *The origins of genome architecture*. Sunderland, Mass.: Sinauer Associates.

Marcus, G. 2008. *Kluge*. Boston: Houghton Mifflin.

Maynard Smith, J. 1995. Genes, memes, and minds. *New York Review of Books* 42:46–48.

Mayr, E. 2004. *What makes biology unique?: Considerations on the autonomy of a scientific discipline*. Cambridge University Press.

Meader, C.L., and J.H. Muyskens. 1950. *Handbook of Biolinguistics*. Toledo, OH: Weller.

Mithen, S.J. 1996. *The prehistory of the mind*. London: Thames and Hudson.

Nadler, S. 2008. *The best of all possible worlds: A story of philosophers, God, and evil*. New York: Farrar, Straus and Giroux.

Otero, C. 1990. The emergence of homo loquens and the laws of physics. *Behavioral and Brain Sciences* 13:747–750.

Piattelli-Palmarini, M., ed. 1980. *Language and learning: the debate between Jean Piaget and Noam Chomsky*. Cambridge, Mass.: Harvard University Press.

Piattelli-Palmarini, M. 1989. Evolution, selection and cognition: from'learning'to parameter setting in biology and in the study of language. *Cognition* 31:1–44.

Piattelli-Palmarini, M. 2006. The return of the laws of form. In *Life on the edge (La vita in Bilico)*, ed. C.P. Manzu', volume 2, 45–57. Centro Pio Manzu', Roma.

Piattelli-Palmarini, M., and J. Uriagereka. To appear. FoxP2: A geneticist's dream; a linguist's nightmare. In *The biolinguistic enterprise: New perspectives on the evolution and nature of the human language faculty*, ed. A.-M. di Sciullo and C. Boeckx. Oxford: Oxford University Press.

Pietroski, Paul M. 2007. Systematicity via monadicity. *Croatian Journal of Philosophy* 7:343–374.

Pigliucci, M. 2007. Do we need an extended evolutionary synthesis? *International Journal of Organic Evolution* 61:2743–2749.

Pinker, S. 1997. *How the Mind Works*. New York: Norton.

Pinker, S., and P. Bloom. 1990. Natural selection and natural language. *Behavioral*

and Brain Sciences 13:707–784.

Pinker, S., and R. Jackendoff. 2005. The faculty of language: what's special about it? *Cognition* 95:201–236.

Richards, R.J. 1992. *The meaning of evolution: the morphological construction and ideological reconstruction of Darwin's theory*. Chicago: University of Chicago Press.

Richards, R.J. 2002. *The romantic conception of life: science and philosophy in the age of Goethe*. Chicago: University of Chicago Press.

Richards, R.J. 2008. *The tragic sense of life: Ernst Haeckel and the struggle over evolutionary thought*. Chicago: University Of Chicago Press.

Spelke, E. 2003. What makes us smart? Core knowledge and natural language. In *Language and Mind: Advances in the study of language and thought*, ed. D. Gentner and S. Goldin-Meadow, 277–311. Cambridge, Mass.: MIT Press.

Sterelny, K. 2007. *Dawkins vs. Gould: survival of the fittest*. Cambridge: Icon.

Tattersall, I. 1998. *Becoming Human: Evolution and Human Uniqueness*. Oxford: Oxford University Press.

Uriagereka, J. 1998. *Rhyme and reason: An introduction to minimalist syntax*. Cambridge, Mass.: MIT Press.

Waddignton, C. H., ed. 1968–1972. *Towards a Theoretical Biology*, volume 1–4. Edinburgh: Edinburgh University Press.

Whitehead, A.N. 1925. *Science and the modern world: Lowell lectures, 1925*. New York: Macmillan.

Yang, C. In press. Three factors in language acquisition. *Lingua* .