The Computer Metaphor and Cognitive Linguistics
(Métaphore de l’ordinateur et linguistique cognitive)

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SUMMARY

The computer metaphor prevails within cognitive science. It originates in the mathematical computability theory [said the Church and Turing theses (1936), and the Turing demonstration (1937)], and likens, since the invention of the material computer, designed by John Von Neumann in 1945 with the EDVAC¹, the mind to software, and the brain to the hardware of a computer. The advent of the computer strengthens a large group of eminent researchers in the idea that thought and computation are equivalent. In this context, consciousness, free-will, intelligence, imagination, creativity, emotions and, feelings, are left aside, and the focus is put on formal rules combining empty symbols without sound and meaning.

The computability theory is thus the original source of cognitive science. The computer, a concrete materialization of this theory (the abstract Turing machine), was invented some years later, enabling the retroactive and durable corroboration and reinforcement of this analogy between thought and computation. As a matter of fact, it is tangible proof that a machine can implement computations, and thus appears as a solution to the old philosophical problem of the relationships between mind and body. Cognitive science being materialist, the brain is henceforth identified with the hardware of a computer, the link being thus established between the computing mind (the mind-software) and its underlying matter (the brain-hardware). The computer becomes the emblem of all supporters of the computational paradigm. Within this materialist frame, the brain is likened to a digital computer.

¹. In June 1945, John Von Neumann published a paper entitled « First Draft of a Report to the EDVAC », in which he presented all the basic elements of a stored-program computer.
Alan Turing, the designer of the abstract Turing machine, has widely contributed to the promotion of this idea with the famous Turing test\(^1\), where an external observer is unable to differentiate a brain from a computer, e.g. the answers made by a human being, from those made by a machine.

The word « metaphor » has a specific meaning within cognitive linguistics. George Lakoff and Mark Johnson\(^2\) (1980) made the assumption that metaphor is not a simple fact of language, a mere figure of style, but a constant, usual and regular mental process, enabling reasoning and understanding. Metaphor operates at a conceptual level, by automatic and unconscious projection from a concrete source domain onto an abstract target domain, and maps on the latter, all or part of the logic of the former, e.g. all or part of the inferences, deductions and conclusions, it implies. Thus the Darwinian brain is imaginative in essence, and in order to reach the objectivity necessary for any scientific work, the researcher must constantly struggle against this natural and unconscious tendency of the brain to build metaphors. The theory of conceptual metaphor leads to the challenge of the Chomskian model.

As a matter of fact, Chomskian cognitive linguistics adheres clearly to the computational paradigm of cognitive science, and its key-stone is the assertion that syntax is equivalent to computation, implying that the Darwinian brain is formal in essence. This view is the consequence of the metaphors used by Chomsky to build his theory of language: first the automaton metaphor and then the computer metaphor. My endeavor in this thesis is to show how they both influence his theory.

In the interests of clarity, and to synthesize a period of work longer than fifty years, I have classified the different states of Chomskian linguistics in three main phases:

- **First phase** (1957-1981): Generative and Transformational Grammar;


Each phase is influenced by a metaphor:

- **The automaton metaphor**, used in an explicit manner, during the first phase;
- **The computer metaphor**, used in an implicit manner, during the two last phases.

The transition between the two metaphors does not coincide exactly with the end of the first phase and the beginning of the second, as they are delimited above. *We can consider that the computer metaphor comes into force as soon as 1975 in Reflections on Language*, where Noam Chomsky reinforces the initial innateness hypothesis, by asserting henceforth that language is a genetically determined organ, thus using the metaphor of the genetic « program », inspired by the computer.

Thus Noam Chomsky proposes an innest theory of language and uses, in his first work, the automata theory, originating in the computability theory, as an instrument to formalize natural languages. Language is mechanized, treated as the formal languages of logicians and computer scientists.

The aim of *Syntactic Structures* (1957) was to develop a formal grammar, e.g. to propose a precise description of the rules able to generate all and only the well-formed sentences of a language.

As from 1965, Noam Chomsky initiates the cognitive turn with *Aspects of the Theory of Syntax*. He gives a psychological and biological dimension to his approach. **The innateness hypothesis transforms his initial formal theory into a cognitive theory of thought.** He thus opens the way to cognitive linguistics. *The formal mechanism is « transplanted » in the biological brain.*

*Aspects of the Theory of Syntax* introduces a second metaphor, the computer metaphor. The assertion « Language is innate », implies the notion of a genetic « program », directly inspired by the notion of a computer program. This second metaphor remains latent until 1975 (*Reflections on Language*) where language is assimilated to a genetically determined organ: **Universal Grammar** which gives an explanation of the acquisition of linguistic competence. Without this hereditary « software », human beings would not be able to speak nor learn to speak. This mental organ is supposed to develop as a physical organ. Noam Chomsky speaks of the « maturation » of the linguistic organ. Thus the child does not learn his mother tongue. **Competence** is the fruit of the innate Universal Grammar, and thanks to it, the child acquires his mother tongue without effort. Syntax is defined as the main field of investigation of the language faculty. This theory delimits at once a perimeter of research deemed adequate. Semantics, phonology, pragmatics, are relegated in interpretative components, modules or interfaces.
The plan of this thesis is as follows:

**In the first part**, I describe the genesis of the computer metaphor, by presenting:

- In a general introduction, the main concepts enabling the clarification of the title of this thesis (among others, the computational and connectionist paradigms of cognitive science, respectively illustrated by the computer and brain metaphors, then an outline of what is cognitive science in general, and Chomskian cognitive linguistics in particular);
- The historical frame and the main paradigms of cognitive science;
- The computability theory (results of Kurt Gödel, Alonzo Church and Alan Turing), which is the mathematical source of the automaton and computer metaphors;
- The links that this theory implies between logic and machine, and between mind and machine;
- The conceptual metaphor theory of George Lakoff and Mark Johnson (1980, 1999) and of Mark Johnson (1987);

**In the second part**, I begin with a critical survey of Noam Chomsky’s main hypotheses, by presenting the major arguments he proposes against behaviorism, structuralism and empiricism. In particular I propose an epigenetic approach against the innest argument, and question one of the fundamental premises of the innateness hypothesis, the so-called argument from the poverty of the stimulus, which implies that syntax could not be learnt by experience. I suggest that it is unnecessary to resort to genome, if we consider syntax, not as a set of formal rules, but in the manner of Ronald Langacker, as a set having schematically a semantic and phonological content. In this context, core grammar arises epigenetically, with biological and environmental constraints, as the other linguistic elements (lexicon, idioms and periphery grammar). When we suppress the modular and mechanist frame, in which syntax is enclosed, because of the automaton and computer metaphors, this part of grammar, core grammar is easier to learn than the periphery grammar, since it is more regular. If the child needs no special module to acquire the complex elements of his mother tongue, he can do without it for the easier ones.

I then show how Chomskian linguistics, is influenced throughout its history, first by the automaton metaphor, then by the computer metaphor, constantly equating syntax with computation, with a mechanism combining abstract symbols without any perceptual or conceptual foundations. Since Noam Chomsky is materialist, the mathematical automaton, and later the syntactic « software » (Universal Grammar), are both inevitably implemented by the brain, the computer metaphor coming into force by itself.
In the third part, I develop a series of arguments, mathematical, linguistic, psychological, biological and, evolutionist, against the computational paradigm of language and mind.

First, I present the mathematical results of Terence Langendoen and Paul Postal (1984) which show that natural languages are not recursively enumerable sets, and those of Paul Postal (2004) which show that lexicons of natural languages are not a finite collection of items.


I develop arguments to show the interdependence of the different levels: phonologic, semantic and syntactic. A strict dichotomy between lexicon and syntax is not supported by the analysis of language. The idea that syntax is equivalent to computation should produce perfectly regular syntactic forms. But exceptions exist everywhere, even for the most general rules. All languages have particularities mainly linked to the lexicon, and thus syntax is submitted to semantic, phonological and also pragmatic influences. If language analysis shows that syntax can undergo influences, we must wonder how it is possible in the Chomskian theoretical framework, where the latter is totally isolated and where it only combines symbolic forms without phonological and semantic content.

I suggest that the hypothesis of « constructions » as adequate cognitive representations to explain all the facts of language, seems more complete and more compatible with language analysis, with the way a child learns his mother tongue [Michael Tomasello (1992, 2003), Michael Tomasello et al. (1997), E. Lieven, J. Pine and G. Baldwin (1997), E. Lieven, J. Pine and C. Rowland (1998)], and with the biology of evolution [Philip Lieberman (2004)].

I question the notion of disembodied mind, by proposing an embodied cognition, where the human mind is described as fundamentally « literary » [Mark Turner (1996)], this property directly arising from the « literary» nature of human consciousness [Antonio Damasio (1999)].

Then I consider the implications of the computer metaphor with regard to the functioning of the true brain, notably the modular hypothesis describing it as a set of specialized systems, each module being genetically « programmed » to perform a precise cognitive task.
I defend the idea of an embodied mind in its physical and social environment [Merlin Donald (1993, 2002), Humberto Maturana and Francisco Varela (1998), Antonio Damasio (1994, 1999, 2003), Gerald Edelman (1992) Gerald Edelman and Giulio Tononi (2000)]. The cognitive aptitudes of human beings originate in their symbolizing capacity, in their extended consciousness, in their culture, and not in simple unconscious mechanisms, even if conscious knowledge is fed by many unconscious routines, emerging from the organism’s conscious action in its environment. I propose an integrated vision of the mind against a modular one. Consciousness seems to be the bridge which links biology and psychology, and which endows the subject with his free will and his capacity to know. It is an extremely complex set of dynamic processes, the most accomplished fruit of evolution. It is still far from being elucidated, but it is fundamental to define human nature and cognition.

I show, with the works of Merlin Donald, why consciousness is essential to explain cognition and how the mind has evolved in the history of species, going through many stages (episodic, mimetic, mythic and theoretic mind), each retaining the memory of previous states, and how it is possible to pass from a primate brain to the modern-man brain.

I present the results of Francisco Varela’s works on the unity of consciousness. He shows how its unity is achieved, thanks to the synchronous activation of different parts of the brain, during the accomplishment of a cognitive task. This synchronization makes consciousness arise, allowing the fulfillment of a transcendent task that no part of the brain can perform in isolation.

I show, with the works of Humberto Maturana and Francisco Varela, why the nervous system is essential to explain consciousness and cognition. I develop their concept of autopoiesis, which clearly rules out any amalgam between natural and artificial intelligence, and the consequences of the autopoietic theory regarding human knowledge.

I present the TNGS (Theory of Neuronal Group Selection) of Gerald Edelman and Giulio Tononi, which proposes a biological explanation of consciousness, defining the brain as a selective system, and selection as an epigenetic process.
I show, with the works of Antonio Damasio, how consciousness is not a monolithic process, but consists of two superimposed strata: core consciousness\textsuperscript{1}, that we share with other species, on which is based extended consciousness\textsuperscript{2}, properly human, which governs the language faculty. It is a hybrid phenomenon which arises from both biology and culture, because of the brain’s plasticity and its long development \textit{ex utero}, within the frame of conscious experience. The linguistic symbolic thought, a product of extended consciousness, originates in non-symbolic thought made up of images; a product of core consciousness. Thus the language faculty is not independent of other cognitive faculties.

Finally I show that the idea of a perfect syntactic organ, as presented in \textit{The Minimalist Program}, matches poorly the theory and biology of evolution [Philip Lieberman (2004)], and that if the hypothesis of a Universal Grammar is true, we should expect genetic deficiencies of some principles or parameters, depriving some individuals of the total or partial capacity to speak, or to learn a particular language. But this does not happen. We should also expect a reinforcement of the parameters of the mother tongue to the detriment of other languages, in order to facilitate children’s learning. But this does not happen either. A Tibetan child, descending from families speaking Tibetan from time immemorial, will learn Arabic or Russian or any other languages, if circumstances oblige his family to emigrate to another country. He will speak as easily his mother tongue as well as the one of his new country.

In my general conclusion, I recapitulate on the key ideas of this thesis, hoping to have dismissed the idea that the human mind works as a computer, and that human language depends on an innate software-organ. The syntactic mechanisms arise epigenetically, within the frame of consciousness and experience, and their automatization takes place through the use of language as any other motor activities. Without regular practice, there is no automatization. Moreover, we can observe this fact when we learn a second language. If computation can simulate some aspects of the human mind and language, this does not mean that the latter may be reduced to a preprogrammed unconscious mechanism. This idea is rooted in the mathematical computability theory, notably the Turing machine (a mathematical automaton, but also the theoretical basis of the computer), reinforced by the Von Neumann machine (a technological version of the computer).

\textbf{1. Core consciousness according to the terminology of Antonio Damasio, and primary consciousness according to the terminology of Gerald Edelman.}

\textbf{2. Extended consciousness according to the terminology of Antonio Damasio, and high-order consciousness according to the terminology of Gerald Edelman.}
Conclusion: Noam Chomsky is doing Artificial Intelligence

The paradox of Chomskian linguistics is to claim to be a branch of psychology and biology whilst ignoring these disciplines. It claims to be materialist yet, at the same time, ignoring matter, focusing only on the **logical function of the mind** and disregarding the material substrate. Noam Chomsky pretends to make a theory of knowledge, but he only simulates some syntactic regularities with mathematical tools, postulating an automaton, then a software, both unconscious, by way of explanation. **He is thus practicing Artificial Intelligence, but explains nothing regarding the functioning of natural intelligence and language.** However, the brain is not a computer. This inadequate metaphor disregards one of its fundamental properties: consciousness which gives access to knowledge.