

10 What is language, that it may have evolved, and what is evolution, that it may apply to language

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Linguistics and biology are both witnessing such a rapid and ground-breaking progress that I think it wise to step back a moment and reconsider the very issue of the evolution of language at its roots. I wish to start with two real-life parables, drawing some important lessons from each. The first is from physics, the second from biology.

Parable 1. The Italian physicist Gabriele Veneziano is acknowledged to have been the first inventor/discoverer of the core idea behind string theory. Veneziano had not realized, back in 1968, where his idea was leading. Initially, his “dual resonance models” were only an elegant way of summarizing several apparently scattered facts and hypotheses and of solving some inconsistencies of the standard theory. In the fullness of time, it turned out that the consequence of that initial idea, and of the mathematical formalism used to express it, was that the world of elementary particles is the projection onto our four-dimensional space of modes of vibration and oscillation of microscopic uni-dimensional strings in a space with eleven dimensions. String theory is, for the moment at least, so many steps removed from experimental observation that its partial success has to be gauged by indirect confirmations of some of its secondary predictions. This is, understandably, far from deterring physicists, and work in string theory is in full swing.

One lesson here (Lesson 1 – L1) is that good scientists may well embark on intellectual ventures the nature, conceptual contents, boundaries and interpretations of which are only dimly perceptible to them at the very start. The hairsplitting conceptual analysis on which certain philosophers so eagerly embark can often be an exercise in futility. Only the full unfolding of a scientific enterprise will reveal what the meaning of certain scientific concepts is.¹ Modern physics has taught us that, even when conceptual analysis manages to lay bare some hidden inconsistencies, the remedy consists in improving and radicalizing the theory, possibly making of these inconsistencies a virtue, not in freezing all inquiry until those concepts are duly sanitized under a shower of educated commonsense.

The second lesson (Lesson 2 – L2) is: No limit should be imposed on the degree of abstraction that may be needed in order to turn observations and careful descriptions into genuine explanations.

The new fields of mathematics that string theory has engendered, and the apparently dead ones it has revamped and redeveloped (such as, for instance, enumerative geometry) are so rich and beautiful that some mathematicians do not care very much whether the theory is actually “true” of the physical world. Hence:

(L3): it is typical of innovative scientific theories to generate also problems they cannot solve, but that would have remained invisible without them. Such theories typically allow to observe facts that would otherwise have gone undetected, and they frequently generate new methods that find applications well beyond the theories themselves.

Parallels with linguistics

I think that a few clear examples will suffice to show how basic theoretical notions required modification, as linguistic inquiry developed and deepened. One prominent example is, of course, the very notion of *language*. The pre-theoretical notion, the one we are all familiar with (instances of which are English, French, Swahili and so on) is an extensional one: a corpus of utterances existing “out there,” produced by a certain community of speakers, analyzable in terms of a rule-governed combinatorics of morphemes, words, and idioms. Classical structuralism, focusing on the distributional analysis of linguistic forms in large corpora and offering Phrase-Structure rewriting rules, refined this common-sense notion, but substantially adopted it (Harris 1986/1951). However, upon a deeper analysis, the apparently unproblematic idea of languages as “common treasures” of expressions turned out to be fraught with difficulties, nay, arguably, to be irremediably inconsistent (Chomsky 1986b). In fact, since its inception, generative grammar made the notion of grammar (a finite object) primary, and the notion of language (an infinite object generated by that grammar) derived.

Moreover, witnessing the sharpness of the native speaker’s grammaticality judgments for a potentially infinite set of sentences never encountered before, it became inevitable that the central object of inquiry shifted from finite corpora and from the speaker’s linguistic “behavior” (performance) to the speaker’s tacit knowledge of language (competence). More precise terms were introduced by Chomsky later on, but in hindsight it is clear that already at the beginning of the generative enterprise the central theoretical notion was that of I-language (individual, internal, intensional) not that of E-language (external, extensional, public). Avoiding the identification of I-languages with strictly individual idiolects, but aiming at a characterization of the speaker’s tacit knowledge as

(somehow, intuitively) capturing a specific E-language (or E-dialect), the distinction between a stable “core grammar” and a mutable “periphery” was introduced. As the theory progressed, the notion of I-language became that of an internal computational-derivational system exhaustively characterized, in its final adult state, by a complete set of values for the syntactic parameters of the ambient language, as chosen by the local linguistic community out of a finite repertoire of theoretical possibilities.

Further progress led to conjecture that all inter-linguistic parametric variation was to be localized in the phonology, the morphology, and the lexicon, dispensing with all syntactic and semantic parameters. A crucial distinction was, thus, traced between a genuinely universal computational-derivational system (Narrow Syntax -NS) and its complex interactions at the interface with two other systems: the perceptual-articulatory one and the conceptual-interpretive one. All inter-linguistic variation is, thus, localized at these interfaces (for an exhaustive exposition and historical reconstruction of these ideas, see Lasnik, Uriagereka, and Boeckx (2005). The abstract concept so central to the present model is quite different from the initial, pre-theoretical, externalistic concept of “language”. Whence:

(L4): I-languages are what one has to attempt to reconstruct the evolution of, when dealing with language evolution.

From constituents to phases

The case of phrasal constituents is also illuminating. Traditional grammars already countenanced Noun Phrases, Verb Phrases, Adjectival Phrases and Prepositional Phrases (Graffi 2001). The founding intuition is that certain substrings of words within sentences strictly belong together and constitute a relevant subunit. Those grammars had ascertained that the inventory of such units is extremely reduced, and that they are, at a deep level of analysis, the same in all languages, the world over. Textbook criteria do exist for singling out phrasal constituents and for making their linguistic reality more transparent (conjunction, coordination, extraposition, adjunction, the perceived naturalness of pauses between – but not inside – constituents, shifts of intonation, etc.). None of these superficial criteria is, however, exceptionless, nor are they entirely reliable even when applied together. Split constituents are especially hard to capture in this way. Traditional grammars also identified, under various terminologies, more prominent elements (heads) and less prominent ones (complements) within the same constituent. It became clear, early on, that syntactic principles have quintessentially to be formulated with reference to constituents (head-complement and head-head relations, c-command, constraints on syntactic movement created by specific nodes in the internal

structure of constituents, etc.). No syntactic principle applies directly to words as such, nor does it apply directly to superficial word ordering. In fact, the paradigm case of an impossible syntactic rule is one that applies, say, to the third or fourth word in each sentence (for a recent confirmation of this impossibility by means of brain imaging see Musso *et al.* (2003).

The logic of linguistic inquiry led to the postulation of other kinds of phrasal constituents, of a more abstract nature, not countenanced by traditional grammars (the so-called functional ones, for instance Complementizer Phrase, Inflectional Phrase, Tense Phrase). Some constituents were nested within other constituents, and these in turn were nested within yet other constituents, recursively. In the early 1990s their proliferation had become almost an embarrassment. It was a standard joke to ask generative linguists how many functional heads there are in the sentence *John saw Mary*. The minimalist program changed all this, reinterpreting an embarrassment of riches as the multifarious consequences of the recursive, cyclic application of just two elementary operations: Merge and Move. The more abstract and more basic concept of *phases* was developed.

Phases are self-contained derivational domains, characteristically nested one into the other, that are simultaneously sent to the two interfaces in strict succession, without any possibility of backtracking or looking -ahead. There are strict constraints of correspondence between the features of phases in a same sentence. Only the “edge” (roughly, the left periphery) of a phase remains momentarily open to modification, until the phase is sent to the two interfaces.

Phases have a theoretical status of their own, but they also map onto two kinds of older phrasal constituents (essentially CP, and vP), not without some problems, though (Carnie 2008). The phase edges are the loci of the transmission, checking, and matching of features. Edge features and their derivation, in the present reinterpretation, embody the specific kind of recursiveness that is at the core of natural language. In a recent lecture at MIT (July 2005) Chomsky suggested that the evolution of language must be reconceptualized as, basically, the evolution of an apparatus capable of dealing with edge features. We will come back to this important suggestion at the very end.

The upshot of these considerations, therefore, is:

(L5): Every inquiry into the evolution of language must be an inquiry into the evolution of the computational brain machinery capable of carrying out edge-features operations.

Parable 2. In the first thirty years or so of the twentieth century a scientific program called mathematical biology (or, alternatively, physical biology) was developed, and it appeared, at first sight, quite promising. The long-forgotten (but in recent years more and more frequently cited) work by D’Arcy Wentworth Thompson on “The Laws of Form” (Thompson and Bonner 1917/1992) was centered on the thesis that biologists of his day had overemphasized

the role of evolution, and underemphasized the roles of physical and mathematical laws in shaping the form and structure of living organisms. Best known are his graphic, formally simple, topological transformations to which differences in the forms of related animals could be attributed. In those same years, the Italian Vito Volterra and the American Alfred J. Lotka independently, but convergently, developed their now famous universal equations of population dynamics. These could indifferently capture the stability/instability of predator-prey ecosystems, of mutually inhibiting/reinforcing chemical reactions, of viral infections, all the way up to the cyclically oscillating equilibria and “fixed points” ascertained in populations of lynxes and hares in the Hudson Bay Valley.

In the words of Lotka, the key of this mathematical biology was:

a viewpoint, a perspective, a method of approach ... a habit of thought ... which has hitherto received its principal development and application outside the boundaries of biological science ... Namely: the study of fundamental equations whereby evolution is conceived as redistribution of matter. (Lotka 1924/1956: 41–42).

Lotka’s dense and immensely erudite 1924 treatise offers many interesting insights on sustainable rates of growth, birth and mortality rates, equilibria between species, biochemical cycles, and rates of energy transformations, even on the evolution of human means of transportation. But there is no doubt that the immense progress in biology we have witnessed since the mid-1950s *could not* have come from these general mathematical analyses. The revolution in genetics and in biology was marked by the advent of the *age of specificity* (Piattelli-Palmarini 1981). Biophysics and bio-mathematics became micro-structural and, powerfully boosted by the quantum revolution in physics, turned their attention to the various kinds of chemical bonds in biological macro-molecules, to the X-ray diffraction of crystals of nucleic acids and proteins, the generation and conduction of the nerve impulse, the modeling of motor control and motor planning, and later on, to the logical modeling of neuronal networks.

The lesson here is:

(L6): The legitimate desire to capture mathematical, formal and physical invariants in biology could not be satisfied by those equations and by D’Arcy Thomson’s topological shears.

Real progress in this direction is presently coming from elsewhere. In order to capture the physical and mathematical invariants in biological systems we have to capitalize on all the microstructural data we have, on what we reliably know about genetic evolution, and on the calculus of optimizations at a microscopic and developmental level (Cherniak, Mokhtarzada, Rodriguez-Esteban and Changizi 2004). The key to the laws of form is in a different look at specific microstructures, at biochemical and molecular evolution (Kauffman 1993). We will come back to this in a moment.

The age of specificity in cognition

General equations of learning and mathematical learning curves were also, at the beginning of the twentieth century, the core of experimental psychology, especially of behavioral psychology, and they stayed that way until, roughly, the late 1950s. The slow, progressive demise of behaviorism came from insuperable internal predicaments (Gallistel 2000, 2002) and from an increasing awareness of the importance of data from ethology, i.e. data on different innate species-specific repertoires of spontaneous behaviors and different innate species-specific learning potentials. The early success of abstract neural modeling (McCulloch and Pitts 1943) and of developmental neurobiology (Letttvin *et al.* 1959; Hubel and Wiesel 1959, 1962) also began to change the picture. A radically new perspective was to emerge from the study of language and language acquisition, and, on a different front, from the experimental study of the impact of top-down processing on perception and reasoning (Bruner and Postman 1949; Bruner, Goodnow, and Austin 1956; Bruner 1973). Cognitive science as we now know it and love it is ultimately the offshoot of this change of perspective (Nadel and Piattelli-Palmarini 2003).

The coming of the age of specificity in cognition has given us generative grammar, the modularity of mind, visual cognition, special attention to specific brain lesions and the corresponding cognitive pathologies, a sound developmental psychology and the progressive ascertainment of the awesome subtlety and abstraction of bottom-up mental processing (which also characterizes the most interesting parts of the domain of Judgment and Decision Making (Kahneman 2003)). In this long and complex story, however, I wish to stress the much-resisted ascent of specificity in the domain of language.

Formal inquiries into different classes of languages, natural and artificial, based on the theory of automata, were remarkably productive as a mathematical enterprise (Chomsky 1956; Bar-Hillel 1953a, 1953b, 1954; Schutzemberger 1961). The Chomsky hierarchy identified a new mathematically well-defined class of automata (pushdown automata), corresponding to an interesting class of output languages (context-free languages – CFLs) and could establish, on the basis of rigorous proof, that natural languages belong in a more powerful class than CFLs. Consequently, the even less powerful class of finite-state languages (notably statistical grammars, and in-frame-substitution grammars, quite popular in those years) could be ruled out on principled grounds. To this day, however, it remains uncertain, from a purely formal point of view, where natural languages exactly lie. They are situated higher than CFLs and lower than Universal Turing Automata, but it's hard to characterize them more precisely (Stabler 2009). Possibly the right formal characterization still eludes us, or possibly there cannot be any such purely formal characterization, because of inherent bio-evolutionary contingencies. Be that as it may, since the very

beginning (ever since “The Logical Structure of Linguistic Inquiry” and “Syntactic Structures”) (Chomsky 1955, 1957) real progress in the study of human languages has been made by supplementing the formal analysis with specific plausible considerations and constraints of a cognitive-linguistic nature (introducing unpronounced linguistic components, accounting for equivalences and contrasts that are obviously clear to every speaker, applying learnability constraints, avoiding ad hoc stipulations, and the duplication of rules and principles, etc.).

This style of theorizing (strictly in terms of the speaker-hearer’s tacit knowledge of her I-Language) has progressively (and I suspect irreversibly) supplanted formal analyses. To the point that, with the possible exception of an earlier impact of E. M. Gold’s mathematical results (Gold 1967; Pinker 1979, 1984) on learnability theory before principles and parameters (Wexler and Culicover 1980), the recent rebirth of formal linguistics with claimed consequences on language evolution (Nowak, Plotkin, and Jansen 2000; Komarova and Nowak 2001; Nowak, Komarova, and Niyogi 2001, 2002), whatever its merits, is isolated both from linguistic theory proper and from the quest for the genetic and neural bases of language evolution.

In summary, from the mid-1950s onwards the age of specificity has conquered linguistics too. It became progressively more and more evident that there was little gain of understanding to be derived from a study of language seen as a special application of general principles of cognition (exemplary in this respect still is, I think, the whole of the Piaget–Chomsky debate at Royaumont, now over thirty years old) (Piattelli-Palmarini 1980). Not everyone agreed then, nor does everyone agree now. In fact, it is still frequently the case that generic explanations of the workings of language are tried and retried, up to exhaustion, *before* any specificity of the language system is admitted or even contemplated. As rightly underlined by Chomsky and Sperber at the Royaumont debate (Piattelli-Palmarini 1980), *any* future, yet unspecified *possible* explanation was judged by some participants (notably Piaget, C  ll  rier, Papert, and Wilden) preferable to an actual, detailed, and satisfactory explanation, offered there and then, based on the specificity and the autonomy of syntax.² Contrary to a frequent misunderstanding, the specificity of language *still* is at the core of the minimalist program. Narrow syntax is the optimal solution to the problem posed by the interaction with two quite specific interfaces (the phonatory-perceptual one and the conceptual one) and the model as a whole still has no revealing analogies with other cognitive systems (visual, motor, pragmatic, ratiocinative etc.).³

The minimalist program invites us to explore the possibility that the design of the narrow language faculty (Narrow Syntax) is more akin to that of an optimal physical system than to that of a contingent species-specific juxtaposition of modules shaped by evolutionary tinkering (as it was still largely the case with

the Theory of Government and Binding). But the broad faculty of language (as defined in (Hauser, Chomsky, and Fitch 2002), is still specific, and does not resemble other cognitive systems. In this domain too, the answer lies not in any of the older generalist strategies (Piaget's auto-equilibration, thematization, reflexive abstraction etc., nor the modern versions offered by connectionists). This leads to:

(L7): It would be ill advised to deny or belittle any bit of insight that the age of specificity has brought us. The point is to explain all these insights in a compact way, not to explain them away.

Some limits of the “age of specificity” outlook in biology

In the title of his Croonian Lecture of 1908 and of his later book *Inborn Errors of Metabolism* (1909/1923), Regius Professor of Medicine at Oxford, Archibald E. Garrod, coined a revealing expression, and one destined to stay.⁴ In hindsight, it was inevitable that the first instances of a causal connection between genetic mutations and defective phenotypes were those of genes possessing very high penetrance, that is, cases in which the probability of the metabolic error, given the presence of the altered gene, is close to one, regardless of endo-environmental and exo-environmental variations.

Garrod's list has not ceased to expand. Any modern textbook of human genetics offers ample and detailed reviews of such cases, duly explaining dominance, recessivity, homo- and hetero-zygosis, gene regulation and so on. However, in recent years, even textbook cases à la Garrod, such as cystic fibrosis, have been reexamined, because data on a wide range of different severities of the syndrome have disclosed more subtle, less penetrant, genetic influences. Any attempt even at a rapid review of these conceptual changes and the data that have prompted them would be utterly out of place here. Nonetheless, I wish to point out that the picture is changing. The textbook picture only applies to a quite restricted subset of all the pathologies that have genetic causes. The classical Garrodian picture is real, and important, and those high-penetrance pathological cases are often, alas, lethal. But it now appears quite likely that the majority of gene-caused pathologies are not of that kind.

Once DNA and RNA were identified as the carriers of genetic information, and the protein-synthesizing machinery of the cell (ribosomes, t-RNAs etc.) was adequately characterized, arbitrary strings of nucleic acids could be inserted into this machinery, even in artificial *in vitro* preparations, and the corresponding polypeptide chains were systematically obtained. Thanks to this ingenious method, with artful variations, (insertions and deletions of chemical bases into chains of nucleic acids), the genetic code was eventually deciphered (for a detailed historical account, see Judson 1979/1986). Though our understanding

of the whole process has witnessed momentous refinements (RNA editing, quality control, chaperonines, the histone code, etc.), the overall picture remains substantially unmodified in the eyes of a majority of biologists.

Biological evolution is still today conceived as driven by random mutations, followed by the synthesis of the corresponding modified protein (or proteins), followed by a developing organism that expresses the consequences of possessing those altered proteins. As the story goes, the ensuing reproductive potential of the mutants, in competition with other variants, decides who will survive and leave progeny and who will not. The process is blind, mechanistic, gradual and it eventually produces better and better organisms. Most attempts developed so far to account for the evolution of language follow this path, including recent speculations about the evolutionary role of FOXP2. I am suggesting that this picture requires radical expansion. I am a member of a scientific generation that was educated within the (now) standard textbook picture. I love every bit of it, and I am still persuaded that it has been a vast, deep, and healthy scientific revolution. The molecular-genetic revolution has pushed biology as a whole out of scientific pre-history into scientific history. But now the time has come to expand this picture, to start a further revolution.

A host of other factors, *all perfectly* mechanistic (one has to insist on this point) have recently come to enrich it.

A quick summary

There are macroevolutionary changes that are caused by single point mutations in regulatory genes (for a quite dramatic instance see Ronshaugen, McGinnis, and McGinnis 2002)). These changes may well affect several organs and several functions at once, for instance the testes, the liver and the cerebral cortex (Simeone *et al.* 1992). The existence and the evolutionary impact of “spandrels” (Gould and Lewontin 1979; Lightfoot 2000) are corroborated at a strictly molecular, mechanistic level. At the price of repeating the obvious, if a function A (say, connectivity in the cortex) is driven by the selective pressures on another function B (blood filtering by the kidneys) because they are *both* under the control of a same regulatory gene, then there is no gain in understanding if we construct an adaptive story *only* for A.

Repeated genes and transposable elements give a whole new perspective on evolution (Juan Uriagareka and I have developed this story, and its plausible impact on language evolution in two recent papers (Piattelli-Palmarini and Uriagareka 2004, 2005, in press). At least one clear case of a major new biological function brought about by transposable elements exists: adaptive immunity (Agrawal, Eastman and Schatz 1998).

Epigenetics, the genetic regulatory effects of subtle environmental factors, sometimes inheritable at least two generations down the line, is a crucial new

dimension to be reckoned with (Petronis 2001; Gibbs 2003; Grewal and Moazed 2003; Jaenisch and Bird 2003; Pray 2004; True, Berlin, and Lindquist 2004). The functional evolutionary connection between the differential spread of repeated sequences in different species (for instance chimps and humans, as we have learned quite recently) and epigenetic regulation is being actively investigated as we speak (Vercelli, Martinez, and Chandler, personal communication). There is little doubt that *some* connection exists and that its impact on evolutionary reconstructions can hardly turn out to be secondary.

The pervasiveness, through evolutionary quite distant organisms, of certain regulatory genes shows that different parameters of the internal environment can differently switch a same gene towards the production of quite different forms. The PAX6 genetic system is substantially the same from the fruit fly all the way up to humans, but it gives rise to predictably different kinds of eyes, depending on the signals it receives from the tissues that surround it. Pace François Jacob, the eye was not independently invented five times by evolution. Rather, the same set of developmental genes can give rise to five different kinds of eye, under five different kinds of signals. The effects of evolutionary tinkering à la Jacob are everywhere to be found in biology, but one should not over-extend the power of tinkering. There are, in biology at large, also instances of discrete variations, piloted by a discrete number of possible assemblies of biochemical and structural parameters. And there are bona fide optimal solutions to be found in biological systems (Cherniak *et al.* 2004; Cherniak in press). Contrary to the still prevailing wisdom, it may well *not* be the case that *all* the sub-optimal solutions have been tried out in the course of evolution, to be then discarded by selection. When optimal invariants are found across many orders of magnitude and across evolutionarily wildly scattered species it is more likely that they are the result of a regimentation by physico-chemical factors than of the eleventh-hour filtering of innumerable independent blind trials.

Finally, a host of subtle, context-dependent, dynamic and cross-chromosomally coordinated, gene regulations has been revealed. This also adds a new dimension not only to embryological development, but ultimately to biological evolution more generally. The cumulative lesson here is, in my opinion:

(L8): Many current attempts to reconstruct the evolution of every biological trait in terms of gradualistic, piecemeal, functionally driven cumulative changes are doomed to fail. The biological picture is becoming so complex and multi-faceted that one has to start afresh, with different assumptions and models.

So, what about language?

Some fifteen years ago, summarizing and combining insights I owed to Chomsky, Gould, and Lewontin, I launched a detailed challenge to all

explanations of the evolution of language in terms of communicative needs. The linguistic examples (some already well known at the time) that I had collected, organized, and laid out in that paper showed how unlikely it was (to put it mildly) that the communicative function could have shaped the structure of language, of syntax in particular (Piattelli-Palmarini 1989). Steven Pinker and Paul Bloom rose to the occasion and did their best to counter that move, offering *other* linguistic material and suggesting hypotheses that could, they claimed, reconcile linguistics with an evolution driven by the communicative function (Pinker and Bloom 1990). I have not been moved by their (or anyone else's) attempt. Juan Uriagereka, in a whole very fine book (Uriagereka 1998), and David Lightfoot in a crisp article (Lightfoot 2000), joined forces with me. Our central point was, and still is, that a vast collection of data on syntax from a variety of languages, patiently collected and analyzed over decades, defies all communication-based, praxis-based and motor-control-based explanations.

Fragments, sluicing and deletions

To the heap of syntactico-semantic facts expounded in the papers and the book I just mentioned (in fact, in the whole of the formidable literature in generative grammar of the past fifty years or so), I want to add here another challenge for the functionalists. If language had been shaped by communicative needs, one would expect a paradigmatic confirmation of this alleged fact in truncated expressions, when whole parts of sentences are elided, yet every speaker-hearer clearly understands what is being said, given the context of the utterance. The following are canonical and well-studied examples:

- Q: Who did Mary see?
 A: John FRAGMENT
 Mary met someone, but I do not know who. SLUICING
 Q: Who was Peter talking with?
 A: *Mary* FRAGMENT w. PREPOSITIONAL STRANDING
 Mary bought a book, and Bob did too. VP-ELLIPSIS

In each of these cases some sentential component has been elided, left as tacitly understood, because considered (and correctly so) redundant, obvious and not essential. The rub, for the functionalist, is that these fragments must obey, in every language, very precise syntactico-semantic constraints. For instance, in languages that have manifest case, both *Who* in the question and *John* in the truncated answer will have Case (accusative or dative, or whatever case the verb assigns). In languages that, unlike English, do not allow prepositional stranding, such as Italian and Spanish, one cannot answer with a bare noun (*Mary*), but must repeat the preposition (*with Mary*). More subtle syntactic constraints apply to the truncated expressions in more complicated constructions, in perfect

agreement with the syntactic specificities of the various languages. There is indeed, as Jason Merchant insightfully states, “a syntax of silence” (Merchant 2001, 2004; Fox and Lasnik 2003).

Interestingly enough, such truncations are *not* always possible. Superficially similar sentences reveal a clear contrast in this respect. The asterisks here below indicate such impossibility.

- She was reading, but I don't know what.
- *She was wearing, but I don't know what.
- *She is bathing, but I don't know who(m).

Many corresponding examples have been collected from a variety of languages (Merchant 2004), showing that there are strict syntactic constraints even on such fragments. The boundaries of what can be elided, where and how, neatly match the syntactic differences between languages. The lesson here is (borrowing an expression from Alec Marantz).

(L9): There is no escape from syntax, not even when it would seem that mere isolated words or mere fragments of sentences could suffice to communicate.

This kind of virtual reverse engineering shows that, once a brain has been built to handle full-blown languages, you cannot shut off this capability, not even temporarily or episodically, not even when the subtleties of the whole grammar are a hindrance to communication (Lightfoot 2000).

Similar considerations apply to idioms (Marantz 1997), i.e. something one would have supposed to come as close as anything fully linguistic can to a list of arbitrary, non-compositional, sign-meaning pairs. Finally (for the present discussion) the full weight of syntax is also present in code switching, that is, when words and expressions from one language are naturally inserted by a multilingual speaker into sentences of another language. Several syntactic and morpho-lexical constraints apply (MacSwan 2005; van Gelderen and MacSwan 2008). Since codeswitching entails the union of at least two (lexically encoded) grammars, but ordering relations are not preserved under union, codeswitching within one component of Phonological Form is not possible. For instance,

English *eat* and Spanish *comer* cannot be inserted with the other language's morphemes for verb inflection

- * Juan *com-* ed *Juan esta *eat-* iendo
- Auxiliaries cannot be mixed either
- The students had seen *il film italiano*
- But
- * The students had *visto il film italiano*

Restrictions to switching apply also to agreement, closed class words, functional words, determiners, and quantifiers.

Summing up so far: Some authors have described grammar as “the servant of language, not the master” (Minsky 1986: 266), as a later social construct (Arbib 2005), a remedy for ambiguity (for an effective counter, see Uriagereka 1998) or somehow a byproduct of semantics and pragmatics (for instance Piaget, in Piattelli-Palmarini 1980, and Tomasello 2000).

The lesson here is that communication as mere speech minus syntax is not an option, lest we fall into the fallacy of subtraction. Various conjectures about a protolanguage in our ancestors instantiate this fallacy, in my opinion.

Protolanguage and/as the fallacy of subtraction

Words are fully syntactic entities and it's illusory to pretend that we can strip them of all syntactic valence to reconstruct an aboriginal non-compositional protolanguage made of words only, without syntax (see for instance Arbib 2005). It's very hard to even *define* words in the absence of a full panoply of phonological, morphological, and syntactic criteria (Di Sciullo and Williams 1978). Intuitively, pre-theoretically, words are sub-sentential and sub-phrasal linguistic units, but there is great variation across languages as to what constitutes a single word.⁵ No single phonological, morphological, syntactic, or semantic criterion applies in all cases, for all languages. As soon as inquiry deepens, more refined technical notions have to be introduced (listemes, lexemes, vocables, etc.).

Words typically possess a rich internal structure, not only in terms of phonemes, syllables, and morphemes, but also in terms of syntactic valence. The clearest example is the rich internal structure of verbs, with their full complement of arguments, light verbs (pronounced or unpronounced), power to assign Case, to select their subject and object and to select their auxiliary. But it has been argued that determiners (*a, the, all, some*, etc.) are relevantly similar to verbs (Larson 1991; Larson and Yamakido 2005), also having internal arguments. Prepositions head Prepositional Phrases and assign Case. Nominals derived from verbs preserve at least some of the rich internal structure of the verb (the most famous example in the generative literature being *destroy/destruction*) (Chomsky 1972).

In some versions of linguistic theory (lexicalism), syntactic structures simply *are* the projection of lexical internal structures. In other versions (constructivism) independently existing syntactic structures constrain the insertion of lexical structures into specific nodes, and meaning is the result of the match between these structures (Hale and Keyser 1993, 2002). Minimalism has fully developed a suggestion that was already present, in a weaker form, in previous versions of the theory: parts of words (morphemes, or more abstract features) move as such, are checked and matched as such, and possess their own syntactic reality. The very idea behind IP (Inflectional Phrases) already was that

inflectional traits are the head of a whole phrasal constituent, with systematic parametric differences (rich versus poor inflection) between languages. The very idea of a distributed morphology (Halle and Marantz 1993) and then the minimalist theory of feature-checking, of probe-goal relations and feature-deletion, make it very hard to disentangle the concept of word from a host of structures within words, and from the compositional potentials of words (internally available links with other words).

In the light of all this (and much besides I cannot go into for reasons of space), it is illegitimate to conceive natural language as {words + syntax} as it is to conceive, say, the color system as {something visible + hue + saturation + brightness}. What would the “something visible” be, once you strip a given color of its hue, saturation, and brightness? What would a non-compositional protolanguage be, once you strip words as we know them from their internal structure and their compositional valence (Piattelli-Palmarini 2008)? We have what Quine has called the fallacy of subtraction (for a crisp warning against falling into this fallacy in a different case, see Fodor 2003). The no-escape-from-syntax lesson and the other lessons I have selected above should redirect a more productive inquiry into the evolution of language.

Conclusion: tentative redirections

Let’s adopt the view that the evolution of language may not be the result of a cumulation of a host of smaller steps (this is akin to the view offered by Hauser, Chomsky, and Fitch 2002 and at odds with the one offered by Jackendoff 2002 and Pinker and Jackendoff 2005). And let’s adopt the hypothesis that communication may not have been *at all* the driving force behind language. We have just seen that contemporary biology offers cases of major anatomo-functional discontinuities resulting from atomic events in the genome (point mutations in regulatory genes). As I have said above, cases of the evolution of one trait as a result of selective pressures on a functionally (though not genetically) totally different trait have also been documented. If we keep looking only at communication we may miss the discovery of the trait whose selective pressures may actually have driven language evolution.⁶

Memory facilitations for the growth of a syntax-free lexicon, whatever that may be, do not seem a promising avenue (contra claims by Nowak, Komarova, and Niyogi, 2002). Recursion is undoubtedly a centerpiece of the story (arguably *the* centerpiece) and there cannot be, on logical grounds, a fraction of recursion.⁷ Not any kind of recursion will do, however. We do not speak in numbers, nor in LISP. Chomsky’s suggestion that the derivation and checking of edge features (EFs) is *exactly* the kind of recursive, discrete, compositional computation that characterizes natural language deserves close attention.

Phases are of two kinds. To put it simply, they are predicational units (vP) or introducers of propositional attitudes (CP). Complementizer Phrases (CPs) stand at the pinnacle of the syntactic hierarchy, because they introduce the sentence as a whole, and the relation of the speaker to the proposition (the thought) that the sentence expresses. In a first approximation, C (the Complementizer) can be represented as a (mostly tacit) equivalent of “that ...” It’s the highest functional head of the sentence. The other kind of phase (vP) is constituted by a verb and all its complements. Again in a first approximation, it expresses what is being predicated of what, and what modifies what.

It stands to reason that predication is embedded, sometimes deeply embedded, within a propositional attitude, and that one predication may be embedded within another. Predications are kinds of judgments, we grasp what is being predicated of what. The carriers of predicates must lie within the scope of the predication, which in turn can lie within the scope of another predication, and ultimately must lie within the scope of the propositional attitude introduced by C.

There is a crucial consideration which goes all the way back to Immanuel Kant but seems to be ignored by many who suggest scenarios for language evolution (Jerry Fodor has been relentless, over the years, and rightly so, in reminding us of this sharp divide. Most recently in Fodor 2003.) One thing is a relation between perceptions or between mental representations (say, perceptions or representations may be similar or causally interrelated), quite another is the perception, or the mental representation, *that* there is a similarity out there, *that* A is causally linked to B. The similarity (the causality, the coincidence, the difference, etc.) must be itself *in the scope* of the sensation, or the mental representation. Pace the empiricists of yesterday and of today, no number of repetitions of similar sensations caused by A and B, no number of occurrences of mental representations prompted by C being followed by D, can *by themselves* generate the judgment *that* A is similar to B, the representation *that* C is the cause of D. The current state of linguistic theory suggests that only a brain/mind equipped with the capacity to handle CPs and vPs recursively *can* make this transition. Relations of identity, co-reference, and the tracking of what is being predicated of what, of what modifies what (Ike-uchi 2003) become crucial only for a brain/mind so equipped. Words and their meanings become permeated through and through by these dependencies. All reference is only to objects and events *under a description*, objects and events are presented to the mind by language always *from a certain mental point of view* (Chomsky 1995a; Pietroski 2005).

Intensionality becomes both inescapable and primary, while extensionality is derived. The recursive handling of edge features is *precisely* what allows all this. To the best of our present knowledge, nothing else can. This is why it makes a lot of sense that we should care to reconstruct the evolution of *this* capacity, if we care at all to reconstruct the evolution of language.