

Continuity and Discontinuity in Human Language Evolution: Putting an Old-fashioned Debate in its Historical Perspective

Andrea Parravicini¹  · Telmo Pievani¹

Published online: 13 October 2016
© Springer Science+Business Media Dordrecht 2016

Abstract The article reconstructs the main lines of three hypotheses in the current literature concerning the evolutionary pace which characterized the natural history of human language: the “continuist” and gradualist perspective, the “discontinuist” and evolution-free perspective, and the “punctuationalist” view. This current debate appears to have a long history, which starts at least from Darwin’s time. The article highlights the similarities between the old and the modern debates in terms of history of ideas, and it shows the current limits of each of these perspectives. In the final part, we present an alternative approach which considers human language not as a single trait, but as the result of a mosaic of different elements, some of which recently evolved, and some others gradually evolved and phylogenetically ancient. When matched with a tree thinking and comparative perspective, this view suggests that expressions of symbolic and linguistic behaviors in other human species could have preceded the more complex and systematic behaviors showed by *Homo sapiens*.

Keywords Human language evolution · Gradualism · Punctuationalist approach · Mosaic evolution · Exaptation · Tree thinking · Historical debates

Andrea Parravicini and Telmo Pievani have contributed equally to the research and the realization of this paper.

✉ Andrea Parravicini
andrea.parravicini@unipd.it

¹ Research Unit in Philosophy of Biology - Department of Biology, Università degli Studi di Padova, Via U. Bassi n. 58/B, 35131 Padua, Italy

1 Introduction

It was 150 years ago when the famous edict of the Société de Linguistique de Paris was approved by ministerial decree on the 8th March 1866, discouraging members to present any paper on the subject of the origin of language (not “evolution” of language, but “origin” of language). Such a focused prohibition could be explained by the delicate nature of the issue, which puts at stake the meaning of human nature and crucial religious, philosophical and political ideas, and by the highly speculative nature of the topic at that time (Harris 1996).

The extreme difficulty to reconstruct what happened to our ancestors in relation to the origin of their linguistic behaviors and the paucity of empirical evidence are the main reasons why still today some of the leading experts in the field argue pessimistically that “the fundamental questions about the origins and the evolution of our linguistic capacity remain as mysterious as ever” (Hauser et al. 2014).

However, despite the fragmentary empirical evidence, we suspect that a major problem related to the inquiry about human language evolution lies also in the theoretical approaches characterizing the research so far. The current article presents the discussions among the supporters of what we call a “continuist” perspective, the supporters of a “discontinuist” and non-Darwinian perspective, and the advocates of a “punctuationalist”, but still evolutionary, view. The debate in the current literature appears to have a long history, which starts at least from Darwin’s time. In this paper we reconstruct the main lines of the three different hypotheses concerning the evolutionary pace which marked the natural history of human language (without the pretense of exhaustiveness, given the narrow limits of an article) and we highlight the interesting similarities

between the old debate and the modern one in terms of history of ideas. Our thesis is that such historical similarities provide an indication that the current debates on the evolution of language (and namely on its pace) tend to be sclerotized around persistent and no longer adequate patterns. We show the limits of each of these perspectives and we present a tentatively alternative approach to the issue that is recently arising in the field.

2 Modern Naturalistic Approaches to the Evolution of Human Language

2.1 Evolution-free Discontinuity

The “Universal Grammar” (UG) hypothesis, originally proposed by Noam Chomsky in 1950s, has been the predominant model in linguistics and in the largely prevailing tradition of the cognitive science for almost 50 years. The idea that all human languages share fundamental similarities, attributable to innate principles unique to language, has generated a wide amount of interest in linguistics, psychology, philosophy, and other social and cognitive sciences. Although today UG model is coming under increasing criticism from a variety of sources (Dabrowska 2015), it has been supported for a long time by several authors (e.g. Jackendoff 1993; Pinker 1994; Smith 1999).

UG model supports the idea of a universal structure shaping the internal architecture underlying the whole human language production. In other words, the syntactic structures at the base of the different languages can be traced to common procedures of grammatical construction. Therefore, UG is usually defined as the “system of categories, mechanisms and constraints shared by all human languages and considered to be innate” (O’Grady et al. 1996: 734).

In the light of the UG model, human language is characterized by fundamental operating processes which are not entirely learned being part of the genetic endowment of the human brain. Humans are provided with a biological “organ”, a sort of privileged “module” (sensu Fodor 1983) for language learning, which enables language acquisition in defined and predictable times. Language is an innate and universal component of the human mind-brain and it is a species-specific faculty which marks a sharp qualitative difference between humans and any other animal (Chomsky 2006). Furthermore, according to Chomsky, UG is a very complex system, “an intricate and highly constrained structure” shaped by “various subsystems of principles” (1986: 146, 148).

The complex nature of UG and its uniqueness in natural world led Chomsky, in an early stage, to refuse any kind of evolutionary explanation for the origin of human language,

proposing an evolution-free approach (EFA). UG was depicted as an irreducibly complex organ, incompatible with any gradual and selective process. Presenting the problem in a Gouldian way, what does it conceivably mean for an organism to possess half a symbol, or the 5 % of a rule? Symbols, rules and modular systems must be acquired as a whole, on an all-or-nothing basis and not through a gradual process. The same puzzle lies in the 5 % of a wing described by paleontologist Stephen J. Gould (2002). In Chomsky’s terms (1988: 167), “In the case of such systems as language or wings it is not easy even to imagine a course of selection that might have given rise to them. A rudimentary wing, for example, is not ‘useful’ for motion but is more of an impediment. Why then should the organ develop in the early stages of its evolution?”. Chomsky argued that human language cannot be accounted by the gradualist and continuist model of Darwinian evolution, even though this faculty is a proper biological organ, universal and innate in our species. A biological, universal and innate organ (three hallmarks of a common phylogenetic origin for any evolutionist), but without any known evolutionary process: this the paradox of the discontinuist approach.

The paradox is based on the idea that evolution cannot develop complex organs piece by piece, by starting from a simpler incipient organ and then by adding components through the accumulation of small, slight variations, in a gradual selective process. Therefore, language is not a biological adaptation and the neo-Darwinian evolution theory is unable to account for its origin: “There is a long history of study of origin of language, asking how it arose from calls of apes and so forth. That investigation in my view is a complete waste of time, because language is based on an entirely different principle than any animal communication system. It’s quite possible that human gestures...have evolved from animal communication systems, but not human language. It has a totally different principle” (Chomsky 1988: 183).

2.2 Gradual Evolutionary Continuity

Two distinguished Chomsky’s pupils, Steven Pinker and Paul Bloom (1990) and Pinker (1994), supported the UG hypothesis to describe human language structure and agreed with Chomsky that human language is a biological, innate and universal “module” hardwired in our mind. Language is an “instinct”, a very complex instinct from an engineering point of view, “composed of many parts [...] physically realized as intricately structured neural circuits, laid down by a cascade of precisely timed genetic events” (Pinker 1994: 362).

Despite Pinker and Bloom followed Chomsky’s UG model, they expressed a very different view regarding the

origin of language faculty. Saying that language is an innate and universal faculty, they argued, is tantamount to say that it is a biological adaptation, the outcome of a gradual engineering process. "If human language is unique in the modern animal kingdom, as it appears to be", Pinker (1994: 342) writes, "the implications for a Darwinian account of its evolution would be as follows: none. A language instinct unique to modern humans poses no more of a paradox than a trunk unique to modern elephants. No contradiction, no Creator, no big bang". Language is an instinct of our mind, a universal endowment of our species, evolved by genetic variation and natural selection.

As Pinker (1994: 360) argues, "Natural selection is not just a scientifically respectable alternative to divine creation. It is the *only* alternative that can explain the evolution of a complex organ". And complex organs which have emerged by natural selection tend to evolve by small steps and slowly accumulation of random changes. The adaptive complexity of human language is not an exception. Therefore, as human language shows a complex design for the adaptive function of communication, it has evolved through natural selection processes, by gradual accumulation of a number of slight and subsequent adaptive changes. According to Pinker and Bloom the evolutionary sequence of increasingly complex and specialized universal grammars that constituted the antecedent to modern human language may have appeared in a hominin species that diverged from the chimp-human common ancestor, such as *Australopithecus afarensis*. Henceforth, this first proto-language ability may have gradually evolved through "plenty of organisms with intermediate language abilities" (Pinker 1994: 346).

This gradualist approach (GA) supports the idea that language is not a unique and unrepeatable faculty possessed by a single "special" organism, *Homo sapiens*, through some discontinuous process, but it is the normal product of a gradual implementation by natural selection. Such "naïve evolutionist's approach", as Tecumseh Fitch (2012) dubbed it, is currently shared by a considerable group of scholars. Firstly, this perspective stresses the continuity in communication systems over human evolutionary history. Secondly, it maintains that the proto-language of our ancestors became gradually richer and more elaborate until it evolved the complexity of our modern languages, but without any sudden changes or truly novel features. Although Pinker and Bloom supported Chomsky's idea of a qualitative difference among human verbal capacity and other animal communication systems, most of the scholars adopting GA typically consider primate vocal communication as the actual precursor system of human language (e.g., Hockett and Ascher 1964; MacNeilage 1998; Dunbar 2003). Other scholars have argued for gestural communication as the

precursor system (e.g., Hewes 1973; Armstrong et al. 1995; Corballis 2003; Arbib 2005; Tomasello and Call 2007).

GA presents some serious known problems. First, an adaptationist view underlies such an approach, referring to the idea that human language has been selected for the current communicative functions from the beginning, and then gradually and slowly developed by natural selection, and this should be the only scientific alternative to the creationist tale or to the call for mysterious discontinuities. This kind of explanation may fall into the theoretical difficulties already highlighted by Chomsky himself, who maintains that language is a complex organ which is very difficult to be accounted for by the slight accumulation of selected variations in relation to the current use. The linguistic rules appear to be a kind of "all-or-nothing" operations, which can only evolve as a whole, and not piece by piece in a gradual fashion. This is the problem of the organization of language components.

Secondly, in GA there is a wide use of reverse engineering method (Dennett 1995), according to which we should start from the current form of the trait which has to be evolutionary explained, and try to reconstruct backwards its design conditions and the process of its gradual improvement by natural selection. As for language, this means trying to reconstruct the evolutionary path which led from pre-morphemes to true morphemes, from pre-language to true language, in a linear and gradual sequence. But there is no direct evidence of such a gradual implementation in the available data. This kind of functionalist and mechanistic method could be useful for some traits (e.g., the convergent evolution of eyes) but, as for other complex traits as human language, it may involve a strong risk to tell highly speculative adaptive stories (Gould and Lewontin 1979; Gould 1997). This is the problem of the just-so-stories concerning the evolution of human language, lacking any robust empirical evidence.

Finally, just about empirical evidence, the genus *Homo* phylogenetic tree is highly branched, with several hominin species (morphologically and behaviorally distinct) living at the same time and with different social groups scattered all over the world, often isolated because of dispersal and vicariance processes in an ecological instable context and constantly fluctuant climate (see, e.g., Parravicini and Pievani 2016). In this tangled and wide biogeographical scenario it is not parsimonious to imagine stable and uniform selective pressures (hunting, sociality, technology) that could have shaped the human physiology and even mind in a linear way, gradually increasing the communication and cognitive skills of our ancestors for 2.5 millions of years. This is the problem of the growing gap with the real paleo-anthropological data.

2.3 Punctuationist Evolutionary Approach

In literature we may find another important kind of evolutionary approach to human language, called by Fitch (2012) “punctuationist”, which is very different from the gradualist one, without being evolution-free as Chomsky’s earlier position (see par. 2.1). The punctuationist approach (PA)—recently joined even by Chomsky, but in a non-Darwinian version (e.g., 2009, 2010)—stresses the symbolic and linguistic gulf between anatomically and cognitively modern *Homo sapiens* and all the other non-human and hominin species, such as between the current human language faculty and all the other known communication systems. Our species is not only cognitively unique, but qualitatively so.

According to the PA, which claims to be evolutionary but not necessarily neo-Darwinian in all the mechanisms supposed, human language emerged relatively late during human evolution (ca 65–60 Kya) and in a single, rapid event (from the biological point of view) due to some macro-mutation or emergent property. Human language is an entirely new trait, without functionally relevant precursor traits. Hence, it is pointless to seek the “precursors” of language in vocal or gestural communication. The origin may have been not in the communicative context, but in that of private thought, as Chomsky (2010) and Bolhuis et al. (2014) argued. According to these authors, language may have been originally functional to clarify and to better process thoughts and, only afterwards, it may have become a powerful communication tool in social groups.

It must be said that “punctuationism” refers to abrupt changes (at a biological and paleontological timescale) due to speciation processes by divergence or to systemic anatomical or behavioural changes, like in the Punctuated Equilibria model proposed in 1972 as alternative to phyletic gradualism and subsequently updated by Stephen J. Gould and Niles Eldredge (Eldredge 2013). Punctuationism is compatible with the neo-Darwinian processes, occurring for instance during the speciation, and should not be confused with “saltationism”, that is an anti-Darwinian account for evolution based on the idea of catastrophic macro-mutations, which was popular among early geneticists but also quite accurately describes Chomsky’s position on the origin of language as it has been for most of the time.

Some supporters of PA claim that articulate language is not a biological direct adaptation, but the outcome of exaptive evolutionary processes. In this view, language appears to be a byproduct of processing systems evolved for other purposes, a cooption of preexistent cognitive and physical potentials (e.g., peripheral equipment that allows articulate speech) (Chomsky 2009; Tattersall 2014).

The introduction of exaptive mechanisms into the possible explanations regarding the origin of human language—far from constituting an alternative to a real Darwinian explanation as some authors wrongly claimed (Dennett 1995)—represents an enrichment of the debate towards a pluralist evolutionary framework, and an additional conceptual neo-Darwinian tool in order to better focus the conundrum of language evolution (see Pievani and Serrelli 2011 for a conceptual analysis of the term “exaptation” in reference to human evolution). Then not any punctuationist view is necessarily anti-Darwinian. However, PA reveals some serious problems as well.

The first problem may be called “the contradiction of discontinuity”. According to PA, *Homo sapiens* is doubtless part of an ongoing evolutionary process rooted in a remote past (no miracles; no breakdowns in the generational continuity). At the same time, however, our species is thought to be unique, shows a deep cognitive discontinuity when compared with any other animal species, and human language seems to be a sudden emergence irreducible to its antecedent conditions. Thus we need a continuous process able to generate such a huge qualitative discontinuity: it is a mystery, as Hauser et al. (2014) provocatively argued in a controversial essay, but the degree of mystery depends on the degree of radical discontinuity we suppose for the articulated language in *Homo sapiens*.

The reasons why Hauser et al. declare that the origins and evolution of our linguistic capacity remain “as mysterious as ever” lie mainly in the alleged lack of available empirical data. But this is a too harsh judgment, and this is the second problem. As a matter of fact, the most recent archeological findings suggest that *Homo sapiens* could not be the only member of our lineage possessing sophisticated cognitive and behavioral traits. A fair amount of ornaments, embellishments of the body, maybe also rock art and intentional burials, have been associated to *Homo neanderthalensis*, while an engraved shell, usually associated to symbolic capacities, dating back ca. 540 Kya, has been attributed to *Homo erectus* (see *infra*, ch.4). Given this growing evidence, is it still useful to define symbolic intelligence and language faculty as recent, mysterious traits uniquely belonging to one species?

Third problem: evidence is a constraint for all the hypotheses. If empirical data are fragmentary, scarce, questionable (as in some extent they really are), then we do not have enough data either to claim the presence of a symbolic intelligence and articulate language or to assert the absence of them in the other hominin species. If the empirical evidence is the problem, the same has to be true both for the gradualist and the punctuationist approach.

3 Nothing New Under the Sun? The Debates on Language Evolution at Darwin's Time

3.1 Darwin's Problem and the Evolutionary-free Discontinuity

Quite interestingly, the modern discussions held by scientists and philosophers who support EFA, GA, PA are reminiscent of the old debate which took place at the time of the Société de Linguistique's edit. The apparent discontinuity and uniqueness of human language when compared with cognitive and behavioral traits of non-human species seemed to contradict the idea of an evolutionary process proceeding by gradual accumulation of slight and small variations, to the point that Bolhuis et al. (2014) have dubbed this supposed contradiction "the Darwin's problem".

More than 150 years before, Francis Bowen, philosopher at the Divinity School of Harvard, posed a very similar problem in a review to the *Origin of Species* (1859): "Mr. Darwin is bound to find the means of bridging over, by imperceptible fine gradations, the immense gap which now separates man from the animals most nearly allied to him,—a gap [...] between reason and instinct, where nearly all psychologists are agreed that the difference is in kind, and not in degree" (Bowen 1860: 501–502).

Some years later, the British zoologist George Mivart (1871) expressed a serious criticism to the gradualist explanation, relating to the incompetence of natural selection to account for the incipient stages of useful structures. What can early variations of a complex organ serve, if the organ itself can perform its actual function only when it is fully developed? As stated above in Gouldian terms, what could the 5 % of a wing or an eye serve if that beginning of the wing is not able to fly and that beginning of the eye cannot see? If natural selection is unable to explain the origin of complex traits in gradualist terms, then complexity in nature depends only on sudden evolution-free leaps. And this is precisely the key argument of the first Chomsky in his EFA.

In 1860s and 1870s many scholars supported the idea of a radical discontinuity related to the origin of human language, by claiming the impossibility of any attempt to explain the emergence of complex structures by a gradualist evolutionary view. The German philologist Max Müller, in his 1861 *Lectures on the Science of Language* (see Harris 1996: 14–15), argued that "The one great barrier between the brute and man is Language. Man speaks, and no brute has ever uttered a word. Language is our Rubicon, and no brute will dare to cross it. [...] no process of natural selection will ever distill significant words out of the notes of birds or the cries of beasts".

We are aware that this exclusivism regarding the origin of language betray spiritual and religious sentiments that are not comparable with the present, even though we see a strong similarity of patterns in terms of history of ideas. Even Alfred R. Wallace (1869, 1870), co-discoverer with Darwin of the principle of natural selection, and for the rest a truly gradualist, argued about the insufficiency of natural selection to account for the specific origin of the "moral and higher intellectual nature of man". According to Wallace the higher human faculties were an exception, "the living proof of a supreme mind", and even certain human physical characteristics, such as "the brain, the organs of speech, the hand, the external form of man, offer some special difficulties" to an evolutionary explanation (Wallace 1869: 391). In conclusion he appealed to the miraculous action of a metaphysical "Higher Intelligence" working for a supreme end, namely the development of human species (Wallace 1869: 394). As a pattern of explanation, this is a non-naturalistic ancestor of EFA.

3.2 Darwin's Approach and Other Gradualist Hypotheses

In the same years a series of theories which privileged an evolutionary and gradualist approach to the origin of language were proposed. In 1860s Frederic Farrar indicated that Darwinism can be useful in explaining the historical development of languages, although refraining from any comments about the origin of the faculty of language. Hensleigh Wedgwood and Edward B. Tylor supported continuist and gradualist theories for the evolution of language, which emerged, according to these hypotheses, from interjections and imitation of natural sounds, like in onomatopoeia. Max Müller ridiculed these theories by dubbing them "pooh-pooh" and "bow-wow" theories (see Harris 1996).

In *The Descent of Man* (1871), Charles Darwin supported the idea that human beings derived from an apelike ancestor, belonging to the Catarrhine monkeys line, and originated in Africa. All its physical traits, from the hand to the big brain, are the evolutionary results of natural and sexual selection. Darwin argued for a quantitative difference between humans' and non-humans' mental powers, as "there is a much wider interval in mental power between one of the lowest fishes, as a lamprey or lancelet, and one of the higher apes, than between an ape and man; yet this immense interval is filled up by numberless gradations" (1871: 35). Within this gradualist scenario, even human language is different from the other non-human communication systems only in degree, and not in kind. In particular, the difference is supposed to lie in the degree of the ability to associate sounds with ideas, then in the

developmental degrees of the animal mental faculties. For Darwin, then, human language is not an impassable Rubicon and it “owes its origin to the imitation and modification, aided by signs and gestures, of various natural sounds, the voices of other animals, and man’s own instinctive cries” (1871: 56). At the very beginning, proto-humans used the voice in the wake of emotions (love, jealousy, triumph) or during courtship, to produce musical cadences, and subsequently they started to imitate the other animal cries or natural sounds combined with other signs and gestures (for example to indicate a threat to fellow). The faculty of language gradually evolved from these early habits and gestures, in continuity with other mental and behavioral animal traits. This is the naturalistic beginning of GA.

3.3 Chauncey Wright’s “Punctuationalist” Approach

Something similar to a PA *ante litteram* was undertaken by the American philosopher Chauncey Wright (1830–1875). Wright is better known as the coryphaeus of the Metaphysical Club in Cambridge (Mass.), the place, attended also by Charles S. Peirce and William James, where the philosophical movement of American pragmatism is supposed to be born (Menand 2001). However, Wright’s contributions to the history of thought is also closely related to the history of evolutionism. Wright was a strong supporter of Darwin in USA and he wrote some effective papers where he defended the evolutionary theory against Mivart’s attacks and Wallace’s changes of mind (Wright 1877).

In his epistemological contributions to the evolutionary theory (written also in a correspondence with Darwin himself), Wright gave great importance to what he called the “principle of uses”, according to which traits selected in relation to some functions can be subsequently co-opted for different uses—something very similar to the concept of *exaptation*, proposed after more than one century by S.J. Gould and Elisabeth Vrba (1982). Through this principle, Wright was able, on the one hand, to significantly support Darwin, even before the publication of the *Origin’s* 6th edition (1872), in order to cope with the arguments of Wallace and Mivart against the efficacy and agency of natural selection; on the other hand, he also proposed a kind of “punctuationalist” approach to the origin of human language and self-consciousness in his 1873 paper on *The evolution of self-consciousness* (Wright 1877: 199–266; see Parravicini 2009, 2012).

According to Wright, the evolution of physical traits and behaviors may give place to unpredictable side effects which incidentally appear only in a second time. The symbolic behavior and the faculty of language are such a kind of evolutionary emergences, unpredictable novelties

with respect to their antecedent conditions. These evolutionary innovations, even if they are qualitatively different from any kind of animal behavioral traits and communication systems, are not a Rubicon, or miraculous emergences, but they can be explained by the normal patterns of evolution, namely accumulation of variations, selective processes and, overall, cooptation of old traits for new functions [a phenomenon hypothesized by Darwin in the sixth edition of *The Origin of Species* in (1872), and named “exaptation” by Stephen J. Gould and Elisabeth Vrba in (1982)]. Symbolic capacity and articulate language emerge thanks to a new use of signs, a functional shift which occurs through a continuity of slow and slight variations on physical and cognitive traits (brain, vocal tract, memory, attention). Wright’s approach is an interesting example of still Darwinian PA.

4 Back to the Future of a Possible New Path: Language as a Mosaic of Traits and Tree Thinking

We have identified so far three main different and recurrent approaches to the evolution of language:

1. EFA, according to which the origin of articulate language is a mystery that science has been unable to solve so far. Human language is qualitatively different from all the other non-human communication systems, it emerged all at once, in a sudden way which is inexplicable in current evolutionary terms.
2. GA, according to which articulate language is an adaptation gradually evolved through natural selection over millions of years.
3. PA, according to which human language is an evolutionary novelty, recently and rapidly evolved in *Homo sapiens* and qualitatively different from non-human communication systems; the evolution of human language is a mystery only if we try to explain it in a gradualist and adaptationist way, but there is no ontological break at all. Language evolved through an evolutionary cascade of exaptations and unpredictable side-effects.

Is there any alternative way to approach the problem today, without drowning in the serious objections to which the three above mentioned hypotheses are exposed?

Hauser et al. (2002) proposed to distinguish a faculty of language in a broad sense (FLB) and a faculty of language in a narrow sense (FLN). The former includes, beyond FLN, sensory-motor system (or speech) and conceptual-intentional system (semantic). FLN is the abstract linguistic computational system alone (syntax) and involves the computational mechanisms for recursion and the capacity

to generate an infinite range of expressions from a finite set of elements. The authors stress the fact that probably only human brain is provided with FLN, that FLN is unique in kind in our species, that it does not seem a biological adaptation gradually evolved by natural selection, but a trait emerged for certain evolutionary reasons and then coopted for different functions. On the contrary, the other components of FLB have probably gradually evolved and shared with other non-human vertebrate species.

What is interesting in this proposal, beyond the question if it really works or not as a model of language when compared with empirical evidence and research on historical languages, is the general idea that language is not a single trait but a mosaic of different processing systems complexly intertwined, with different functions. Each element and process in this mosaic could have evolved through different paths, such as functional direct adaptations, exaptations or even structural/developmental constraints. According to this mosaic approach (MA), language faculty seems to be shaped by different factors—not necessarily evolved through selective pressures for communication—, and subsequently coopted for communicative functions within changed and diversified environmental conditions (e.g., the need to cooperate due to changing social relations during Pleistocene).

This idea could be, and it has been, the starting point for further fruitful research and hypotheses. Okanoya (2007) developed the idea that “FLN is not an independent faculty, but an ‘emergent’ property, arising from interactions between several other non-syntactical sub-faculties of FLB, including vocal learning ability”. Fitch (2012) proposed to consider human language not as a monolithic trait, but as a collection of semi-independent components, each one coming from a possibly different evolutionary history. Some structures may be very old and come even before genus *Homo*, and then exapted in new ecological niches. Others could be more recent and even typical of our species, namely the syntactic aspects of language.

MA opens the door to a pluralistic view of language evolution, in which some *derived traits* could have evolved in a punctuational fashion, while some others are *retained traits* which may have gradually evolved and shared with other non-human species. In this sense, language requires a plurality of evolutionary explanations, because it has not been shaped by a single selective agent for a single function. As Pievani (2014, 2015) and Suman and Pievani (2015) recently proposed, we need to consider the issue of human language evolution in the light of an extended neo-Darwinian research program, i.e. an updated theory of evolution, more pluralistic in its explanatory patterns and methodologically advanced, which could help to rethink the so-called “Darwin’s problem”.

The first unescapable task to reshape the entire issue is putting human language evolution in the bushy hominin evolutionary tree. Despite tree thinking (TT) is the great missing in the studies on language and human psychology, the idea of language as a mosaic of traits works very fine when matched with paleoanthropological evidence. An increasing amount of archeological and fossil evidence is supporting the idea that innovations indicative of modern cognition are not restricted to *Homo sapiens* as thought before. Recent archeological findings show an asynchronous appearance and disappearance of key cultural innovations not only in African Middle Stone Age but also in Eurasian Middle Paleolithic (300–40 Kya) before becoming fully consolidated (D’Errico and Stringer 2011; D’Errico and Banks 2013; see also Conard 2008; Hovers and Belfer-Cohen 2006; Langley et al. 2008; Nowell 2010; Zilhão 2007). Sporadic expressions of symbolic behaviors are associated to Neanderthals. Burials, use of pigments, complex lithic and hafting technologies, and personal ornamentation at the end of the Neanderthal evolutionary trajectory are among the elements that challenge the idea that behavioral modernity is unique to our species. Recently, even a set of putative abstract patterns engraved on a shell, usually associated to symbolic capacities and amazingly dated back to ca. 540 Kya, was found in Trinil (Java) and attributed to *Homo erectus* (Joordens et al. 2015).

As D’Errico and Stringer (2011: 1061) argued, adopting a model of language more related to the symbolic expressions, the cognitive prerequisites of modern human behaviour may have been already “largely in place among the ancestors of Neanderthals and modern humans”, and “social and demographic factors, arguably triggered by climate change”, could explain “the asynchronous emergence, disappearance and re-emergence of modern cultural traits among both African ‘modern’ and Eurasian ‘archaic’ populations”. Sporadic expressions of symbolic intelligence and linguistic behaviors could have preceded the more complex and systematic behaviors showed by *Homo sapiens*. Different hominin populations and species may have followed multiple and non-linear trajectories of cognitive and cultural evolution among the plurality of branches which featured human phylogeny (D’Errico and Banks 2013).

In this complex scenario, the interplay between biological evolution and cultural evolution becomes crucial. These collection of evidence, quickly gathered here, coming from the paleo-anthropological and archaeological record and supported by additional molecular data, suggests that cultural evolution may have played an active role, along with the biological evolution of language, that has been underestimated by the different approaches. Pre-syntactic, pre-semantic and pre-pragmatic features of

language (Hurford 2003) were most probably present in other hominin species long before the appearance of modern language in *Homo sapiens* and they have been exapted due to a modification of the selective environment and the eco-cultural niche. Niche construction activities (Odling Smee et al. 2003) and in particular cultural mitigation of selection (Suman and Pievani 2015; Suman 2016) probably generated the conditions through which a high-fidelity form of cultural transmission would result advantageous within a population in which reliance on cultural transmission was already relatively high, due to high degrees of cooperation and prosociality. From this viewpoint, as dependence on acquired behaviors (such as tool use) became more and more crucial, a selective gradient towards higher-fidelity transmission systems might have ensued. As a matter of fact, this selective regime was shaped by those acquired behaviors, hence culture. Being culture itself an evolving system (Mesoudi 2011), we can assess that, in the long course of language evolution (including protolanguage in this perspective), cultural evolution biased biological evolution of hominin species at least since the appearance of the genus *Homo* (Laland et al. 2010), leading to the recruitment of already existing morphological, neural and cognitive traits improving novel (linguistic) functions. Some of the newly emerged traits could have been fixed even at the genetic level, if selection remained consistent enough [see the assimilate stretch principle proposed by Dor and Jablonka (2000)]; other traits, for several reasons, might have not been fixed genetically, remaining at the status of culturally acquired traits. These processes led to modern language as we know it today, a mosaic of exapted traits, some of which might be more genetically modulated than others.

MA matched with TT could also be able to avoid any *scala naturae* view, namely any uni-linear representation of the distribution of cognitive traits. According to MA, language did not evolve by a gradual refinement of increasing complexity, as pointed out by the GA. On the opposite side, human language is not even a system suddenly emerged as an all-or-nothing trait and already configured in its complexity, as EFA supporters argue, stressing only discontinuity, while PA depicts the evolution of human language as a single trait suddenly evolved in *H. sapiens* by a cascade of exaptations.

Summing up, MA and TT show that the multiple factors of language may have evolved in different phylogenetic lines—some older, some newer—through gradual adaptations and exaptations, innovations and reconfigurations, until the current confluence of mechanisms and elements which shaped the specific verbal language expressed by *Homo sapiens*. In this view, evolution of language is the outcome of a plurality of biological and cultural processes and evolved as an experimentation of different linguistic

and symbolic trajectories through a plurality of hominin species within the bushy tree of human evolution.

Acknowledgments The authors would like to thank the organizers of the ProtoLang4 Conference for creating such an inspiring meeting. This paper is one of the outcomes of the International research program entitled “The Hierarchy Group: Approaching Complex Systems in Evolutionary Biology” (www.hierarchygroup.com), directed by Niles Eldredge and Telmo Pievani, funded by the John Templeton Foundation.

References

- Arbib MA (2005) From monkey-like action recognition to human language: an evolutionary framework for neurolinguistics. *Behav Brain Sci* 28:105–167
- Armstrong DF, Stokoe WC, Wilcox SE (1995) *Gesture and the nature of language*. Cambridge University Press, Cambridge
- Bolhuis J, Tattersall I, Chomsky N et al (2014) How Could Language Have Evolved? *Plos Bio* 12:1–6
- Bowen F (1860) Darwin on the origin of species. *North Am Rev* 90:474–507
- Chomsky N (1986) *Knowledge of language: its nature, origin and use*. Praeger, New York
- Chomsky N (1988) *Language and problems of knowledge*. The MIT Press, Cambridge (Mass)
- Chomsky N (2006) *Language and mind*, 3rd edn. Cambridge University Press, Cambridge (1st ed. Harper & Row, New York 1968)
- Chomsky N (2009) Opening remarks. In: Piattelli Palmarini M, Uriagereka J, Salaburu B (eds) *Of Minds and Language*. Oxford University Press, New York
- Chomsky N (2010) Some simple evo devo theses: how true might they be for language? In: Larson RK, Déprez V, Yamakido H (eds) *The evolution of human language: biolinguistic perspectives*. Cambridge University Press, Cambridge
- Conard NJ (2008) A critical view of the evidence for a Southern African origin of behavioural modernity. *S Afr Archaeol Soc Goodwin Ser* 10:175–179
- Corballis MC (2003) From hand to mouth: the gestural origins of language. In: Christiansen M, Kirby S (eds) *Language evolution*. Oxford University Press, Oxford
- D’Errico F, Banks WE (2013) Identifying mechanisms behind middle paleolithic and middle stone age cultural trajectories. *Curr Anthropol* 54:S371–S387
- D’Errico F, Stringer CB (2011) Evolution, revolution or saltation scenario for the emergence of modern cultures? *Philos Trans R Soc B* 366:1060–1069
- Dabrowska E (2015) What exactly is Universal Grammar, and has anyone seen it? *Front Psychol*. doi:10.3389/fpsyg.2015.00852
- Darwin CR (1859) *The origin of species by means of natural selection, or the preservation of favoured races in the struggle for life*. John Murray, London (6th ed:1872)
- Darwin CR (1871) *The descent of man, and selection in relation to sex*, vol 2. Murray, London
- Dennett DC (1995) *Darwin’s dangerous idea*. Evolution and the meanings of life. Simon and Schuster, New York
- Dor D, Jablonka E (2000) From cultural selection to genetic selection: a framework for the evolution of language. *Selection* 1(1–3):33–55
- Dunbar RIM (2003) The origin and subsequent evolution of language. In: Christiansen M, Kirby S (eds) *Language evolution*. Oxford University Press, Oxford

- Eldredge N (2013) Stephen J. Gould in the 1960s and 1970s, and the Origin of “Punctuated Equilibria”. In: Danieli GA, Minelli A, Pievani T (eds) Stephen J. Gould: the scientific legacy. Springer, New York
- Fitch T (2012) Evolutionary developmental biology and human language evolution: constraints on adaptation. *Evol Biol* 39:613–637
- Fodor J (1983) The modularity of mind. The MIT Press, Cambridge
- Gould SJ (1997) The exaptive excellence of spandrels as a term and prototype. *PNAS* 94:10750–10755
- Gould SJ (2002) The structure of evolutionary theory. The Belknap Press of Harvard University Press, Cambridge
- Gould SJ, Lewontin R (1979) The spandrels of San Marco and the Panglossian paradigm: a critique of the adaptationist programme. *Proc R Soc Lond B* 205:581–598
- Gould SJ, Vrba ES (1982) Exaptation—a missing term in the science of form. *Paleobiology* 8:4–15
- Harris R (ed) (1996) The origin of language. Thoemmes Press, Bristol
- Hauser MD, Chomsky N, Fitch T (2002) The faculty of language: what is it, who has it, and how did it evolve? *Science*. doi:10.1126/science.298.5598.1569
- Hauser MD, Yang C, Berwick RC et al (2014) The mystery of language evolution. *Front Psychol* 5:401. doi:10.3389/fpsyg.2014.00401
- Hewes GW (1973) Primate communication and the gestural origin of language. *Curr Anthropol* 14:5–24
- Hockett CF, Ascher R (1964) The human revolution. *Curr Anthropol* 5:135–147
- Hovers E, Belfer-Cohen A (2006) “Now you see it, now you don’t”: modern human behavior in the Middle Paleolithic. In: Hovers E, Kuhn SL (eds) Transitions before the transition: evolution and stability in the Middle Paleolithic and Middle Stone Age. Springer, New York
- Hurford JR (2003) The language mosaic and its evolution. In: Christiansen M, Kirby S (eds) Language evolution. Oxford University Press, Oxford
- Jackendoff R (1993) Patterns in the mind. Language and human nature. Basic Books, New York
- Joordens JCA, d’Errico F, Wesselingh FP et al (2015) Homo erectus at Trinil in Java used shells for tool production and engraving. *Nature* 518:228–231
- Laland KN, Odling-Smee J, Myles S (2010) How culture shaped the human genome: bringing genetics and the human sciences together. *Nat Rev Gen* 11:137–148
- Langley MC, Clarkson C, Ulm S (2008) Behavioral complexity in Eurasian Neanderthal populations: a chronological examination of the archaeological record. *Camb Archaeol J* 18:289–307
- MacNeillage PF (1998) The frame/content theory of evolution of speech production. *Behav Brain Sci* 21:499–546
- Menand L (2001) The Metaphysical Club. A story of ideas in America. Farrar, Straus and Giroux, New York
- Mesoudi A (2011) Cultural evolution—how Darwinian theory can explain human culture and synthesize the human science. University of Chicago Press, Chicago and London
- Mivart GJ (1871) On the Genesis of Species. Macmillan, London
- Nowell A (2010) Defining behavioral modernity in the context of Neandertal and anatomically modern human populations. *Annu Rev Anthropol* 39:437–452
- O’Grady W, Dobrovolsky M, Katamba F (1996) Contemporary linguistics. An introduction, Longman
- Odling-Smee FJ, Laland KN, Feldman MW (2003) Niche construction—the neglected process in evolution. Princeton University Press, Princeton and Oxford
- Okanoya K (2007) Language evolution and an emergent property. *Curr Opin Neurobiol* 17:271–276
- Parravicini A (2009) A new use for an old theory: Chauncey Wright between Darwinism and pragmatism. *Cognitio-Estudios: Revista electrónica de filosofía* 6(2):110–118
- Parravicini A (2012) Il pensiero in evoluzione. Chauncey Wright tra darwinismo e pragmatismo. ETS, Pisa
- Parravicini A, Pievani T (2016) Multi-level human evolution: ecological patterns in hominin phylogeny. *J Anthropol Sci* 94:1–16
- Pievani T (2014) Between skeptics and adaptationists: new prospects for human language evolution. *Ciência & Ambiente*, special issue on human evolution 48
- Pievani T (2015) How to rethink evolutionary theory: a plurality of evolutionary patterns. *Evol Biol*. Doi 10.1007/s11692-015-9338-3
- Pievani T, Serrelli E (2011) Exaptation in human evolution: how to test adaptive vs exaptive evolutionary hypotheses. *J Anthropol Sci* 89:1–15
- Pinker S (1994) The language instinct: how the mind creates language. Morrow, New York (2nd edn. 1995. Penguin Books, London)
- Pinker S, Bloom P (1990) Natural language and natural selection. *Behav Brain Sci* 13:707–784
- Smith N (1999) Chomsky: ideas and ideals. Cambridge University Press, Cambridge
- Suman F (2016, in press) An updated evolutionary research programme for the evolution of language. *Topoi*
- Suman F, Pievani T (2015) The evolution of human language: and alternative scenario. *Paradigmi* 2:173–196
- Tattersall I (2014) An evolutionary context for the emergence of language. *Lang Sci* 46:199–206
- Tomasello M, Call J (2007) Ape gestures and the origins of language. In: Call J, Tomasello M (eds) The gestural communication of apes and monkeys. Lawrence Erlbaum, London
- Wallace AR (1869) Sir Charles Lyell on geological climates and the origin of species. *Q Rev* 126(252):359–394
- Wallace AR (1870) The limits of natural selection as applied to man. In: Wallace AR (ed) Contributions to the theory of natural selection. A series of essays. Macmillan, London
- Wright C (1877) Philosophical Discussions. Holt and Company, New York
- Zilhão J (2007) The emergence of ornaments and art: an archaeological perspective on the origins of “behavioral modernity”. *J Archaeol Res* 15:1–54