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Self-Organization and Natural Selection: The Intelligent Auntie's Vade-Mecum

Víctor M. Longa & Guillermo Lorenzo

1. Introduction

This paper is aimed at clarifying one particular aspect of Derek Bickerton's recent contribution to *Biolinguistics* (Bickerton 2014a), where he contends that biolinguists tend to emphasize the specifics of certain non-standard evolutionary models in order to prejudicially avoid the theory of natural selection. According to Bickerton (2014a: 78), "they [biolinguists] have problems with the notion of natural selection, up to and including a total failure to comprehend what is and how it works". This is the most understandable, also according to Bickerton, because even evolutionary psychologists and philosophers like Pinker and Dennett, who have devoted well-known papers and books to explaining and applying natural selection to the case of cognition and language, have failed to understand the real import of Darwin's idea: "Natural selection could not 'explain' complex design", claims Bickerton (2014a: 79), "even if Pinker & Bloom (1990), Dennett (1995), and others who are not biologists think it does. In fact, natural selection does not provide a single one of the factors that go into creating design".

Bickerton's comments in the *Biolinguistics* piece are specifically targeted at the model of 'self-organization' associated to complexity sciences, which is introduced in Longa (2001) as potentially capable of dealing with some recalcitrant problems of the evolution of language. Bickerton (2014a: 79) writes that Longa's attacks point to "a straw man", and that his claim that self-organization is an alternative to natural selection is "a category mistake", for self-organization is simply one of the factors that generates the variation that natural selection selects from. So, according to Bickerton, natural selection and self-organization must be conceptualized as two complementary mechanisms that operate in a coordinated manner to bring about complex biological designs.

In this response we want to explain that this is a wrong conclusion supported on wrong premises. For that purpose, we first document that biologists generally agree on the idea that natural selection creates design; second,

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we explain that self-organization is primarily concerned in the stability and robustness of form rather than in introducing variation; and, finally, we systematize the differences between self-organization and selection as explanatory paradigms. Considering all these pieces of evidence altogether, we conclude that they cannot be conceptualized as coordinated evolutionary strategies, save at the price of making one or another devoid of its original meaning. As a matter of fact, we think that this is exactly the position of Bickerton, to whom 'natural selection' boils down to the idea of the 'survival of the fittest'. But if so, we agree with Fodor & Piattelli-Palmarini (2010: 139ff.) that natural selection becomes a platitude: "There survive those that survive".[1] At the end of this response we offer a good illustration of the possibility of respecting the difference between natural selection and self-organization for explanatory purposes, curiously enough taken from Bickerton (2014b).

2. Natural Selection: The Biologists' View

According to Bickerton's presentation, natural selection does not create design: Natural selection simply selects among designs independently created by other means—self-organization being just one (Bickerton 2014a: 79). Consequently, we ought not to present natural selection and, for example, self-organization as rival evolutionary mechanisms, because they are complementary pieces or a single multifaceted process. This is not what the relevant specialized literature shows (see Table 1), for there one can easily find what is characterized as the 'creative view' of natural selection (Razeto-Barry & Frick 2011, Razeto-Barry 2013). According to Razeto-Barry and Frick's presentation, natural selection "is a creative force because it can generate new traits by the cumulative selection that makes probable a combination of mutations which are necessary for trait development and that would not probably be combined together without natural selection" (Razeto-Barry & Frick 2011: 344). As a matter of fact, such a characterization is an unavoidable one if we take the neo-Darwinist dissection of the evolutionary process at face value. As Gould (2002: 141-146) explains, the variation on which natural selection acts is small, copious and isotropic (i.e. insensitive to direction). Consequently, "variation only serves as a prerequisite, a source of raw material incapable of imparting direction or generating evolutionary change by itself" (Gould 2002: 155). In other words, such raw material is only creatively cooked by selection.[2]

1 According to an anonymous reviewer, this phrase is an epitome of the creationists' creed, a fact we were not aware of when we originally wrote it. Be as it may, we consider this observation irrelevant to the point. Some biologists have previously defended the thesis that natural selection entails a tautology (for example, Vallejo 1998), without aiming it at supporting creationism. For that matter, one might also correctly say that Darwin's concept of adaptation was continuous with that of theologians. Obviously enough, from this fact one cannot derive an argument supporting Darwin's intimate beliefs. The same reviewer notes that Bickerton nowhere mentions 'survival' or 'fitness' in his paper. This is correct, but if it means that Bickerton sees these concepts alien to the theory of natural selection, readers may wonder what natural selection actually boils down to for him.

2 A reviewer suggests that supporters of the creative view clearly reify and anthropomorphize evolution, envisioning it as an agent with abilities proper of intentional minds. This

According to Gould, it was one of Darwin's key postulates "the claim that natural selection acts as the creative force of evolutionary change" (Gould 2002: 583). We think that Gould (and Darwin, for that matter) is not suspect of being one of those non-biologists that failed to comprehend what natural selection is and how it works.

"Selection molds the separate units of heredity into a coordinated whole, a process as truly creative (although of course not planned or directed) as the combination of separate bricks into a building."	(Simpson *et al*. 1957: 413)
"All evolution is due to the accumulation of small genetic changes, guided by natural selection."	(Mayr 1963: 586)
"Natural selection is at one and the same time a blind and a creative process."	(Dobzhansky 1973: 126)
"Darwin's theory of evolution by natural selection is satisfying because it shows us a way in which simplicity could change into complexity, how unordered atoms could group themselves into ever more complex patterns."	(Dawkins 2006 [1976]: 12)
"We start from the presumption that natural selection is the only plausible explanation for adaptive design."	(Maynard-Smith & Szathmáry 1995: 290)
"Selection thus acts as a creative force that has made possible biological organizations that would otherwise have been highly improbable."	(Strickberger 2000: 136)
"It is the cumulative selection ('adding up,' in Darwin's terms) of variation that forges complexity and diversity."	(Carroll 2006: 32)
"As a consequence of natural selection, organisms exhibit design, that is, exhibit adaptive organs and functions."	(Ayala 2007: 8570)
"Complexity cannot evolve except by natural selection."	(Futuyma 2009: 296)

Table 1. Natural selection: The creative view

3. Self-Organization: The Complexity Scientists' View

Complexity Sciences aim at discovering laws of form capable of offering models for patterns of order and regularities found in nature. The laws of concern are alien to external pressures (as for example, to adaptive pressures), but obey intrinsic generative principles that induce organization on matter in a self-sufficient way. They are typical of dynamic complex systems, composed of an intricate net of interacting elements, capable of abruptly and spontaneously reaching ordered patterns of organization. From a logical point of view, such systems could attain many different positions within a space of possibilities, but they place themselves in a well-defined area ('at the edge of chaos'), where self-organization arises.

argument has been recently elaborated and directed against contemporary Darwinists in Fodor & Piattelli-Palmarini (2010) and Richards (2012) explains that it is correct at least of Darwin's original formulations of the idea of natural selection. From the Darwinist side, philosophers however argue that the very properties emphasized by Gould guarantee that it is a 'stupid' process (Dennett 1995), incapable of planning, looking ahead, and other intelligent qualities, notwithstanding being creative.

This short presentation may be enough to appreciate that self-organization is not really the best of the allies of variation, for one of its main properties is anisotropy (i.e. directionally biased). Besides, self-organization produces steady and robust patterns of combined elements, not in competition with slightly different concurrent patterns. Obviously enough, forms thus generated may not be particularly fitted to survive in a given environment, and so they may be rejected and disappear from it. But this is not natural selection positively acting on raw materials, but a negative filter disposing of independently cooked ones.

Readers can contrast the accuracy of this short presentation, enough for our purpose, in the following sources: Lewin (1992), Waldrop (1992), Goodwin (1994), Kauffman (1995), Stewart (1999), Solé & Goodwin (2000), Camazine et al. (2001), Johnson (2001), Longa (2001), Gribbin (2004), Edelmann & Denton (2007), and Heylighen (2008).

4. Self-Organization and Natural Selection: A Short Summary of Differences

The following is a list of a total of eight differences between natural selection and self-organization that reflects that they cannot be conflated into a unique mechanism: They are complete explanatory frameworks on their own, each incompatible with the other in particular applications (see Table 2). Of course, they may be thought of as particularly fitted to different aspects of organic designs (see section 5), but successfully applying one of them in a particular occasion automatically renders the other inadequate for the same goal.

Natural selection (NS)	Self-organization (SO)
NS is gradual.	SO is abrupt.
NS is positively creative.	Selection after SO is negatively rejective.
Order is accidentally induced by tinkering.	Order is induced by intrinsic inertias.
NS is an externally guided process.	SO is an internally guided process.
NS acts on passive matter.	SO happens in active matter.
NS's outcomes are open.	SO's outcomes are fixed.
NS is historically contingent.	SO is generatively necessary.
NS is gene centered.	SO is epigenetic.

Table 2. Natural selection and self-organization: A case of incompatibility of character.

The table is eloquent enough and justifies Edelmann & Denton's conclusion:

> Self-organization is […] totally different in essence from cumulative selection as a causal agent of bio-complexity. If self-organization is in fact widely exploited by organisms to generate adaptive complexity […] then this does indeed provide a serious challenge to the Darwinian claim that cumulative selection is the major creative agency in evolution.
>
> (Edelmann & Denton 2007: 598)

Let us to dwell a little more on the list.

4.1. *Gradual vs. Abrupt Character*

According to Gould, gradualism "may represent the most central conviction residing both within and behind all Darwin's thought" (Gould 2002: 148), for otherwise variation itself, and not selection, should be deemed the true agent of evolutionary change. From the point of view of Darwinism, "creativity must reside in the summation of [the tiny increment of each step]," with natural selection acting "as the agent of accumulation" (Gould 2002: 150). Dawkins also points out that denying gradualism entails "to deny the very heart of [Darwinian] evolution theory" (Dawkins 1986: 318).

Self-organization operates on a radically different basis, which Edelmann & Denton explain in the following way:

> The realm of self-organized complexity is an unpredictable realm of sudden spontaneous emergent complexity that is generated by non-linear interactions via something like a phase transition. This is a realm where saltation, emergence, spontaneous sudden change and bifurcations rule; a realm in which the concepts of intermediacy, gradualism and continuity, so central to the Darwinian, no longer apply.
> (Edelmann & Denton 2007: 585)

4.2. *Positive vs. Negative Selection*

Natural selection acts positively inducing order and consistency upon a material that would otherwise diversify to the point of making populations amorphous collections of mutually unrecognizable individuals. On the contrary, self-organization guarantees similar outcomes without the need of selecting among competing designs. This does not entail that a parallel guarantee exists that self-organized designs are automatically sanctioned to overcome the perils of every imaginable environment. However, self-organized structures are simply 'selected', not 'naturally selected', for they are subject to a negative or filtering process of rejection, different from the source that independently creates them. The idea can be traced back, for example, to the works of Richard Owen, who favored an idea of 'natural rejection' along these lines as an alternative to Darwin's natural selection (Owen 1860). The following fragments offer more recent formulations of the idea:

> [Selection] does not have a lot to do except act as a coarse filter that rejects the utter failures. (Goodwin 1994: 157)

> Self-organized material patterns may be selected by, but not created by natural selection. (Edelmann & Denton 2007: 598)

4.3. *Tinkering vs. Generative Inertias*

The expression 'tinkering' is customarily used to express the opportunistic character of natural selection, which manages to take advantage of any haphazardly occurring variant within the range of a population. Tinkering is thus the resource that natural selection has at hand to accidentally impose order where otherwise "there would be nothing but incoherent disorder"

(Kauffman 1995: 8). Instead, self-organization derives order from inner generative laws, internal to the organism, so from this perspective, "vast veins of spontaneous [not accidental] order lie at hand" (Kauffman 1995: 8; the insert is also from Kauffman, same page).

4.4. *External vs. Internal Guidance*

Within the framework of natural selection, the isotropic character of variation determines that the directionality of change is a function of the external pressures acting on individuals. In other words, the evolution of populations follows the path of the proliferative superiority of their fittest representatives (Strickberger 2000, Gould 2002, Ayala 2007, Futuyma 2009). According to Futuyma, natural selection boils down to "any consistent difference in fitness among phenotypically different classes of biological entities" (Futuyma 2009: 283). Contrary to this, self-organization is an internalist framework, where complexity comes for free and it is attained by means of internal dynamics alone. This contrast is well captured in the following quote from Gould:

> "Under internalist theories of evolution, environment, at most, holds power to derail the process not behaving properly […]. Under Darwinian functionalism, however, environment becomes an active partner in both the modes and directions of evolutionary change." (Gould 2002: 161)

Or in the words of Edelmann & Denton (2007: 588): "Self-organized order is spontaneous from within; the order of selection is additive from without".

4.5. *Passive vs. Active Character of Matter*

This difference follows from previous ones:

> From the externalist viewpoint, living matter is a passive and a non-intrinsically ordered entity that needs an external factor (natural selection) to acquire from. From the internalist perspective, living matter is an active entity capable of exhibiting order spontaneously.
> (Linde Medina 2010: 25)

4.6. *Open vs. Fixed Outcomes*

The isotropic character of variation and the instability of environmental conditions determine that natural selection can lead to any result within a given space of design (Dennet 1995). As illustrated by Goodwin (1994: 87): "Small variations are such that almost anything can happen—organisms can take any form, have any color, and eat any food, subject only to very broad constraints". In the case of self-organization, systems robustly point to a specific point within a space of logical possibilities, one in which the attractor captures and stabilizes it.

4.7. *Historical Contingency vs. Generative Necessity*

Natural selection connects biology with history, while self-organization connects it with physics or chemistry. The point of view of the former is that of "historical narratives: Which species come from which ancestors under which circumstances" (Goodwin 1994: 88). The latter aims at explaining biological phenomena like other sciences "in which principles of organization allows one to understand the […] world in terms of regularities and general principles" (*ibid.*).

4.8. Genocentrism vs. Epigeneticism

Natural selection is commonly associated to the idea that evolutionary change is ultimately and chiefly anchored on genes (but see Okasha 2006). Thus, Dobzhansky's (1937: 11) classic definition of evolution as "a change in the genetic composition of populations" still pervades Darwinian thought (to wit, see Futuyma 2009). Self-organization limits the centrality of genes, for self-generated patterns of organization cannot be said to be a matter of genetic pre-specification. Accordingly, "self-organized order is indeed genuinely epigenetic and not necessarily in the genes at all" (Edelmann & Denton 2007: 587).

5. From Adam to Wallace: An Illustration of the Difference

We want to conclude this clarification note with a particularly nice example taken from the field of evolutionary linguistics, where the suggestion is made that the evolution of language was originally bootstrapped thanks to a process of a selective character, but lastly accomplished through self-organization at the brain level. The case has been raised in two successive books by Bickerton (2009, 2014b), which offer a perfect illustration of what we have been trying to explain and document above.

According to Bickerton, "the transition from the alingual state that characterizes all other species to something that might qualify as a genuine precursor of language" (Bickerton 2010: 128) could only have happened as an adaptive response to some particular need of some hominid species. Consequently, Bickerton elaborates an historical narrative that reads approximately like this: There was a time when some human ancestor entered a confrontational scavenging niche, where announcing one's sightings and asking for help were imperative. Then some individuals accidentally developed the capacity of producing some noises while the image of their sightings still reverberated in the head. The capacity was inherited and accidentally more and more elaborated and successively inherited by the progeny of those individuals, until it became species typical. In due time, human ancestors were endowed with an inborn full-fledged capacity for displaced communication by means of a protolanguage (Bickerton 2009, 2014b: Chap. 4).

Bickerton's proposal has been subject to strong criticism for different reasons (Balari & Lorenzo 2010a, Balari & Lorenzo 2010b, Arbib 2011, Clark 2011), but this is not what is at issue here. What we want to emphasize is the value of Bickerton's idea as a 'textbook case' of the application of natural selection to a particular aspect of the evolution of human mind: It presents the earliest stages of language evolution as due to a process of "long, slow gestation" (Bickerton 2009: 212), that succeeded because it worked as an "evolutionary adaptation, just as much as walking upright, shedding body hair, or getting and opposable thumb" (p. 103)—in this particular case for "recruitment, that turns out to be the key word in the birth of language" (p. 132). Even if they do not occur in a vacuum, but in a niche, adaptations are "genetic changes [that] can improve the ability of organisms to survive, reproduce, and, in animals, raise offspring" (p. 110). In dealing with processes like this one, "there's no recourse […] but to tell just-so stories" (p. 218).

Bickerton explains the evolution of language proper from protolinguistic communication very differently, for the former shows properties that defy any clear adaptive motivation—Bickerton basically assumes Chomsky's thesis of the underspecification of language for communicative uses and of the never ending array of communicative and non-communicative uses of language. He also explains that the most defying features of language regarding its concatenative properties do not require a long story of evolutionary development by small increments. So he opts in this case for a solution inspired by the alternative model of self-organization: "The tasks that were required [for protolanguage to become true language] lie well within the brain's powers of self-organization" (Bickerton 2014b: 117; insert also from Bickerton, same page), and they were executed without "any kind of external pressure" (p. 119).

Bickerton's complete account of the process is this:

> Protolanguage emerged because of triggering external events: confrontational scavenging led to the need for recruitment, which in turn necessitated displaced communication, which eventually sufficed, in social animals with large brains, to create a crude and structureless protolanguage—all that nature needed. However, these processes necessarily caused symbolic items to be stored in the brain, and […] brain-internal processes […] were directly initiated by the brain's need to deal with such items. (Bickerton 2014b: 115)

It is Bickerton himself who emphasizes that "syntactic infrastructure resulted from self-organizing activity within the brain itself" (Bickerton 2014b: 106) and that "such changes do not need to be triggered by natural selection" (p. 107).

Bickerton's goal in his last book is to explain how it is possible that languages seem universally to be so far away, from a formal point of view, of any imaginable human particular need, an aspect of what he refers to as 'Wallace's Problem'. His suggested solution is a multi-staged model of language evolution: One of these stages resulted from "particular selective pressures operating specifically on human ancestors," which were capable of releasing these people from the strictures of animal communication; another stage "consisted of purely brain-internal operations responding to unusual phenomena" that previous evolution had originated, but now with "no relation to the ecological needs of humans" (Bickerton 2014b: 262) and opened to them the never ending possibilities of language recursion. Let us conclude this note by simply noting how scrupulously Bickerton respects in this project the distinction that he simultaneously questions in the *Biolinguistics* piece (Bickerton 2014a).

6. Conclusion

The aim of this paper has not been to defend any personal stance regarding the advantages of auto-organization over selection in explaining the evolution of the language faculty, but to correct Bickerton's (2014a) misconception of the former, as if it were an evolutionary mechanism at the service of the latter. According to Bickerton, auto-organization auto-organizes variation, that selection further selects—our phrasing, of course. Here we have tried to show that fortunately enough, this has little to do with the status that current biological theories attribute to the said mechanisms. They rather conceptualize them as alternative mechanisms, a consequence of which is that the door is open to apply them separately to different aspects of a particular organism or organic system, as Bickerton actually does in his latest book, *More than Nature Needs*.

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Víctor M. Longa
Universidade de Santiago de Compostela
Departamento de Literatura Española,
Teoría da Literatura e Lingüística Xeral
Praza Isabel a Católica 2, 2ºE
36204 Vigo (Pontevedra)
Spain
victormanuel.longa@usc.es

Guillermo Lorenzo
Universidad de Oviedo
Departmento de Filología Española
Área de Lingüística General
Campus El Milán s/n
33011 Oviedo
Spain
glorenzo@uniovi.es