MEANING FOR FREE

Why the development of human language may be less surprising than it seems

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Introduction:

Language has long been cited as an essential distinguishing feature of humans, and its development is generally seen as unexpected and surprising. Some who readily accept natural selection as the source of the eye and the brain balk at thinking that the slow and blind processes of evolution could produce such a highly-developed facility so quickly (relatively speaking) and in such magnificent isolation. Depending on their taste, such skeptics assign the cause to very-unlikely chance, direct divine intervention, or side effects from some other mysterious event that produced consciousness. Here I explore the opposite possibility -- *so far from being a surprise, language may be inevitable*.

To support this heterodox conclusion, I will rely on several convergent and interrelated lines of reasoning. The first line looks at the connections between language and other mental capabilities that are more widely distributed. The parallels between basic concepts such as "object" and basic verbal constituents such as "noun" are not coincidences -- much (probably most) of thought was there before the talking started. Part of the glamour that language enjoys is just good publicity work. A word is a concept with a press agent.

A second line of reasoning is that use of language-like behavior is much more widely distributed than is realized. By this assertion I do not refer so much to signing bonobos (although they, like honeybees, have their place in the argument) as to much broader and deeper "language" patterns of which human language is only one manifestation.

A final line of discussion connects this topic to another "miracle" area, the origin of organic life. The brilliant work of geneticist Stuart Kauffman has shown how even the type of seemingly-contrived order seen in complex interrelated assemblies (such as cell enzyme cycles) can emerge naturally and inevitably with little need for good luck or evolutionary patience. This "order for free", which greatly reduces the height of the improbability mountains that natural selection must scale, was my inspiration for the idea that perhaps there is less to explain about language and epistemology than tradition indicates.

The tree beneath the leaves: the rest of the mind

As impressive as verbal language is (at least to those of us who use it), it is clearly not most of what the brain does. All higher animals use their brains to coordinate and control motion and sensory perception, for example. High-order operations such as object recognition, situation analysis, and social responses also are widespread. Purposive problem-solving can also be observed among animals – try keeping raccoons from using a cat door to reach your kitchen. Although it is difficult to assess the extent to which different animals use the same mental mechanisms, there is little reason to think that these other areas have the apparent discontinuity we see with human language skills.

Yet many of the situations addressed by "animal" levels of mental competence have strong parallels to language issues. The recognition of distinct objects matches the use of nouns. Verbs are analogous to deliberate actions (this matching, which implies that objects act with purpose, would also explain the widespread "kick/scratch/bite/curse the uncooperative object" behavior). Relational prepositions (above/below/beside/in/out) are describing things that are clearly already within the mental framework of active animals. Modifiers such as adjectives may also be strongly correlated to

underlying non-linguistic biological organization. For example, the assignment of the myriad possible color sensations to color words has been found to follow a tightly-constrained pattern that matches the neurological mechanisms of visual perception.

There are also some indirect connections between object-perception and words. A leading theory about how people (and presumably at least other primates as well) recognize objects makes use of the "geon" concept, in which objects are described as combinations of a limited set of geometric shapes. The criteria for the geon shapes clearly have a visual origin rather than a linguistic or abstract one – they are those shapes which can be recognized from a wide variety of viewpoints, which is of course of particular utility for object recognition. But a geon-based object-recognition mechanism naturally lends itself to categorization ("brick-ish" things vs. "cone-ish" things), and thence upward to hierarchies (a group of "lump-ish" geons without sharp corners as distinct from "box-ish" ones) and outward to modifiers (an ebony cane is a "stretched black cylinder") and even to subordinate phrases corresponding to smaller-scale objects imbedded in larger ones ("the box decorated with little balls").

There is thus a sophisticated grammar of objects that may well be a precursor of the grammar of words, or at least share common mental mechanisms with it. Even a modest set of geons (about two dozen are suspected, each with about a dozen "attributes" such as size and several dozen significantly-different connection "relations") have so many potential combinations that there are a much greater variety of two- or three-geon objects than the 30,000 or so shape-related object names. So in this area language seems sketchy compared to the comparable non-verbal process.

Another highly-evolved nonverbal mental trait is motion planning (especially significant for tree-dwellers and their kin -- you may not get a second chance). While this seems to me to be a bit further from language, motion planning has some temporal-sequence aspects that language has and object-recognition lacks. And of course our primary word-production tool, the vocal tract, is a complex motor system.

A hypothesis about the contribution that different special-purpose modules might make to a new talent is elaborated by Steven Mithen in *The Prehistory of the Mind*. His concentration is on what archeology implies about the emergence of modern human intelligence from its starting point at the chimpanzee level, not on language per se. Language is seen as a social-relations module (the "gossip" hypothesis), although he assigns it a critical role in the eventual breakdown of the barriers between the separately-evolved modules whose coordination he sees as creating the modern human mind. While there is much of interest in his analysis, its relevance here is as an example of a plausible scenario of how powerful new capabilities could result from the interplay of comparatively rigid (and thus "stupid") special-purpose subsystems.

The line of argument of this section as a whole can be summarized as *concepts are more basic than words*. Even if it is not clear which particular earlier systems contribute the most to language capability, the rich set of possibilities undermines the argument that its emergence was miraculous. We must not let the impressive feedback effects by which language use promotes the creation of new concepts and the mutation of naive ones (of which more below) obscure the fact that the meanings of a great many words were understood and acted on long before words themselves entered our toolkit.

Other voices heard from: life is full of languages

The previous section identified some of the places where capabilities evolved for other purposes may have provided contributions to the development of communication skills. This section looks at other types of communication, pointing out that human language is not the only expression of the pattern of which it is an instance. Just as drums, bagpipes, and violins are all musical instruments despite their drastic differences in form, sound-production methods, and suitable applications, so the

various other communication systems share elements that indicate that useful patterns will show up more than once.

The aspect of this issue that has been most thoroughly discussed, the symbolic-language abilities of other animals, is one of the least impressive. While greatest attention has been given to the two chimp species that are our closest surviving kindred, communication in other mammals, birds, and even insects has been intensely studied and debated. Skeptics would summarize the results as [1] communication plays an important role in many species, and [2] almost all of this communication (except for humans) uses nonsymbolic methods, with the exceptions playing limited roles at most. Other-animal symbol-generation mechanisms do not seem capable of much in the way of modifications to handle novelty, and the ones (such as the bee navigation dances) which are other than simple few-option signals use analog rather than digital coding methods, with the resulting loss of both information capacity and evolutionary potential. (The instinctive nature of a representation does not in itself disqualify it – human language would still be impressive even if we were born hardwired for basic Esperanto.)

While there may be more to other-animal communication than has been found so far (whales remain a mystery, for example), this skepticism seems to me to be reasonable as a critique of various overstated claims. But when skeptics go on to say, as they sometimes do, that such data shows that animals are essentially irrelevant to the language question, they presume a clarity in the distinction between symbolic and nonsymbolic representation which may be more tidy than true.

Is a handshake symbolic, or is it a concrete demonstration of a weaponless hand? What about a smile? What about an insincere smile? When is a gesture symbolic? Is a dog using language when it brings its master its leash? When it follows commands at a dog show? When it responds to the howls of the other dogs in a hunt? Is the word "hiss" nonsymbolic because it mimics its referent? Or semi-symbolic because the mimicry is incomplete? What about imitative gestures ("monkey see, monkey do")? Is there any place on the path from unconscious copying to pantomime to sign language at which a clear line can be drawn?

Visual observation of another subject can be extremely informative, especially if the perceiver has an evolved-for sensitivity for the subject (such as mate, prey, or predator). It is very common for all participants in such interactions to change their behavior in response to the presence and actions of the other. These mutually-responsive behaviors can have great depth and complexity. Surely such behavior is communication, but is it a use of language? Does the correct answer to this question change depending on whether the behavior at issue is instinctive or a cultural convention? But what if instinct requires that some convention be established but lets either local custom or chance association determine its form?

It is difficult to define language in a way that eliminates all such problematic cases without seeming arbitrary, or without removing it to a theoretical level so far from normal as to make it questionable that the methods ordinary people use to communicate really qualify. (Such theoretical definitions are reminiscent of how little is left of mathematics and reasoning after the formal logicians get through with it – the surviving concepts are so pure as to be unrecognizable in actual thinking.)

The nature of juvenile play is also a challenge to classify as symbolic or not. It is obviously imitative in some respects, but also is not dealt with in the same way as the "real thing" for which it seems to be preparatory. Its mastery implies some kind of ability to distinguish levels of authenticity, and thus has affinities with the story-telling which is clearly one of the "killer applications" that were part of the early payoff for the development of human-style language.

Another natural communication system that might be characterized as symbolic comes from a

different direction altogether: genetics. I am referring here not just to the simple three-letter spell-an-amino-acid coding used in DNA and RNA, but to the entire complex of control signals, activator and suppressor genes, cell type designation, etc. We have here the transmission of information at several scales: control of much of the function of the organism (shared with learned information to some extent), guidance of the initial development of the individual, and adaptive propagation to successor organisms (over many millions of generations!). Genetic systems clearly have a complex, multi-level grammar and vocabulary, and act on a digital code that is basically arbitrary symbols, thus exhibiting many of the characteristics of language systems. One way of looking at short-term human genetic activity is as a conversation among (and within) cells based on a "vocabulary" of 40,000 or so genes, of which only a fraction are active in any particular cell at any time.

The point here is not that verbal language is a direct consequence of the language of genetics (if so, why do all other species seem to be exceptions?), but that language is a natural pattern which, when it emerges, can become the dominant force in subsequent development.

Order for free: giving the evolution of meaning a head start

The work of geneticist Stuart Kauffman, comprehensively summarized in his book *The Origins of Order*, is based on the idea that much of the order which exists in living things comes as a "free" consequence of inevitable emergent properties of certain kinds of chemical (or logical) systems, and thus does not have to be explained as fortuitous chance captured by natural selection. His work is supported by extensive computer simulations, biological research data, and logical analysis, and has some startling successes such as explaining the relationship of the number of cell types to the number of genes in an organism (he shows why one is approximately the square root of the other) and, most impressively, giving a compelling scenario for the origin of complex, highly-tuned biological cycles (i.e., life). Without trying to explain his staggeringly-multifaceted work in detail, I will describe one of its central ideas that I see as relevant to the language question.

One of the main mysteries of the origins of life is that each of the basic chemical cycles that support cellular activity consists of a dozen or so extremely-specific catalysts, each of which depends on the exact form of the others. How can such an assemblage evolve, since the absence of any portion would "break the ring" and make all the rest useless? Does natural selection have to await a fortuitous collection of simultaneous favorable mutations? That might work for refinement of an already-existing cycle, but how about the original establishment of it? The odds do not look good, and yet what scientifically-plausible alternatives exist to such an evolution from simpler constituents?

Kauffman's insight is that the solution to this problem has been looked for in the wrong direction, and that the biological cycles did not evolve by piecemeal additions to a simpler chemical situation, but rather by thinning a more complex one. He points out that many chemicals have a natural weak catalytic action – that is, they preferentially promote certain other reactions, and that for simple chemicals the catalytic action is usually broad (affecting many different reactions), so that almost every potential reaction would be influenced by the presence and balance of some other chemicals as well as the direct reactants. This means that in the prebiotic soup there would develop a "supracritical" stew of mutual interactions between great numbers of chemicals – a chaotic tangle of cycles more complex (although much less stable) than early cellular life forms.

As some reactions within this chaos deplete the feedstock chemicals used by themselves or other reactions, the balance of activity would shift. But any groups of mutually-reinforcing reactions (it can be shown that some will almost certainly exist) would tend to persist, since they constitute a local economy. And as the chemicals in such a group coevolve to become more specific and efficient in their catalytic action, space would open up for other cycles, some based on variants of the same chemicals.

Once the race for feedstock resources started, the soup would "cook" quickly, with the equivalent of a phase change – disconnected or less-efficient reactions would be squeezed out.

There seems to me to be a useful analogy here for the development of communication actions and their meaning. Steven Pinker, in his book *The Language Instinct*, reports a similar sudden coalescence in language in the formation of creoles when different-language children are mixed, where a race for expressive power and coherence forms a unified language out of a tower-of-Babel chaos in a single generation. His report of a similar phenomenon (this time in sign language) by Nicaraguan deaf children when they were first collected in a school is even more impressive, since in this case they clearly did not borrow linguistic complexity from their parents or teachers, who were much less competent in signing.

Note that Pinker takes this surprising language-creation competence as evidence of the existence of a well-developed instinct for language in humans, not as a sign that language emergence is automatic or easy. Thus his thesis and mine might seem to be mutually exclusive. I do not see it that way, any more than Kauffman sees his "natural order" explanation of cell-cycle origins as mutually exclusive with the natural selection that sharpened them and gave them a hereditary basis. On the contrary, *the paths taken by natural selection will necessarily include any accessible shortcuts*, and ***natural selection will subsequently reshape the organism to take maximal advantage of those shortcuts***. Thus the existence of an evolved instinct to do a particular activity is strong evidence in support of a hypothesis that the activity was relatively easy (and advantageous) to begin with.

I see the communication "soup" from which language precipitated as being based in the social signals that are highly developed in all social species. These use several modalities (visible, audible, tactile, and olfactory) and play vital roles in fundamental life activities: power, reproduction, and food acquisition. Where the communication needs associated with these activities remained modest, there was no pressure to radically supplement them. But if some situation (such as the increase in social-group size hypothesized by Mithen as a consequence of adoption of a scavenging-based economy) created an advantage for increased ability to communicate, the materials were at hand.

Mithen's hypothesis that human language evolved in response to the internal-politics demands of increased group size, while admittedly speculative, is attractive in several ways. For one thing, the increase in social tasks (which includes keeping track of relationships between others as well as having more people to deal with directly) rises very rapidly with increasing group size -- ask anyone who has started in a small company and seen it grow. Another point is that the standard chimp political tool, social grooming, does not scale well to larger groups; you can scratch only so many backs before you run out of time (and out of itches). So expansion in that direction is blocked.

A final clue as to what precipitated the change comes from the need to explain why sound rather than sight became the primary linguistic mode. Human vision has a far greater information-acquisition capacity than human hearing. Among chimps, gesture seems at least as well developed as sound-making. Even as things turned out, gesture has a well-developed support role in human communication (it's hard to talk without using your hands), and sign language shows that it can quite easily take over the whole job. The ease with which reading is learned also shows that vision is a good path for language. So why did we go to the trouble of evolving the substantial anatomical refinement in the throat and tongue required for speech production?

Any answer is guesswork, of course, and it may be that something else like the need for hunting coordination was a primary cause. But one can certainly see how a political origin for language might favor a modality that permits both orations and private whispered conversations. Speech also works in the dark, thus enabling the development of group-unifying (and -educating) storytelling and group-

singing traditions – bedtime stories go way back! Such stories and songs could also be overlapped with the mutual grooming which was no doubt a major evening activity, and which may have been already keeping hands occupied enough that any diversion to additional communication gestures could not be afforded.

A political origin to speech would also help explain the explosive quickness of language development. Politics implies power, which implies preferred access to reproduction and to food (also a reproduction-related issue when children do not support themselves for several years). This could be the key: political power is for people what catalytic power was for enzyme cycles. Traits that confer even minor competitive reproductive advantage spread very quickly within a species, and each improvement is soon built on and upstaged by a successor. Genomes that couldn't keep up with the developing conversation got left behind (or driven to extinction) as inarticulates.

Another important similarity of language with chemical cycles is a misleading pattern I will call "coherent arbitrariness". The enzymes in a ring are not the only solution to the task they perform, and many variant sets of forms would have equivalent capabilities. This could be taken as implying that the "winner" was arbitrary, and that anything might have happened. A better description would be that the pool of potential winners (which was a very small subset of the overall possibilities) shared special properties and internal harmonies, but that the choice among equally-qualified "finalists" had a substantial element of chance. The element of chance in who wins the Super Bowl, however, does not change the fact that both contenders have extraordinary skills that sharply differentiate them from a random team. A winning team also has internal coherence, with the skills of players matched to those of their teammates (receivers with passers, for example).

Language shows the same pattern. The assignment of word-symbols to concepts has a substantial arbitrary component, but also has substantial internal coherence. The use of inflections (e.g., to indicate noun case and verb tense) as well as compound words, prefixes, and suffixes results in language vocabularies being interrelated webs of symbols rather than sets of arbitrary designations. The coherence is even greater in the grammatical component of languages, where it is apparently the case that a modest number of "switch settings", learned by children in response to their parents' speech, determine the particulars of the grammar.

Meaning for free?

Thus part of why humans developed meaningful speech quickly was that there was already plenty of meaning around – politics preceded political speeches, courtship preceded valentines, working partnerships preceded staff discussion meetings, and practical jokes preceded verbal ones. There were also several existing communication methods to build on, as well as indications (e.g., from genetics) that communication emerges naturally in complex systems.

But once the talk got going, it must have become a major influence in its own development, just as Kauffman's chemical cycles changed their own chemical environment. It is the existence of such positive feedback that converts gradual adaptive drift into dramatic transformations. In fact, the tendency to alter its starting environment ("erase its tracks", as it were) explains why positive feedback is often implicated in situations where it seems that something has sprung into existence from nowhere.

What might such feedback have looked like for human language? I see four main types: sharpening/splitting, borrowing, recursion, and useful mistakes. All these are suggested by current word-development patterns, so it is quite possible that I am missing some mechanism that played a major role in the past but is less relevant now. But these examples suffice to illustrate, without having to evoke mysterious causes, my assertion that language once launched would quickly move not just vocabulary but thinking itself to a much more elaborate level.

We see both in children and in the history of science many illustrations of the process by which an initially-vague concept causes one word to be used widely at first, but be subjected over time to a sequence of distinctions and which generate a correspondingly greater vocabulary. Note that the initial concept/word is not a passive object of this rearrangement, but instead is an active participant in the conversations (and thus the actions they provoke) that lead to an awareness of more precision. Scientists didn't really know what they meant by "energy", for example, until they had found out the insufficiency of their understanding through use of the term in a variety of contexts that permitted it to be distinguished from related ideas such as momentum.

I have already mentioned that many words are just tags for concepts that were developed in support of nonlinguistic capabilities. This process can be inverted to generate new meaning by using an existing word or sentence in a new context. Such metaphors do more than label a new concept – they contribute significantly to its content. One of the more dramatic examples is the progression from "Who made this pot?" to "Who made the world?" The existence of an answer to the first question is taken as implying that an answer exists to the second (and that both "who"s share essential characteristics).

While the concept of applying a process to itself probably predates language (making a tool to make tools, for example), it turns out to be extremely powerful in the linguistic context, and is the basis for the ability to make sentences of substantial complexity (through subordinate phrases, clauses, etc.). Such recursion comes from treating a linguistic expression with the methods used for individual words, and is thus a natural consequence of making language constructs into mental "objects". Productive use of recursion also requires some sophistication in the use of pronouns or their equivalent (what computer programmers would call "pointers"). Such higher-order forms of reference then facilitate further self-reference and thus may well be significant contributors to self-awareness.

My final category of positive feedback, "useful mistakes", serves to remind us that progress may result from stumbles as well as plans. The genetic variability made use of by natural selection is a classic example of this process, and is instructive in that one can see that a genome-duplication method that made no errors at all would have left its bearer back at the start of the race. Verbal language has its own opportunity for mistakes, from puns to paradoxes. In addition to any incidental "happy accidents" in which what is heard was truer than what was said, such stretching of verbal categories (which clearly has great interest for people, and is a major component of humor) serves to direct attention to the nature of language and thought itself. And once such self-reflection starts, the stage is set for another transforming explosion of capability – that is the wave that the human race is riding right now.

The problem with a paper of this kind is that it occupies an uncomfortable middle ground between the dinner conversation that provokes it and the book it deserves for proper exposition. It is a sketch rather than a demonstration (let alone a proof). But I suspect that when the fascinating topic of language is untangled, the contribution of "meaning for free" will play a prominent part.

Major references:

[1] Steven Pinker, *The Language Instinct*
[2] Steven Mithen, *The Prehistory of the Mind*
[3] Stuart A. Kauffman, *The Origins of Order* and *At Home in the Universe*