



sLAB (Strategic Innovation Lab)

2010

## Mind and language architecture

Logan, Robert K.

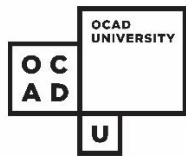
---

### Suggested citation:

Logan, Robert K. (2010) Mind and language architecture. *The Open Neuroimaging Journal*, 4. pp. 81-92. ISSN 1874-4400 Available at <http://openresearch.ocadu.ca/id/eprint/871/>

*Open Research is a publicly accessible, curated repository for the preservation and dissemination of scholarly and creative output of the OCAD University community. Material in Open Research is open access and made available via the consent of the author and/or rights holder on a non-exclusive basis.*

*The OCAD University Library is committed to accessibility as outlined in the [Ontario Human Rights Code](#) and the [Accessibility for Ontarians with Disabilities Act \(AODA\)](#) and is working to improve accessibility of the Open Research Repository collection. If you require an accessible version of a repository item contact us at [repository@ocadu.ca](mailto:repository@ocadu.ca).*



2010

## Mind and Language Architecture

Robert K. Logan

Department of Physics, University of Toronto

Strategic Innovation Lab OCAD University

[logan@physics.utoronto.ca](mailto:logan@physics.utoronto.ca)

---

© Robert K. Logan released under Creative Commons: Attribution 4.0 License. This article originally appeared in [The Open Neuroimaging Journal](#) DOI: 10.2174/1874440001004020081.

**Suggested citation:**

Logan, Robert K. "Mind and Language Architecture." *The Open Neuroimaging Journal* 4 (2010): 81–92. Web.

# Mind and Language Architecture

Robert K. Logan\*

*Chief Scientist, Strategic Innovation Lab, Ontario College of Art and Design, Professor Emeritus Physics, University of Toronto, Canada*

**Abstract:** A distinction is made between the brain and the mind. The architecture of the mind and language is then described within a neo-dualistic framework. A model for the origin of language based on emergence theory is presented.

The complexity of hominid existence due to tool making, the control of fire and the social cooperation that fire required gave rise to a new level of order in mental activity and triggered the simultaneous emergence of language and conceptual thought. The mind is shown to have emerged as a bifurcation of the brain with the emergence of language. The role of language in the evolution of human culture is also described.

**Keywords:** Mind, brain, emergence, conceptual thought, percepts, concepts, language.

## INTRODUCTION

Although this collection of essays is entitled Brain and Language Architectures my focus will be on the architecture of the mind and language because it is the mind and language that belong to the same sphere not brain and language. The brain belongs to the material world of the physiosphere. It has extension and materiality. Language, on the other hand, has neither materiality nor extension and it belongs to a domain, the symbolosphere that we will shortly define. The mind as we shall argue also belongs to the symbolosphere and is distinct from the brain. The mind emerged as a bifurcation of the brains with the emergence of language, which permitted for the first time conceptual thought, but more of that later.

There is an architecture of the brain that processes language and I suspect it will be well treated in this collection of essays as authors discuss bicamerality, Broca's area and mirror neurons. These mechanical aspects of language processing, while extremely interesting, are not my area of expertise. I am a media ecologist and I am interested in the way in which language created the human mind. With all respect to animals lovers and fully acknowledging how clever non-human animals can be I will still claim that we humans are the only animals capable of a generative language as opposed to being capable of only signaling as is the case with many different animals. Animals in the wild have a vocabulary of at most 50 signals and they cannot use these signals generatively to form different propositions. If they have 50 signals they have 50 propositions whereas a child with a vocabulary of 50 words can make a very large number of propositions. We are also the only animals capable of planning; conceptualization; symbolic thinking as exemplified by our story telling, our logic, our science and

our mathematics; and symbol-based culture. I would not claim that generative language gave rise to these other capabilities but rather that these unique capabilities including language are interconnected and form an autocatalytic set skills unique to us.

Architecture originated as the organization of material objects to achieve some function useful to humans such as habitation. The term has come to describe the organization of any set of elements. In this essay we will consider the conceptual architecture of mind, language, culture and symbolic thought. In order to do this we will review the extended mind approach that models the origin of language [1-3].

We believe that human thinking can be divided into percept-based thought, which takes place in the brain and concept-based thought, which takes place in the mind. We are clearly making a distinction between the brain and the mind. We claim that the brains of our hominid ancestors from which we evolved were purely percept processors and that the human mind only emerged with language, which made conceptual thought possible. Furthermore we will claim that our first words were our first concepts. The relationship of the brain and the mind is complicated but as we will attempt to show the mind emerged from the brain as a bifurcation simultaneously with the emergence of language. The focus of this article will be on the conceptual architecture of the mind. We will leave to others in this volume a description of the architecture of the brain vis-à-vis language where no doubt they will discuss the bicamerality of the brain whereby the language facility of human brain is located for the most part in the left hemisphere and contains certain structures such as Broca's area that are essential for speech.

Our focus in this article will be on the conceptual architecture of the mind. One of the hypotheses that we will support with our argumentation is that the brain and the mind are not identical. We will argue that the human mind emerged from the brain as a bifurcation with the

---

Address correspondence to this author at the sLab, OCAD, Suite 600, 100 McCaul St. M5T 1W1 Toronto ON Canada; Tel: 416-361-5928; E-mail: logan@physics.utoronto.ca

simultaneous emergence of language or speech and that the mind = brain + language. In order to develop our model for the conceptual architecture of the mind we will need to develop a theory for the origin of language, which we will discover was motivated by the need for conceptualization to deal with the complexity of hominid life. As our first hominid ancestors learned to make tools and control fire there arose the need for planning which requires to deal with and think about situations that are remote in both the space and time dimension and hence not immediately susceptible to perception. There arose a need for conceptualization and for the ability to think of things abstractly and symbolically. It is our claim that language was the medium by which humans were able to conceptualize, to think abstractly and symbolically and to plan. It is no coincidence that man is the only animal capable of a generative symbolic language, the only animal with a symbolic culture, and the only animal capable of planning.

Building on this approach we will argue that before language the brain operated purely as a percept processor and that with language the brain bifurcated into the human mind capable of conceptualization. The hypothesis that before language hominid thought patterns were purely perceptual has also been developed by Merlin Donald (ref [4], p. 226) who makes a similar assumption about the perceptual basis of mimetic culture, the culture of hominids that existed just before the emergence of verbal language. "The principle of similarity that links mimetic actions and their referents is perceptual, and the basic communicative device is best described as implementable action metaphor (ref. [5], p. 61)."

Our earliest hominid ancestors who were toolmakers and users probably developed this skill as a way of defending themselves when they left their arboreal habitat and began their residency on the savannahs of Africa. Shortly thereafter they learned to control fire, which in turn led to living together in large family groups to share the benefits of the hearth. There also emerged group foraging, coordinated hunting and food sharing. These activities also resulted in a more complex form of social organization, which also increased the complexity of their lives. At first, this complexity could be handled through more sophisticated percept-based responses, but at some point the complexity overwhelmed them. Percept-based thought alone could not provide sufficient abstraction and enough richness to deal with the increased complexity of their existence. A new abstract level of order emerged in the form of verbal language and conceptual thinking to deal with the information overload and chaos that ensued with this complexity.

This new level of order emerged in the form of concepts, which provided enough requisite variety to model or regulate the challenges of day-to-day life. Percepts arise as the direct impressions of the external world that we apprehend through our senses. Concepts, however, are abstract ideas that result from the generalization of our percepts but the mechanism that allowed this to happen was language. Concepts allow one to deal with things that are remote in both the space and time dimension. We posit that our first words were our first concepts that allowed us to represent all of our percepts associated with that particular concept. So our first words

were probably nouns and verbs and it was only later that grammatical terms arose.

Concepts increased the variety with which the brain could model the external world. Percepts are specialized, concrete and tied to a single concrete event but concepts are abstract, general and generative. They are generative in that they can be linked to each other to describe even more complex situations. They can be combined with other concepts and percepts to increase the variety of thought and expression in ways that percepts cannot.

Words representing concepts allowed a transition from the non-verbal forms of communication and percept based thinking of our hominid ancestors to the verbal form of communication and the conceptual symbolic form of thinking that is characteristic of the human mind. Language is both a form of communication and an information processing system that permitted the transition from percept-based thought to concept-based thought. The spoken word is the actual medium or mechanism by which concepts are expressed or represented. The relationship of spoken language and conceptual thought is not a linear causal one. Language did not give rise to concepts nor did concepts give rise to language, rather human speech and conceptualization emerged at exactly the same point in time creating the conditions for their mutual emergence. In a certain sense language and conceptual thought self-organized.

This hypothesis parallels the work of Vygotsky [6] in his seminal work *Language and Thought*. He describes the relationship between words and concepts in the following manner:

Our investigation has shown that a concept is formed, not through the interplay of associations, but through an intellectual operation in which all elementary mental functions participate in a specific combination. This operation is guided by the use of words as the means of actively centering attention, of abstracting certain traits, synthesizing them, and symbolizing them by means of a sign.

The process leading to concept formation develops along two main lines. The first is complex formation: The child unites diverse objects in groups under common "family names;" this process passes through various stages. The second line of development is the formation of "potential concepts," based on singling out certain common attributes. In both, the use of words in an integral part of the developing processes, and the word maintains its guiding function in the formation of genuine concepts, to which these processes lead (ibid., p. 81).

Concepts are absolutely essential for planning because they allow for displacement in time and they make abstraction possible, which is why humans are the only animals that speak and plan. "The available ethological evidence so far indicates that man is the only species with the ability to imagine future wishes and to plan and act accordingly [7]."

Language and conceptual thought are self-organizing, autopoietic using the language of Maturana and Varela [8] and autocatalytic using the language of Kauffman [9]. They are the dynamically linked parts of a dynamic cognitive

system, namely, the human mind. Autocatalysis is the mechanism that Kauffman (ibid., p. 49) used to explain the emergence of life: "A living organism is a system of chemicals that has the capacity to catalyze its own reproduction." An autocatalytic set of chemicals is a group of organic molecules where the catalyst for the production (or really re-production) of each member of the set is contained within the set itself. As a result of this the system can become a "self-maintaining and self-reproducing metabolism," i.e. a living organism, in the presence of a source of energy and the basic atoms needed to build organic compounds. A key idea in Kauffman's approach is that the members of the autocatalytic set self-organize and, hence, bootstrap themselves into existence as a set with an identity different from the individual members that make up the set, and hence represents an emergent phenomenon.

The autocatalytic process catalyzes itself into a positive feedback loop so that once the process starts, even as a fluctuation, it begins to accelerate and build so that a new phenomenon emerges. The emergence of language and conceptual thought is another example of an autocatalytic process. A set of words work together to create a structure of meaning and thought. Each word shades the meaning of the next thought and the next words. Words and thoughts are both catalysts for and products of words and thoughts. Language and conceptual thought represent emergent phenomena, which bootstrap themselves into existence.

Any set of mechanisms or ideas that catalyze each other's existence is an autocatalytic set - an autocatalytic set of mechanisms or ideas. Language and conceptual thought form an autocatalytic set because language catalyzes conceptual thought and conceptual thought catalyzes language. Later in our study we will return to Kauffman's idea of autocatalysis and its application to the origin of language and the notion of language as an organism.

## **THE RELATIONSHIP OF PERCEPTS AND CONCEPTS**

The use of a word transforms the brain by replacing a set of percepts with a concept. A word acts as a strange attractor for all the percepts associated with the concept represented by that word. A word, therefore, packs a great deal of experience into a simple utterance or sign. All of the percepts of a linguistic community associated with a word are boiled down by the language to that word acting as a concept and a strange attractor for all those percepts.

The notion that a concept and a word are equivalent was first presented in my Extended Mind model in Logan [1]. Words represent concepts and concepts are represented by words. It is my belief that they emerged simultaneously and that words provided a medium by which concepts could be represented, manipulated, spoken about and thought about. This differs dramatically from the position of traditional linguists who believe that words emerged for the purpose of the communication of concepts that already existed before language existed. In other words conceptual thought was possible without language. I share the view of traditional linguists that claim that words and concepts are connected. Pinker recently suggested that "a word is an arbitrary sign; a connection between a signal and a concept." Where we differ is on the question of which came first the word or the

concept. For Pinker first comes the concept and then the word whereas I believe that they co-emerged. I believe that the word gave rise to the concept and the concept was represented by the word. The word is more than a symbol or a sign that represents a thing or a concept. To my way of thinking the word is the concept and the concept has a handle, which is the word. The origin of language and words is tied to the origin of concepts so to understand why language arose we need to understand why we needed concepts.

Because the concept has a handle in the form of a word its use links the many percepts the speaker has associated with the concept. The word therefore facilitates the speaker's memory of those percepts and the ability to use those past experiences to plan new ways to incorporate those past experiences into actions that enhance the speaker's survival. Words help organize the user's past experience to make a better future.

The use of a word like water representing the concept of water triggers instantaneously all of the mind's direct experiences of water as well as instances where the word "water" was used in any discourses in which that mind participated either as a speaker or a listener. The word "water" acting as a concept and an attractor not only brings to mind all "water" transactions but it also provides a name or a handle for the concept of water, which makes it easier to access memories of water and share them with others or make plans about the use of water. Words representing concepts speed up reaction time and, hence, confer a selection advantage for their users. And at the same time those languages and those words within a language, which most easily capture memories enjoys a selection advantage over alternative languages and words respectively.

My use of the notions of percepts and concepts, which is central to my model of the architecture of the mind and language, is the result of the influence of Marshall McLuhan with whom I collaborated and who introduced me to idea that our mental life can be divided into percept-based and concept-based thinking. The following passage from *Understanding Media* (ref. [10], p. 56) also had an influence on my thinking about language and its impact on human thought.

All media are active metaphors in their power to translate experience into new forms. The spoken word was the first technology by which man was able to let go of his environment in order to grasp it in a new way. Words are a kind of information retrieval that can range over the total environment and experience at high speed. Words are complex systems of metaphors and symbols that translate experience into our uttered or outered senses. They are a technology of explicitness. By means of translation of immediate sense experience into vocal symbols the entire world can be evoked and retrieved at any instant (ibid.). I share with McLuhan the notion that the use of language speeds up thought processes.

Although the very first words were probably the strange attractors of percepts associated with the concept represented by the word I do not mean to imply that all words arose in this fashion. Once a simple lexicon of words came into being a new mental dynamic was established. The human mind

now capable of abstract thought and abstract concepts would now require the ability to express new relationships that would need to be represented by new words. These new words would not have emerged as attractors of percepts but rather as representations of abstract concepts in the form of grammatical relationships among words. The first words of this nature would have been, in all likelihood, associated with grammar and categorization. Examples of the former would be grammatical words such as: he, she, this, that, and, or, but, if, etc. and examples of the words for categorization would be words such as: animals, people, birds, fish, insects, plants, and fruits.

My hypothesis that human language began with the emergence of words acting as concepts falls within the tradition known as the lexical hypothesis, which posits that “the lexicon is at the center of the language system (ref. [4], p. 250).” Language began with a lexicon, which then gave rise to grammatical and syntactical structures. Advocates of this hypothesis include Donald [4,5], Bickerton [11-15], Locke [16], Levelt [17] and Hudson [18]. Syntactical structures are also concepts. They are concepts that encompass relationships between words just as words are concepts that encompass relationships between percepts.

### THE COMPLEXITY OF HOMINID EXISTENCE

We now turn to the question of what developments in hominid evolution gave rise to the complexity, the information overload, and, hence, the chaos that led to the bifurcation from perception to conception and the emergence of speech. It was not a single development or breakthrough that triggered this event but rather the accumulation of many developments that included the manufacture and use of tools, the control of fire, the more detailed social organization that was required to maintain the hearth and share the benefits that fire engendered. This led to new social structures required for living in large groups such as food sharing, group foraging and co-ordinated large-scale hunting. It also resulted in the emergence of non-verbal mimetic communication as has been described by Merlin Donald [4] in *The Making of the Modern Mind*.

Deacon [19] describes humans as the symbolic species and suggests that the provision of meat through hunting or scavenging, the use of stone tools for hunting and butchery, and social institutions or organization such as marriage and ritual contributed to the advent of speech. Christiansen [20] and his co-workers [21-23] believe that another set of skills was associated with the advent of speech, namely, sequential learning and processing. The hypotheses of Donald, Deacon and Christiansen are similar since tool making and use, social organization and mimetic communication all involve sequential learning and processing. All of the activities that they cite as influencing the origin of language created new levels of complexity and resulted in new skills, which certainly acted as pre-adaptations of language. In my extended mind model language arises from this complexity while for Donald, Deacon and Christiansen the new skill sets act as pre-adaptations for language. There is nothing contradictory in our approaches. In fact, they reinforce each other. Both the skill sets acting as pre-adaptations and the bifurcation to a new level of order due to the increase xx

complexity complement each other and each in their own way contributed to the emergence of language.

As the complexity of hominid existence increased with the new forms of social organization that tool making and the control of fire made possible, percepts no longer had the richness or the variety with which to represent and model hominid mental activities. It was out of this necessity that speech emerged and the transition or bifurcation from perceptual thinking to conceptual thinking occurred. The initial concepts and the words that represented them served as a metaphor and strange attractor uniting all of the preexisting percepts associated with that word. All of one's experiences and perceptions of water, the water we drink, bathe with, cook with, swim in, that falls as rain, that melts from snow, were all captured with a single word, water, which also represents the simple concept of water.

As a result the human mind emerged as a non-linear dynamic system capable of interacting with its environment, its memories of past experiences and perceptions and its social community. A word operating as a concept acts as an attractor for all of the percepts associated with that word. An attractor is a trajectory in phase space towards which all of the trajectories of a non-linear dynamic system are attracted. The meaning of the word being uttered does not belong simply to the individual but to the community to which that individual belongs.

The full meaning of a word each time it is used emerges from the context in which it is being used. The attractor is a strange attractor because the exact meaning of a word is never the same, although there is a core meaning that might change slowly over time as the meaning of a word evolves and some times takes on more than one meaning. For example fair once had the meaning of not dark or of pleasant or lovely but over time it also took on the meaning of average. But if we ignore the bifurcation of the meaning of a word and stick to one of its meanings, even that changes with context and hence acts as a strange attractor. The trajectories of a strange attractor never meet even though they come infinitesimally close to each other. It is the same with a word. The meaning of a word fluctuates about the strange attractor but it is never exactly the same because the context in which the word is being used is always different. The context includes who is speaking and why, the other words in the utterance, the social context in which the utterance was made, and the medium used to transmit the utterance. Given that the medium transforms the meaning of the word uttered as McLuhan [24] explained with his famous one-liner, “the medium is the message.” The meaning of a word will be subtly affected according to whether the word was spoken, whispered, written, telephoned, telegraphed, emailed, or appeared on a Web site.

The use we made of the word “utterance” in the above paragraph is an example of how context shifts the meaning of a word. Utterance usually refers to the spoken production of language but in the context we just used it took on the meaning of the general construction of a sentence independent of the medium used to express it. Although in most cases a word moves around an attractor in the phase space of meaning from time to time a word can bifurcate into two meanings. An example of this is the appropriation of the words hot and cool to refer to two different styles of jazz,

namely, Dixieland and bebop respectively. The word cool used in jazz further bifurcated to add the meaning *avant-garde*, "with it", or hip.

We identify words as strange attractors because of the fact that words in the contexts of an utterance have multiple, even ambiguous meanings, or multiple simultaneous perspectives. Within the context of spoken language the ambiguity is reduced because the prosody and accompanying gestures and hand movements add additional meanings to the words being spoken. Because of the lack of these extra-verbal signals in written language written words are more ambiguous than spoken words. Within the context of mathematics and science in which terminology is given precise definitions the ambiguity of words is minimized. The attractors that represent mathematical and scientific terms approach fixed-point attractors but are not totally fixed-point attractors. There is always a bit of fuzziness about even mathematical and scientific terms, which can be attributed to the differences of opinions of mathematicians and scientists, on the one hand, and to Gödel's Theorem in the realm of math and the Heisenberg uncertainty principle in the realm of quantum physics, on the other hand.

We have argued that speech arose because of the need to conceptualize but we should also mention that there is another element that contributed to the spontaneous emergence of language, namely the human desire to communicate verbally which has been attributed to three closely related attributes of human cognition, namely, a theory of mind, the sharing of joint attention, and the advent of altruistic behavior. In order to want to engage in the joint attention that Tomasello (ref. [25], p. 208-09) suggests was essential for the emergence of language it is necessary to have a theory of mind (ref. [26], p. 102), namely the realization that other humans have a mind, desires and needs similar to one's own mind, desires and needs. At the same time there must have developed a spirit of altruism (ref. [27], p. 41) once a theory of mind emerged so that human conspecifics would want to enter into the cooperative behavior that is entailed in the sharing of information. Theory of mind and joint attention catalyzes the social function of communication and cooperative behaviour and vice-versa. The mechanisms of social communication and cognition through language also form an autocatalytic subset.

### EMERGENCE AND PUNCTUATED EQUILIBRIUM

We have suggested that spoken language and abstract conceptual thinking emerged at exactly the same time as the bifurcation from the concrete percept-based thinking of pre-lingual hominids to conceptual-based spoken language and thinking. This transition is an example of punctuated equilibrium, and I believe, was the defining moment for the emergence of the fully human species *Homo sapiens*. This discontinuous transition illustrates Prigogine's theory of far from equilibrium processes and the notion that a new level of order can suddenly emerge as a bifurcation from a chaotic non-linear dynamic system [28,29].

I have also made use of the possibility of the emergence of a new level order from a complex chaotic situation to explain the evolution of language from speech to writing and mathematics and from there to science and then to

computing and finally to the Internet in my book *The Sixth Language* [30]. Each new language emerged as a response to the chaos of the information overload that the previous languages could not handle. Let us take a small detour to discuss this evolution of language as it illustrates the same mechanism we use to explain the transition from non-verbal communication to speech as well as the transition from percept-based thinking to concept-based thinking.

Language is not the passive container or medium of human thought whose only function is to transmit and communicate our ideas and sentiments from one person to another. Language is a "living vortices of power" [10], which shapes and transforms our thinking. Language is both a system of communications and an informatic tool. Language is a dynamic living organism, which is constantly growing and evolving. Not only does spoken language grow in terms of its increased semantics and new syntactical forms it also evolves into new forms of presentation and expression.

Language has two functions: a social communication role and a conceptualization or informatics role. We can express this dual nature of language with the equation: language = communication + informatics. As the informatics role of language expanded and became more complex with the increased complexity of human life information overloads developed that could not be resolved by spoken language. Speech and the human capacity for memorization encountered limits as to how much data could be recorded in this manner. In this environment written language and mathematical notation emerged at precisely the same moment in time in Sumer approximately 3100 BCE. The teaching of the skills of reading, writing and arithmetic led to formal schools and teachers who in turn became scholars which led to another information overload that eventually gave rise to science or organized knowledge. Science and science-based technology led to another information overload that led to computing. Computing greatly facilitated the production of information and the subsequent overload of computing led to the emergence of the Internet. The evolutionary chain of languages consisting of speech, writing, mathematics, science, computing and the Internet arose step by step as a new level of order, an emergent phenomenon that dealt with the information overload created by its closest predecessor. Each new language arose as emergent phenomena addressing the information overload that the language from which it emerged gave rise to and could not resolve [30]. Each new language incorporates all of the features of the languages that preceded it with the exception of writing and mathematics, which emerged simultaneously and each incorporates the other plus spoken language. As a result of this dynamic each new language emerges as the autocatalysis of the previous languages plus some new cognitive capacity that is stimulated by the information overload generated by the previous language.

### THREE PREVERBAL FORMS OF PROTOLANGUAGE: TOOL MAKING, SOCIAL INTELLIGENCE AND MIMESIS

The transition from percept-based thinking to concept-based thinking represented a major discontinuity from hominid thought to human thought. Our hominid ancestors developed the set of survival skills associated with tool

making and use, the control of fire, co-operative social structures and organization, large scale coordinated hunting and gathering, and mimetic communication [4]. Based on the work of Merlin Donald [4] I would interpret these major breakthroughs in hominid cognition as the emergence of three distinct percept-based preverbal proto-languages:

1. tool making and use (or manual praxic articulation),
2. social intelligence or organization or the language of social interaction,
3. mimetic or preverbal communication, which entails the use of hand signals, mime, gesture and prosodic vocalization [4].

I believe that these three forms of preverbal activities identified by Donald as elements of mimetic culture are actually proto-languages although he never spoke of them in these terms.

These breakthroughs in hominid cognitive development can be understood as three percept-based preverbal protolanguages because they each represented the two basic functions that I have used to define a language, namely a form of communication and information processing, albeit a bit primitive. Mimesis according to Donald (ref. [5], p. 61) “establishes the fundamentals of intentional expression in hominids, without which language would not have had an opportunity to evolve such a sophisticated, high-speed communication system as modern language unless there was already a simpler slower one in place.”

These three preverbal proto-languages were the cognitive laboratory in which the skills of generativity, representation and communication developed. They were the source of the cognitive framework for speech [4]. They also entail sequential learning and processing and, hence, following the ideas of Christiansen [20] probably served as pre-adaptations for speech.

Justification for regarding the mimetic skill set Donald [4] identifies as preverbal proto-languages is that each one possesses its own unique primitive form of semantics and syntax. The semantics of manual praxis or tool making and tool-use are the various components that go into making of the tool, i.e., the materials and the procedures needed to create and use the tool. The tools themselves become semantic elements in the preverbal proto-language of tool use. The syntax of tool making and tool-use is the order or sequence in which the procedures for making and using the tools are carried out. If the correct order or sequence is not adhered to then the task to be completed will not be accomplished.

In *The Sixth Language* [30] we postulated that a new language emerges when there is some form of information overload. What was the chaos or information overload that led to the emergence of the preverbal proto-languages we just described? Perhaps it was the flood of extra information that the earliest hominids had to deal with in order to survive as bipeds in the savanna where the protection of living in the tree tops was no longer available. Tools were created to deal with the new challenges of living at ground level where there were far more dangers than in the tree tops.

The skills associated with tool making presumably led to the control of fire and to transporting it from one site to another. The control of fire in turn contributed to new and more complex social structures as nuclear families banded together to form clans to take advantage of the many benefits that fire offered such as warmth, protection from predators, tool sharpening, and cooking, which increased the number of plants that could be made edible, killed bacteria and helped to preserve raw foods such as meat. These larger social structures bred a new form of information overload because of the increased complexities of social interactions and organization. In this environment a new preverbal protolanguage of social interactions emerged with its semantics of social transactions, which included greetings, grooming, mating, food sharing, and other forms of co-operation appropriate for clan living. The syntax of the social organization or intelligence included the proper ordering or sequencing of these transactions in such a way as to promote social harmony and avoid interpersonal conflict, and, hence, contribute to the survival and development of hominid culture.

As the number of people one had to deal with to share the benefits of the hearth increased and as more sophisticated activities were required to manage the hearth a new information overload emerged that led to the need for better communications to better co-ordinate social transactions and co-operative activities involved in the sharing of fire, the maintenance of the hearth, food sharing, and large scale coordinated hunting and foraging. From the chaos of this complexity emerged the preverbal proto-language of mimetic communication.

The semantics of mimetic communication, the third preverbal proto-language, consisted of the following elements: the variety of tones of non-verbal vocalization, facial gestures, hand signals and miming actions (or body language). The syntax of this form of communication is the sequencing and co-ordination of these elements. Combining a gesture and a vocal tone would have a different meaning than the same tone followed by the gesture after some delay or the gesture followed by the tone. As the syntactical complexity of mimetic communication grew and became more sophisticated it set the stage for the next development in hominid communication, namely, verbal language in the form of speech, which vestigially incorporates the elements of mimetic communication. It is not the literal meaning of words alone, which convey the message of spoken language but the tone of the words, the way they are inflected, as well as the facial gestures, hand motions and body language that accompany them.

Embedded in the syntax of each of the three preverbal proto-languages of tool making, social intelligence and mimetic communication there are generative grammars that allow:

1. different ways of articulating tools and manual praxis to carry out a variety of new tasks as new challenges arise;
2. the creation of new forms of co-ordination and social cohesion to meet the infinite variety of challenges life presents including the navigation through different forms of social conflict, the variety of which is endless;



3. the expression of a large number and shades of meaning and feelings through mimetic communication. Starting with the manufacture and use of tools hominids began to develop the capability of generativity essential for verbal language. Employing the correct syntax of the preverbal proto-languages, i.e. doing things in the proper order or sequence served as the pre-adaptation for the generative grammar of verbal language. This model supports Chomsky's theory [31] that humans possess a generative grammar that makes the rapid and universal acquisition of speech by young children possible. It also provides an alternative explanation to Chomsky's notion that the generative grammar is somehow magically hard wired into the human brain.

Merlin Donald's [4] work suggests that the generative grammars for the preverbal proto-languages of tool making (or manual articulation), social organization (or social intelligence) and mimetic communications served as a pre-adaptation for the generative grammar of spoken language.

Mimetic skill represented a new level of cultural development, because it led to a variety of important new social structures, including a collectively held model of the society itself. It provided a new vehicle for social control and coordination, as well as the cognitive underpinnings of pedagogical skill and cultural innovation. In the brain of the individual, mimesis was partly the product of a new system of self-representation and mostly the product of a supramodular mimetic controller in which self-action may be employed to 'model' perceptual event representations. Many of the cognitive features usually identified exclusively with language were already present in mimesis: for instance, intentional communication, recursion, and differentiation of reference. (ibid., p. 199-200).

The model for the emergence of language presented here is based on Donald's work with the added twist that I believe that speech is concept-based and emerged as a bifurcation from the percept-based preverbal proto-languages we have just identified. My model for the origin of verbal language, which I have just outlined was developed in [1] and, for the most part, grew out of my previous work [30,32] with the evolution of notated language plus my reading of Merlin Donald's Making of the Modern Mind.

Deacon's [19] The Symbolic Species also suggests an association of the emergence of speech with tool making:

The appearance of the first stone tools nearly 2.5 million years ago almost certainly correlates with a radical shift in foraging behaviour in order to gain access to meat. And this clearly marks the beginnings of the shift in selection pressures associated with changes in the brain relevant for symbolic communication (ibid., p. 386).

Deacon does not make use of the concept of social organization or intelligence, but he does introduce the notion that changes in the social dynamics of hominids led directly to symbolic communication and that marriage itself was one of the first forms of symbolic communication in which the parties to the marriage were themselves symbols.

The near synchrony in human prehistory of the first increase in brain size, the first appearance of stone tools for hunting and butchery, and a considerable reduction in sexual

dimorphism is not a coincidence. These changes are interdependent. All are symptoms of a fundamental restructuring of hominid adaptation, which resulted in a significant change in feeding ecology, a radical change in social structure, and an unprecedented, (indeed, revolutionary) change in representational abilities. The very first symbol ever thought, or acted out, or uttered on the face of the earth grew out of this socio-economic dilemma, and so they might not have been very much like speech... Marriage is not the same as mating, and not the same as a pair bond. Unlike what is found in the animal world, it is a symbolic relationship....Symbolic culture was a response to a reproductive problem that only symbols could solve: the imperative of representing a social contract....The symbol construction that occurs in these ceremonies is not just a matter of demonstrating certain symbolic relationships, but actually involves the use of the individuals and actions as symbol tokens. (ibid., p. 400-401; 406).

While Donald speaks of speech emerging from mimetic communication, Deacon, in a slightly different tack, sees speech as assimilating these features and co-evolving with them.

With the final achievement of fully articulate speech, possibly as recently as the appearance of anatomically modern Homo sapiens just 100,000 to 200,000 years ago, many early adaptations that once were essential to successful vocal communication would have lost their urgency. Vestiges of these once-critical supports likely now constitute the many near-universal gestural and prosodic companions to normal conversation. (ibid., p. 364).

Deacon [19] or Donald [4,5] each provides a plausible model for the relationship between tool making, social organization and mimetic communication and speech. There is no scientific criterion for making a choice. It is difficult if not impossible to falsify their propositions because data from the events they describe is so scarce. We must resort to the Kuhn's [33] notion that the choice of rival descriptions will have to be based on what the reader finds most compelling.

#### **FROM PREVERBAL PROTO-LANGUAGE TO PROTOTYPE: THE ORIGINS OF TECHNOLOGY, COMMERCE AND THE ARTS**

The human mind does not reside totally in the brain. It extends out from the brain and one of those extensions is human culture. The three percept-based preverbal protolanguages we have identified gave rise to more than just spoken language and conceptual thinking. Transformed by verbal language and concept making that followed in their wake, they also served as the prototypes for three fundamental activities that form the core of human culture, namely technology which emerged from tool making; commerce which emerged from social organization and intelligence; and the art forms which emerged from mimetic communication. "There is a vestigial mimetic culture embedded within our modern culture and a mimetic mind embedded within the overall architecture of the modern human mind (ref. [4], p. 162)." The hypothesis that human culture can be seen as the combination of mimetic culture with verbal language is somewhat speculative, but it

certainly contains some elements of truth. It is presented as a probe to stimulate thought, dialogue and debate.

### **MANUAL PRAXIS: FROM TOOL MAKING TO HIGH TECH**

The skills that early hominids used for making and using tools, which developed before the advent of speech, is still very much a part of the repertoire of modern humans. Generative manual praxis laid the foundation for the creation of human technology. However, with the advent of the verbal language of speech and the evolution of the notated forms of language, namely, writing, math, science, computing and the Internet, technology has evolved into progressively more sophisticated forms of high tech which are hybrid systems which combine percept-based manual praxis with language-based conceptualization. Studies of the evolution of language such as Basalla's [34] book *The Evolution of Technology* point out that all tools and all forms of technology evolve through a process of descent and modification: "Any new thing that appears in the made world is based on some object already in existence (*ibid.*, p. 45)." He cites many examples of how innovative technologies borrowed significantly from earlier technologies citing the cotton gin, the electric motor and the transistor as three examples. Vestiges of pure manual praxis remain in certain forms of traditional technology such as the knife and the ax whose design remains basically the same as that of early hominids and emerged over a long period of time from percept-based trial and error. A scientific analysis of these tools would reveal that they had achieved an optimum design long before the advent of modern engineering.

### **COMMERCE AS A FORM OF SOCIAL ORGANIZATION AND EMOTIONAL INTELLIGENCE**

Another example of a percept-based vestigial cognitive structure, which is still very much part of human intelligence is social or emotional intelligence. The social intelligence that early hominids developed found some of its first applications in the maintenance of the hearth and in large scale co-ordinated hunting and gathering. These skills eventually found their way into other forms of human commerce. Social or emotional intelligence is the basic building block of all forms of commerce. What is commerce after all? It is essentially the co-operative activities that a group engages in for the purposes of acquiring the necessities of life and ensuring the mutual survival of the group as a whole. The basic unit of cooperation and commerce is the family, a unit that can be traced back to our hominid ancestors.

Johnson and Earle [35] also regard the family as a universal and integral institution of all human cultures:

So resilient and adaptive is the family group that it has survived the most momentous changes in the economy and society, changes that in some cases reach to the heart of the family economy. Family groups remain the basis of the subsistence economy, as primary units of production and consumption, at all the evolutionary levels we have discussed... The social organization of the family group is based on the nurturance and trust generated in the daily give and take of family life. (*ibid.*, p.315).

Riding a wave of optimism for a future classless society, the Maoists attempted to convert China's family-based economic and social relations to a system characterized by collectivization and direct state control. They failed; and their failure bears out one message of this book, namely that self-serving individuals and families, far from being the recent products of a depraved capitalism, are the fundamental economic unit in all societies. (*ibid.*, p.291).

Commercial transactions are entered into voluntarily by all the players involved because it benefits each of them. Any other transaction in which only one party benefits is not commerce but some form of exploitation such as theft, fraud, exploitation or enslavement. According to our definition commerce does not necessarily involve the use of money and should not be confused as being solely the money economy. Commerce does not depend of money but is a system of cooperation for the gathering, production and distribution of goods and services essential to survival. Commerce entails trade whose roots can be traced back to the earliest forms of social organization and food sharing when the specialization of tasks first emerged. The co-operation of individuals who performed specialized tasks for the good of the community laid the foundations of trade and commerce. This form of trade and commerce did not, however, entail a notion of a money-based market, which requires the concept of monetary value to operate. Before speech and conceptualization there was no way of computing the value of the goods and services that were exchanged. No one counted or kept score. Those societies where individuals were generous had a better chance of survival than those whose members were selfish.

Before the advent of speech, the commerce of hominids was a percept-based activity based on hunting and gathering. Percept-based hunting and gathering was transformed over the years by the spoken word and conceptual thinking into a more sedentary form of commerce based on animal husbandry and/or agriculture.

The emergence of the industrial form of commerce can be traced to three developments that took place in Europe towards the end of the Middle Ages, namely the evolution of agriculture into the manor system in which agricultural products were transformed in a systematic way to commodities, the rise of a market system for the distribution of these agricultural products and commodities and the transformation of technology into a systematic form of engineering through the rise of the science of mechanics. The industrial system arose by combining new forms of social organization with the abstract conceptual skills of engineering, science and mathematics.

The Information Age economy, another hybrid system of commerce, arose from the development of the computing, which gave rise to new forms of social organization. We are on the threshold of a still newer form of commerce known as the knowledge economy, which differs from the Information Age economy in that the focus is on the sharing and management of knowledge rather than information. Information is structured or contextualized data, which gives it more meaning but knowledge is the ability to exploit information to achieve one's objectives. The Knowledge Era will require greater co-operation, collaboration and sharing than was the case in the Information Age or the Industrial

Era both of which were based on the hoarding of proprietary knowledge [36].

### THE FINE ARTS AND FINE MOTOR SKILLS

The roots of the fine arts can be traced to percept-based mimetic communication whose basic elements were prosody (the tones of vocalization), facial gesture, hand signals and mime (or body language). The very first art forms were all non-verbal and grew out of mimetic communication, the third preverbal proto-language. They included music, painting, sculpture and dance all of which were a part of ritual. Music can be traced to the variation of tone and rhythm and hence to prosody. Dance is basically a form of body language set to music. The first forms of painting were body and face painting and the first forms of sculpture were masks and costumes, which can be seen as attempts to enhance and intensify facial gesture and mime. With the advent of spoken language new hybrid forms of the arts emerged, which combined mimetic communication with words to produce modern (post-verbal) art forms such as poetry, which includes both words and prosody, songs which combine words and music and theater, which combines words with mime and dance.

### A GRAND UNIFICATION MODEL OF HUMAN THOUGHT AND CULTURE

Spoken language gave rise to a number of concept-based cultural forms such as story telling or narrative, writing, mathematics, science and computing. Speech also transformed a number of earlier forms of percept-based activities to generate new hybrid forms of human culture including science-based technology; agricultural, the arts, industrial and computer based forms of commerce. Our model for human cognition combines the three percept-based preverbal proto-languages of manual praxis, social intelligence and mimetic communication with concept- and language-based skills associated with the six verbal languages of speech, writing, math, science, computing and the Internet. This approach provides a common link for activities that are often treated as quite independent of each other, namely, commerce, technology, the arts, and science and results in what might be regarded as a Grand Unification Theory of Human Thought and Culture.

### THE ORIGIN AND EVOLUTION OF THE EXTENDED MIND

We have examined the role that language has played in the development of the mind, human thought and culture by combining ideas on the nature and function of language, the concept of bifurcation from chaos theory and Merlin Donald's [4] notions of evolutionary psychology. Building on these ideas we will now tackle the age-old question of the relationship of the human mind and the brain. For some psychologists this is a non-problem as they believe that the brain and the mind are synonymous, just two different words to describe the same phenomena, one derived from biology, the other from philosophy. For others there is a difference. Some define the mind as the seat of consciousness, thought, feeling and will. Those processes of which we are not conscious, such as the regulation of our vital organs, the reception of sense data, reflex actions, and motor control, on

the other hand, are not activities of our mind but functions of our brain.

There is no objective way to resolve these two different points of view, however, I believe that a useful distinction can be made between the mind and the brain based on our dynamic systems model of language as the bifurcation from concrete percept-based thought to abstract concept-based thought. I, therefore, assume that the mind came into being with the advent of verbal language and, hence, conceptual thought. This transition did not occur with the first emergence of words when spoken language contained a modest lexicon but no syntax. I believe the transition to the human mind took place with the emergence of syntax approximately 50 to 100 thousand years ago, which allowed for full generativity and the ability of language to represent all aspects of the world. Before this hominid utterances were only signals and not a generative form of language.

Syntactilized verbal language extended the effectiveness of the human brain and created the mind. Language is a tool and all tools, according to McLuhan [10], are extensions of the body that allow us to use our bodies more efficiently. I believe, that language is a tool which extended the brain and made it more effective thus creating the human mind which I have termed the extended mind. I have expressed this idea in terms of the equation: mind = brain + language.

It was the following passage from McLuhan's [10] book *Understanding Media* that inspired this hypothesis:

It is the extension of man in speech that enables the intellect to detach itself from the vastly wider reality. Without language, Bergson suggests, human intelligence would have remained totally involved in the objects of its attention. Language does for intelligence what the wheel does for the feet and the body. It enables them to move from thing to thing with the greatest ease and speed and ever less involvement. Language extends and amplifies man but it also divides his faculties. His collective consciousness or intuitive awareness is diminished by this technical extension of consciousness that is speech.

When I speak of language as extending the brain into a mind this occurred at the very initial emergence of language as speech. But as new forms of language evolved they too became extensions of the brain. Therefore writing, math, science, computing and the Internet, like the spoken word, are all part and parcel of our minds. A number of authors [10,24,30,37,38] have shown how the mind of the literate person differs from that of the non-literate person.

The human mind is the verbal extension of the brain, a bifurcation of the brain, which vestigially retains the perceptual features of the hominid brain while at the same time becoming capable of abstract conceptual thought. Bickerton (ref. [12], p. 150) reaches a similar conclusion and makes a distinction between a 'brain-state' and a 'mind-state.'

Andy Clark also developed the notion of 'the extended mind [39,40].' The emergence of syntactilized language also represents, for me, the final bifurcation of hominids from the archaic form of *Homo sapiens* into the full-fledged human species, *Homo sapiens*. Crow (ref. [41], p. 93) reaches a similar conclusion. He points out that pictorial art

demonstrating a capacity for representation, an essential element of human language, can only be traced back to around 90,000 years ago and was absent for both Neanderthal and Homo erectus. Citing Stringer and McKie [42], he concludes, “The parsimonious conclusion (because it links the distinctive characteristic of the species to its genetic origin) is that the origin of language coincided with the transition to modern Homo sapiens dated to somewhere between 100,00 and 150,000 years ago.”

Humans are the only species to have developed verbal language and also to have experienced mind. This is not to deny that our ancestors, the earlier forms of hominids, experienced thought. Their thought patterns, however, were largely percept-based and their brains functioned as percept processing engines operating without the benefit of the abstract concepts which only words can create and language can process. It follows that animals have brains but no minds and that the gap between humans and animals is that only humans possess verbal language and mind.

In summary, the emergence of language represents three bifurcations:

1. the bifurcation from percepts to concepts,
2. the bifurcation from brain to mind, and
3. the bifurcation from archaic Homo sapiens to full fledged human beings, Homo sapiens.

These three bifurcations are not necessarily simultaneous. Bickerton claims [11,12] that protolanguage in which the first words were used symbolically emerged with Homo erectus which means the first bifurcation can be dated to approximately 2 million years ago. The second and third transitions, on the other hand, can be dated to the emergence of fully syntactilized language, which occurred only 100 to 150 thousand years ago and seems to be correlated with the explosion of human culture and technological progress of that time period (ref. [12], p. 65).

### NEO-DUALITY

The distinction we have made between the brain and the mind is based on a dualistic notion that recognizes that there are phenomena that are materially instantiated and that have extension and physicality and that there are phenomena such as language, culture, science, mathematics and the mind xx that are (separate that from are) xx not material and have no extension. Descartes designated the physical material domain as *res extensa*, which we prefer to call the *physiosphere*. The other domain, which is purely symbolic or conceptual and is not made of material stuff and as a consequence has no extension. Descartes designated this domain as *res cogitans*, which he claimed contained all of human thought as well as certain spiritual things such as soul and God. We prefer to regard the non-material domain as the *symbolosphere*, which was first formulated by John Schumann [43,44] together with his colleague Namhee Lee [45]. The *symbolosphere* is equivalent to Descartes *res cogitans* but does not contain spiritual elements such as soul and God. In the neo-dualistic approach that was developed by Logan and Schumann [46] we placed the brain in the *physiosphere* or *res extensa* and the mind in the *symbolosphere*. The *symbolosphere* includes language, which is seen as a cultural artifact; that “is neither of the

brain nor in the brain [45].” It is not transmitted biologically but rather culturally and “exists as a cultural artifact or technology between and among brains (*ibid.*)” It is an artifact that is invisible and non-material and hence is not part of the biosphere but rather forms part of the *symbolosphere*, which includes all forms of symbolic communication including such things as written language, mathematics, science, music and the arts. In other words it contains all the products of the human mind.

Schumann argues that humans live within the *symbolosphere*, which influences their lives as much as the biosphere and hence introduces a duality between these two spheres of influence on human existence. He suggests that a distinction should be made between the brain and the mind “because there is an implicit recognition that aspects of mental life take place, not only in the physical brain, but also in some nonphysical medium. Could this mind actually be the *symbolosphere*?” asks Schumann [44].

The *symbolosphere* is embedded within the *semiosphere*, the set of all signs, whether they are iconic, indexical or symbolic. The *symbolosphere* includes all of the phenomena mediated by symbols and hence includes all abstract human thought and communication. Embedded within the *symbolosphere* one can imagine a *memeosphere* or *culturosphere*, the set of all memes or cultural replicators. The complement to the *semiosphere* and the *symbolosphere* is the *physiosphere* within which is embedded the biosphere.

Schumann and I in discussing our respective approaches to understanding the origin of language realized that our approaches both embraced a form of dualism, which in most scientific circles would be scoffed at. We felt rather than a weakness that properly formulated as neo-dualism that this idea had merit.

Descartes formulation of duality is known as substance dualism in which two types of substances, *res extensa* and *res cogitans*, are posited. Logan and Schumann [46] believe, however, that a property dualism is a more appropriate description of the mind/brain system. We therefore posited that “the human brain can have two sets of properties, one physical made of flesh and blood and the other mental composed of thoughts and consciousness (*ibid.*, p. 207).”

We believe that this philosophical debate between substance and property dualism is not amenable to a scientific resolution. Since we do not understand the relationship between the physical events that take place in the brain and the emergence of thought it is folly to try to speculate as to whether they are the same substance. At our present level of understanding the only practical way to deal with understanding the nature of human mentality is to describe the activities of the brain on the one hand and of human thought and emotions which make up the human mind on the other hand and try where possible to find links between these two levels of phenomena, namely the physical brain and human thought and emotion.

### IS THE BRAIN HARD WIRED FOR LANGUAGE?

There are two mysteries of human language that divide the linguistic community, namely an explanation for why young children can pick up their parents *res* language without ever being taught how to speak and, secondly, an

explanation of why the grammar of all 6,000 languages on earth share a common grammatical structure, which was first identified by Noam Chomsky [31] as Universal Grammar (UG).

Chomsky's explanation for these two facts is that we are hard wired for language as a result of a lucky genetic modification:

The brain that evolved might well have all sorts of special properties that are not individually selected; there would be no miracle in this, but only the normal workings of evolution. We have no idea, at present, how physical laws apply when 10 billion neurons are placed in an object the size of a basketball, under the conditions that arose during human evolution. It might be that they apply in such a way to afford the brains that evolved (under selection for size, particular kinds of complexity, etc.), the ability to deal with properties of the number system, continuity, abstract geometrical space, certain parts of natural science, and so on. There are innumerable problems here, but I see no need to appeal to miracles. Nor do the problems that arise seem qualitatively different from familiar problems in accounting for the evolution of physical structures in organisms. (ref. [31], p. 418).

Morten Christiansen's [20] proposed another alternative to Chomsky's hard-wired hypothesis consistent with the Extended Mind model when he suggested that language could be considered as an organism that evolved to be easily learned especially by children despite the poverty of stimulus problem. In a later paper with his colleagues he wrote:

Languages exist only because humans can learn, produce, and process them. Without humans there would be no language. It therefore makes sense to construe languages as organisms that have had to adapt themselves through natural selection to fit a particular ecological niche: the human brain. In order for languages to 'survive', they must adapt to the properties of the human learning and processing mechanisms. This is not to say that having a language does not confer selective advantages onto humans. It seems clear that humans with superior language abilities are likely to have a selective advantage over other humans (and other organisms) with lesser communicative powers. This is an uncontroversial point, forming the basic premise of many of the adaptationist theories of language evolution. However, what is often not appreciated is that the selection forces working on language to fit humans are significantly stronger than the selection pressures on humans to be able to use language. In the case of the former, a language can only survive if it is learnable and processable by humans. On the other hand, adaptation toward language use is merely one out of many selective pressures working on humans (such as, for example, being able to avoid predators and find food). Whereas humans can survive without language, the opposite is not the case. Thus, language is more likely to have adapted itself to its human hosts than the other way around. Languages that are hard for humans to learn simply die out, or more likely, do not come into existence at all (ref. [22], p. 144-145).

This hypothesis at once explains why grammars are universal and are easily learned by children without the need of a hard-wired LAD. It is also consistent with the Extended Mind model for the origin of language and provides a more natural explanation than Chomsky's.

## CONCLUSION

The architecture of the mind and language that we considered in this article is as fascinating and as complicated as the architecture of the brain and language. The architecture of the mind and language exists totally in the abstract domain of the symbolosphere. Describing the architecture of the mind and language required consideration of many additional elements of the symbolosphere including planning, symbolic representation, culture and the many elements of culture including tool making, technology, social intelligence, commerce, mimesis, and the fine arts. The architecture of the mind and language had to be studied in the context of the neo-dualistic philosophical frame formulated by Logan and Schumann [46].

## REFERENCES

- [1] Logan RK. The extended mind: understanding language and thought in terms of complexity and chaos theory. Presented at the 7th Annual Conference of The Society for Chaos Theory in Psychology and the Life Sciences at Marquette U., Milwaukee, Wisconsin 1997.
- [2] Logan RK. The extended mind model of the origin of language and culture. In: Gontier N, Van Bendegem JP, Aerts D, Eds. Evolutionary epistemology, language and culture. Dordrecht: Springer 2006.
- [3] Logan RK. The extended mind: the emergence of language, the human mind and culture. Toronto: University of Toronto Press 2007.
- [4] Donald M. The origin of the modern mind. Cambridge, MA: Harvard University Press 1991.
- [5] Donald M. Mimesis and the executive suite. In: Hurford J, Studdert-Kennedy M, Knight C, Eds. Approaches to the evolution of language. Cambridge: Cambridge University Press 1998; pp. 44-67.
- [6] Vygotsky L. Thought and language. Cambridge MA: MIT Press 1962.
- [7] Gardenfors P. Cooperation and the evolution of symbolic communication. In: Oller K, Griebel U, Eds. The evolution of communication systems. Cambridge, MA: MIT Press 2004.
- [8] Maturana H, Varela F. Autopoiesis and cognition: the realization of the living. In: Cohen RS, Wartofsky MW, Eds. Boston Studies in the Philosophy of Science 42. Dordrecht: D. Reidel Publishing Co (1st edition 1973) 1980.
- [9] Kauffman S. At home in the Universe. Oxford: Oxford University Press 1995.
- [10] McLuhan M. Understanding media. New York: McGraw Hill 1964.
- [11] Bickerton D. Language and species. Chicago and London: University of Chicago Press 1990.
- [12] Bickerton D. Language and human behaviour. Seattle: University of Washington Press 1995.
- [13] Bickerton D. Catastrophic evolution: the case for a single step from protolanguage to full human language. In: Hurford J, Studdert-Kennedy M, Knight C, Eds. Approaches to the Evolution of Language. Cambridge: Cambridge University Press 1998; pp.341-58.
- [14] Bickerton D. How protolanguage became language. In: Knight C, Studdert-Kennedy M, Hurford J, Eds. The evolutionary emergence of language. Cambridge: Cambridge University Press 2000; pp. 264-84.
- [15] Bickerton D. Symbol and structure: a comprehensive framework for evolution. In: Christiansen M, Kirby S, Eds. Language Evolution. Oxford: Oxford University Press 2003; pp.77-93.
- [16] Locke J. Social sound-making as a precursor to spoken language. In: Hurford J, Studdert-Kennedy M, Knight C, Eds. Approaches to

- the Evolution of Language. Cambridge: Cambridge University Press 1998; pp.190-201.
- [17] Levelt WJM. Speaking: from intention to articulation. Cambridge, MA: MIT Press 1989.
- [18] Hudson R. Word Grammar. London: Basil Blackwell 1984.
- [19] Deacon TW. The symbolic species: the co-evolution of the brain and language. New York: W.W. Norton & Co. 1997.
- [20] Christiansen M. Infinite languages finite minds: connectionism, learning and linguistic structure. Unpublished doctoral dissertation UK. Centre for Cognitive Studies, University of Edinburgh. 1994.
- [21] Christiansen M, Devlin J. Recursive inconsistencies are hard to learn: a connectionist perspective on universal word order correlations. Proceedings of the 19th Annual Cognitive Society Conference. Mahwah, NJ: Erlbaum 1997; pp. 160-71.
- [22] Christiansen M, Dale R, Ellefson M, Conway C. The role of sequential learning in language evolution: computational and experimental studies. In: Cangelosi A, Parisi D, Eds. Simulating the Evolution of Language. London: Springer-Verlag 2001.
- [23] Christiansen M, Ellefson M. Linguistic adaptation without linguistic constraints: The role of sequential learning in language evolution. In Wray A, Ed., The Transition to Language. Oxford: Oxford University Press 2002; pp. 335-58.
- [24] McLuhan M. The Gutenberg Galaxy. Toronto: University of Toronto Press 1962.
- [25] Tomasello M. The cultural origins of human cognition. Cambridge, MA: Harvard University Press 1999.
- [26] Dunbar R. Theory of mind and the evolution of language. In: Hurford J, Studdert-Kennedy M, Knight C, Eds. Approaches to the Evolution of Language. Cambridge: Cambridge University Press 1998; pp. 92-110.
- [27] Ulbaek Ib. The origin of language and cognition. In: Hurford J, Studdert-Kennedy M, Knight C, Eds. Approaches to the Evolution of Language. Cambridge: Cambridge University Press 1998; pp. 30-43.
- [28] Prigogine I, Stengers I. Order out of chaos. New York: Bantam Books 1984.
- [29] Prigogine I. The end of certainty. New York: Free Press 1997.
- [30] Logan RK. The sixth language: learning a living in the internet Age. Caldwell NJ: Blackburn Press (1st edition 2000; Toronto: Stoddart Publishing) 2004.
- [31] Chomsky N. Discussion of Putnam's comments. In: Beakley B, Ludlow P, Eds. The Philosophy of Mind. Chp 51. Cambridge MA: MIT Press 1992.
- [32] Logan RK. The fifth language: learning a living in the computer age. Toronto: Stoddart Publishing 1995.
- [33] Kuhn T. The structure of scientific revolutions. Chicago: University of Chicago Press 1972.
- [34] Basalla G. The evolution of technology. Cambridge UK: Cambridge University Press 1988.
- [35] Johnson AW, Earle T. The evolution of human societies: from foraging group to Agrarian State. Stanford: Stanford University Press 1987.
- [36] Logan RK, Stokes LW. Collaborate to compete: driving profitability in the knowledge economy. Toronto and New York: Wiley 2004.
- [37] Havelock E. Preface to Plato. Oxford: Oxford University Press 1963.
- [38] Ong W. Orality and literacy: the technologizing of the word. London and New York: Methuen 1982.
- [39] Clark A. Natural-Born Cyborgs. Oxford: Oxford University Press 2003.
- [40] Clark A, Chalmers D. The extended mind. Analysis 1998; 58: 1023.
- [41] Crow TJ. Candidate gene for cerebral asymmetry. In Wray A, Ed., The transition to language. Oxford: Oxford University Press 2000; pp. 93-112.
- [42] Stringer C, McKie R. African Exodus: the origins of modern humanity. London: Johnathan Cape 1996.
- [43] Schumann JH. The evolution of language: what evolved? Paper presented at the Colloquium on Derek Bickerton's Contributions to Creolistics and Related Fields, The Society for Pidgin and Creole Linguistics Summer Conference Honolulu. University of Hawaii, 2003a; pp. 14-17.
- [44] Schumann JH. The evolution of the symbolosphere. Great Ideas in the Social Sciences Lecture. UCLA Center for Governance 2003b.
- [45] Lee N, Schumann JH. The evolution of language and the symbolosphere as complex adaptive systems. Paper presented at the conference of the American Association for Applied Linguistics, Arlington VA 2003.
- [46] Logan RK, Schumann J. The symbolosphere, conceptualization, language and neo-dualism. Semiotica 2005; 155: 201-14.

Received: September 13, 2009

Revised: October 17, 2009

Accepted: May 18, 2010

© Robert K. Logan; Licensee *Bentham Open*.

This is an open access article licensed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited.