

Letter

What is Language and How Could it Have Evolved?

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Unraveling the evolution of human language is no small enterprise. One could start digging somewhere in the largely unobservable past, working forwards to the present, hoping to surface in the right spot. Alternatively, one could start with the currently observed and well-established properties of human language, the phenotype of language, and work backwards, with these ‘knowns’ guiding the search for otherwise speculative historical ‘unknowns’. In a recent issue of *Trends in Cognitive Sciences*, Corballis [1] appears confident that only the first strategy will serve. Evolutionary explanations necessarily are historical, but few evolutionary biologists faced with such a paucity of historical evidence would forge ahead without first defining what, exactly, the phenotype is that ultimately evolved [2]. Yet, Corballis criticizes what we actually know about the human language phenotype, because it does not conform to his speculations [3]. We believe that Corballis’ odd research inversion suffers from misconceptions regarding what we know about both language and evolution.

The Nature of the Human Language Phenotype (Is Not Communication)

There is no denying that language is sometimes used to communicate, like this Letter. However, this should not lead to the apparently common fallacy that the design of language can be inferred

reverse-engineering style from this single functional perspective. Artful kinesthetics of human skeletal structures in motion, aka ‘dance’, also communicates, but one would be hard pressed to derive the evolutionary history of the human tibia

from watching Swan Lake. In the same way, linguists now know with near surgical-precision how the sentence ‘skeletal structure’ generally fixes meaning. We know how ‘communication’ in the sense of transfer of propositional meaning is

Box 1. Structure Connecting Sound and Meaning

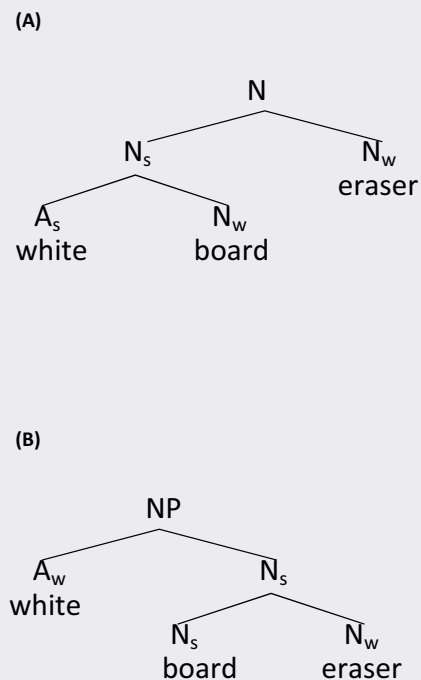
Language is structured at all levels: phonology (sound structure), morphology (word structure), and syntax (phrase structure). The examples below show how structures built by the computational system are systematically mapped onto sound and meaning.

The two ways of pronouncing the string ‘white board eraser’, also reflected in spelling, are paired with a difference in their meaning: (i) whiteboard eraser: an eraser for whiteboards; and (ii) white board eraser: an eraser that is white.

The eraser in (i) itself could have any color, but in (ii) it has to be white. Both meanings and stress patterns are systematically derived from the structural patterns given in Figure 1A,B, respectively.

In Figure 1A, the adjective ‘white’ first merges with the noun ‘board’ and constructs the nominal compound ‘whiteboard’, which, as a unit, is merged with the noun ‘eraser’, yielding a bigger compound, an eraser, erasing what is written on whiteboards. When pronounced, the structure gives rise to the stress pattern [whiteboard eraser].

In Figure 1B, ‘board’ first merges with ‘eraser’, producing the nominal compound ‘board eraser’, which, as a unit, is merged, in syntax, with the adjective ‘white’, yielding a nominal phrase, a board eraser that has a white color. When articulated (in speech), the structure gives rise to the stress pattern [white board eraser].



Trends in Cognitive Sciences

Figure 1. Nominal compound (A) versus nominal phrase (B). Abbreviations: A, adjective; N, noun; s, strong; w, weak.

facilitated by language: our manipulation of meaning is systematic and relies “on an ingrained ability to recognize structure in language.” [4]. Meaning builds on a computational system that is sensitive to structural factors leading to hierarchical structure (Box 1). All this has been overlooked by Corballis.

‘Language’ reduced to a mode of communication becomes vacuous as an explanatory motivation. Bees communicate with flowers, your router communicates with your computer, we communicate via oil on canvas, and so on [5]. The Corballian world of communication is so diffuse that it becomes all the more puzzling why “the emergence of an organ as complex as language” would apparently be limited to humans.

Structured Thought

Corballis claims thought is structured, and that the “nature and structure of thought have a long and gradual evolutionary history”, suggesting that, on this point, he is in agreement with the position advocated by Berwick and Chomsky [3]. However, all examples we know point to thought structured by syntax, not the reverse. The hierarchical structure built by the brain when processing sentences feeds our conceptual apparatus. Consequently, language is basically a thought-expressing tool [3,6]. For Corballis, ‘thought’ permeates the entire animal kingdom. That may be so, but he fails to give any clue as to what he might mean by this expansive notion of ‘thought’, how we could find out how ants, or songbirds ‘think’, and why, in this view, “expressive language” would take millions of years to appear.

Recursion

Corballis suggests that “generative grammar *may* [our emphasis] depend on the generative nature of spatiotemporal imagination, rather than on any property unique to language itself.” However, this

is merely idle verbiage. There is not even a remote connection between the two. If someone were to say that the waggle dance of the honeybee ‘may’ depend on the laws of motion, no one would pay attention. A recent comparative study of cross-species generative systems asserts that nonhuman animals have nothing resembling human recursive syntax [7]. While many animal species recognize statistical-probabilistic sequences, linear associations, or even algebraic rules, only humans appear capable of internalizing generative algorithms. In line with his view on ‘spatiotemporal imagination’, Corballis appears to assume that language inherits these sorts of property from similarly structured actions. Such an approach, linking recursion to observations from interactive language use, however, fails [8]. Moro has shown that the superficial parallels here between action sequences and sentences are misguided, again essentially backwards [9,10]. Self-reference, a defining property of recursion, appears to be absent from the domain of motor action and spatiotemporal imagination of nested maps [7], yet a rich part of human language.

The Nature of Evolution

We are surprised that Corballis subscribes to the view that anything other than an ancient and gradual origin for language “is counter to the theory of evolution”, for he is clearly aware that our understanding of evolutionary mechanisms has been refined considerably over the past 150 years. Certainly, evolutionary change requires transitions from one viable state to another, but this does not entail that phenotypic steps are necessarily the tiny and incremental ones he favors. It is also unclear why he believes that changes in gene regulation cannot “add complexity”, especially when it is almost certainly the case that modifications at this level gave rise to the anatomically distinctive species *Homo sapiens* [11]. Furthermore, the archeological record contains no evidence of behaviors compatible with the style of linguistic

information processing until after anatomical *Homo sapiens* had come on the scene some 200 000 years ago: a fact that Corballis mentions, but whose relevance is left undiscussed.

Mental Time Travel

Corballis also refers to, but regrettably does not discuss, the position that “No other organism, instantaneously and effortlessly extricates from the environment language-relevant data, and in a rather comparable way quickly attains rich linguistic competence, again a feat utterly beyond other organisms even in its rudimentary aspects.” [12]. Corballis attributes these achievements to mental time travel (MTT) and Theory of Mind (ToM), although, as frequently noted, both of these competences are often dissociated from language ability: “autistic children highly defective in theory of mind [. . .] can acquire rich linguistic competence (and in fact a great deal of language acquisition proceeds before a child shows any sign of having attained theory of mind).” [12]. Significantly, again, no mechanism is suggested to lead from ToM to the specific structures of language. Worse, there is no discussion of what the mechanisms of recursive thought in MTT or ToM are, or how they lead to the feat that has to be explained. Shifting the burden from recursive language to recursive thought in MTT and ToM appears to us to leave the problem exactly where it was, adding nothing.

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Letter

Leaps of Faith: A Reply to Everaert *et al.*

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In their comments on my Opinion in *TICS* [1], Everaert and colleagues [2] make several leaps concerning the evolution of language, including the idea that language implies a mental structure unique to humans, and that this came about through an evolutionary ‘great leap forward’ within our limited time span. Against this backdrop, perspectives on language evolution have changed over the past few decades, with language increasingly regarded as a device for communicating thought rather than as thought itself, with the structure of

thought emerging gradually according to neo-Darwinian principles.

Everaert *et al.* suggest there ‘isn’t even a remote connection’ between spatiotemporal imagination and grammar. There is nevertheless a growing understanding that language evolved primarily as a means of communicating about the non-present, with the property of displacement providing ‘the road into language’ [3]. Neurophysiology shows that the entorhinal-hippocampal complex even in the rat can compute information about events in space and time with language-like generativity, and includes incidental episodic information [4]. These internal events are not language, and the human system has certainly gained in complexity [5], but language may well have evolved primarily as a means to express them.

Theory of mind is also critical to the communicative aspect of language. As Chomsky once wrote, ‘Communication relies on largely shared cognoscitive [*sic*] powers . . .’ [6]. Gilles Fauconnier elaborates:

When we engage in any language activity, we draw unconsciously on vast cognitive and cultural resources, call up models and frames, set up multiple connections, coordinate large arrays of information, and engage in creative mappings, transfers, and elaborations [7].

Such resources go well beyond ‘I-language’, and it is difficult to believe they surfaced in a single step late in the evolution of our species.

On Erasers and Sticks

What of the distinction between a whiteboard eraser and a white board eraser? Analogous distinctions do appear to arise in nonhuman animals. New Caledonian crows can use a short stick to extract a longer stick from a barred cage, and use this longer stick to extract food from a long tube, and do so immediately and spontaneously. Therefore, they might be said to know the distinction between a long-stick extractor and a long stick

extractor [8]. Hierarchical structures may well be part of the cognitive apparatus by which humans and animals parse the world, and can exist in the absence of any means to communicate them. Seeking analogs of human cognition does not imply digging into the past and moving forwards, ‘hoping to land in the right spot’, as Everaert *et al.* suggest [2]; rather it takes what we know about language and human cognition, and seeks likely precursors.

Everaert *et al.* complain that I do not give evidence as to how nonhuman animals think, and ‘why . . . “expressive language” would take millions of years to appear’ [2]. The extraction techniques used by the crows provide an example of a window into the nonhuman mind. There are others, a few of which are mentioned in my article. Moreover, the actions of the crows might themselves be considered communicative, perhaps to be copied by a watching bird. Expression might then begin with overt behavior, gradually becoming decoupled and conventionalized, especially in social species where survival depends on effective communication transcending time and space. Thus, the emergence of expressive communication can itself be considered a gradual process, as in the gestural theory of language origins I outlined [1].

On Evolution

As for evolution, even Tattersall seems bemused by the idea that the mind could have changed so dramatically in such a short window of time. In a book cited by Everaert *et al.*, he wrote:

‘It is a qualitative leap in cognitive state unparalleled in history. Indeed . . . the only reason we have for believing that such a leap could ever have been made, is that it was made. And it seems to have been made well *after* the acquisition by our species of its distinctive modern form’ [9].

This sounds more like fiat than fact. Was *Homo sapiens* was really so distinctive? Evidence of mating between early *sapiens*