Is Modeling the Primary Activity of the Human Brain?

Serge Gelalian
Université Saint Joseph, Beirut, Lebanon

The question we concern ourselves with is how novelists, painters, musicians, sculptors, etc. imagine their surrounding world reality before (and even during) “creating” their work which represents a piece of this reality. In this article, the author focuses on fiction but the reasoning works for all kinds of artistic creations. “We reason only on models”, says Paul Valéry. “We communicate only by models”, echoes Gregory Bateson. We know that there is one major way of modeling in science, which is mathematical modeling. There is also nowadays computer modeling (simulation) for highly complex problems. The modeling that constitutes the frame of this article ties with systems thinking modeling. It is Da Vinci’s “Disegno”, Vico’s “Ingenium: It is an art by which the modeler expresses his vision of reality” (AFSCET (Association Française des Systèmes Cybernétiques, Cognitifs et Techniques) (French Association of Cybernetic, Cognitive, and Technical Systems)). Thus, the author believes that, whatever the definition, modeling is the main cognitive process of the human brain. It allows him to represent reality in a certain “code” or “language”, be it mathematical equations, graphs, novels, poems, paintings, music, sculptures, etc.. If the author focuses here on fiction, it is because it all began most probably with the narrative. The human being, although provided with a powerful tool—the brain, fictionalizes in order to understand reality, which escapes him. So he created myths, legends, tales, sagas, etc., after having drawn wonderful paintings in caves. Fiction is a way of modeling reality in order to acquire knowledge. This way of modeling follows the complex process of schematizing, i.e., producing schemes, i.e., minimal mental models, which are pre-conceptual structured sketches of intuition. This schematizing is based on a mixed complex process of: (1) abduction, which, according to Peirce and others, is the natural way of human reasoning (children use it to acquire language); and (2) simplexity, a way of simplifying complexity without its characteristics being lost. All this cognitive complex process leads to conceptualization (then to categorization).

Keywords: modeling, fiction, narrative function, schema, abduction, simplexity

Introduction

The question first arose after having thought about how novelists imagine their surrounding world reality before (and during) “creating” their work which represents a piece of this reality. This question was then extended to other “producers of art works” such as painters, musicians, sculptors, etc.. Simply put, the question is: What happens in a creator’s mind before and during the process of creation, be he a novelist, a musician, a painter, etc.. To the following question: “How do you make the shape of your piece of work appear from within the stone”? Michelangelo used to answer: “It’s already in there”.

It is while thinking about the novel as a process of representation of reality that the following idea surfaced: Modeling could well be the main process of thought of the human brain. “We reason only on models”, says

Serge Gelalian, Ph.D., Université Saint Joseph.
Paul Valéry. “We communicate only by models”, echoes Gregory Bateson. What could this mean besides that there exist many kinds of modeling on the cognitive level: mathematical, schematic, graphical, etc.. Could this mean that there is a modeling prototype, hence a modeling archetype? The answer to this question is far from simple. The author suggests in this article a way of opening the subject with an attempt to find an answer based mainly on human oral and textual productions, without neglecting other productions such as the graphical or the schematic ones. The major objective is to:

(1) Examine the various types of narrative ranging from myth to advertising including tale, saga, legend, etc.;

(2) Examine the various types of scientific representation such as mathematics, physics, and chemistry, but also computer languages, by focusing primarily on the concept of algorithm which is common to all;

(3) Examine artistic works such as music, paintings, sculptures, and sketches.

But examining all those topics would constitute a large program and cannot be tackled in a short article. The author will thus examine briefly some of the examples mentioned above within the general frame of modeling.

What Is Modeling?

The modeling the author is referring to is akin to the systems’ thinking modeling, thus to that of complexity science. It is a technical process leading to a construct (in Levy-Strauss’ sense)—the “model”, i.e., the matching counterpart of complex reality—that is designed to reproduce the perceived reality in order to better understand it, or even to act upon it. Nowadays, a model can be studied on computers (elaboration and simulation) and does not need to be the object of a mathematical demonstration since it just reflects reality or its best possible rough copy.

Here is a personal definition of a system: “A system is an organized whole, composed of interacting components that generates emergent properties that cannot be predicted from the properties of the components of that system”.

Let us recall here that a system is often complex because it is composed of many autonomous components related by non-linear relations. These interrelations make the system’s behavior unpredictable as it is not the result of the sum of each component’s behavior, hence the phenomenon of emergence in a complex system. A simple example would be water: The result of combining two gases—hydrogen and oxygen—is not a gas but a liquid.

Let us keep in mind that systems do not exist in our surrounding reality. Systems are mental constructs that we design to better understand aspects of our environment (nature, society, politics, economy, etc.) that we perceive as being highly complex—but not complicated—and not easily grasped by way of the analytical method, even if this method led to great progress in science. This is why system’s thinking came into being: to help one grasp complex systems. Its core method is modeling.

The construct mentioned above is a model of a piece of reality. It is a kind of reduced dummy of reality used to better understand and predict the evolution of a system one is studying. Thus, modeling is first and
foremost a scientific method. But, the author believes that, as do Paul Valéry, H. A. Simon, P. N. Laird-Johnson, and many others, that modeling is in fact the main cognitive process of the human brain and that it comes in many shapes, its main one being mathematical modeling.

Scientific theories are usually expressed by means of mathematics. Ivar Ekeland, a Norse mathematician, defines modeling as follows: “(an) intellectual construct of a mathematical model, i.e., a network of equations supposedly intended to describe reality”. It is of course a definition of mathematical modeling.

But there are other definitions of modeling. The definition of the group AFSCET⁴ says: “Modeling is an art by which the modeler expresses his vision of reality”. It is a constructivist way. J. L. Le Moigne, in his article “La modélisation est désormais notre mot-clé”⁵, defined modeling as “a process of intentional construction which represents, by means of a system of symbols, a perception of an experience of reality perceived by the modeler”⁶. Finally, in a book on the implementation of modeling (Le Moigne, 2004), Le Moigne said: “Modeling is constructed as a point of view matched on reality” (p. 118).

This way of modeling mentioned here is that of Leonardo da Vinci, the “Disegno”, or that of G. B. Vico, the “Ingenium”. It makes the poet, the scientist, the musician, the painter, the architect, the novelist, the sculptor, realize that they all proceed in the same way to represent phenomena and events, or to build, design, and elaborate projects. We cannot call it a rigorous method but rather a train of thought that leaves room for intuition, fuzziness, and uncertainty.

When we think, ideas “collide” in disorder as we do not think in a linear way but in a non-linear one: We think in a complex manner, in a networked manner. This is why we need to write down our ideas. Modeling helps us manage this complexity. It cannot be represented linearly or as a tree-like diagram, it can only be represented as a network in which the relations between components are more important than the components themselves, but without the components’ importance being neglected. A good example of this method would be Tony Buzzan’s mind-mapping, which teaches us to draw up a heuristic map of our thoughts. Karl Marx said: “A spider conducts operations that resemble those of a weaver, and a bee puts to shame many an architect in the construction of her cells. But what distinguishes the worst of architects from the best of bees is that the architect raises his structure in imagination before he erects it in reality”⁷.

However, the definition of modeling that best appeals to me that of Henri Planchon in his account “La Modélisation”⁸:

Developing a model is akin to writing a poem where, to better express our emotions, we infringe on some rules in order to bring out an aesthetic that will help us get closer to the unspeakable, to this almost uncovered world that the poet fully lives in while trying hard to share it with others. The poet tries to build what can be shown but cannot be said. Consequently, to read a poem is not only to be in an attentive and listening mood, but it is to penetrate the thought of the poet through ourselves. A poem, like a model, is not grasped as an object: It is shared.

Whatever the definition given, the author believes that the process of modeling is a mental characteristic allowing humans to imagine and to represent reality in a given “language”, be it equations, diagrams, a narrative, a code, etc.. There is thus a mental process (thinking and/or imagining, often both), before the

⁵ “Modeling is henceforth our keyword”, in Edil 26, retrieved from http://www.mcxapc.org.
⁶ Let us keep in mind the word “symbol” which, in itself, is a kind of synthetic modeling.
production of a model, which can take the form of equations, a novel, or a symphony. The author will suggest a little further a diagram of this mental process. But first the author will examine briefly some kinds of modeling.

**Kinds of Modeling**

The author uses the word “kind” instead of “type” in order not to confuse with the classification set by the scientific community, which distinguishes types of modeling although without setting visible borders between them (conceptual type, notional type, etc.). The author distinguishes four kinds of modeling:

1. **Mathematical modeling** covering the scientific areas (physics, chemistry, etc.) where modeling is expressed in mathematical language, i.e., equations;
2. **Narrative modeling**—which matters most here—expressed in natural languages in various narrative forms (myth, legend, saga, tale, poem, etc.);
3. **Graphical modeling** expressed usually in the form of diagrams or drawings (painting, sketch, sculpture, caricature, chart, graph, etc.);
4. **Musical modeling** represented by music: This kind of modeling can also belong to the narrative kind as songs are (roughly) words grafted on a melody.

In order to be consistent with himself, the author ought to begin with the graphical kind, because in the beginning there is reality, the physical world surrounding us. Human beings will create for themselves a pictorial representation of this reality—the image, a model of reality—which, for example, can be found in prehistoric caves. But this presupposes that humans had already sketched these pictures in their minds in some certain form(s). After the graphical kind of modeling, the author ought to continue with the narrative kind because if we go back far in the history of mankind, we encounter myths, legends, fables, etc., which are ways of representing reality. But this chronology would force the author to develop his ideas in a more detailed manner that will overstep the limits of such an article. The author will thus begin with the mathematical kind in order to better set up the concept of modeling reality.

**The Mathematical Kind**

The author will not tackle mathematical modeling which is too specific a field. In the view of this article, mathematics does not constitute a way of modeling reality, since mathematical objects are idealized mental abstractions. As these objects are not really perceived by our five senses, there is thus no cognitive
perception-to-conceptualization course\(^9\). Concepts such as infinity or a mathematical point, do not exist as such in reality. Thus we cannot really talk of modeling reality in this case. Mathematics is a field of abstract knowledge built upon concepts such as numbers, shapes, structures, transformations, etc., with the help of logical reasoning. But let us not forget that calculation, the ancestor of mathematics, dealing with real problems such as trade, population, distances, angles, planets, etc. In the Classical Age, mathematics was a science of order and measure. This does not mean that there is no place for imagination or creation within mathematics. Great mathematicians such as H. Poincaré, or great physicists such as A. Einstein, assigned a large importance to imagination, i.e., visualizing a problem-situation (for example, Einstein’s cosmic elevator, Maxwell’s demon, etc.). Henri Poincaré’s mathematical method consisted of four steps: preparation, incubation, illumination, and verification (following the act of creating of G. Wallas). It was during the periods of incubation and illumination that imagination played the biggest role. The mathematician Wendelin Werner said about his work (Werner, 2010),

Of course, I handle abstract objects, but they strike a chord within my imagination. We associate them to something lived in real life, a bit less abstract than other mathematical objects. … I love to deal with these objects. I find in them something personal, not completely untied from me.

So, when mathematics says:

\[
\sum_{n=0}^{\infty} S_n \rightarrow l = \lim_{k \rightarrow \infty} S_n
\]

it describes the behavior of \(S_n\) by saying that the sum \(S_n\) gets nearer to the limit 1 as \(n\) moves toward infinity; and by writing: \(1 = \frac{1}{2} + \frac{1}{2^2} + \frac{1}{2^3} + \ldots + \frac{1}{2^n}\), we are in the presence of a mathematical modeling regarding real numbers which are pure mathematical objects, i.e., abstract, imaginary objects. But, other scientific fields use mathematical modeling, i.e., a description procedure (a “technique”) of reality by way of mathematical language.

Thus, when physics says:

\[
m \frac{d^2x}{dt^2} = -\nabla f(V)(x(t))
\]

it is a modeling that is nearer to our sense of modeling, since it is an equation representing the trajectory of a particle of mass \(m\) in a field of potential, knowing its coordinates in space with respect to time. We could thus say that modeling requires identifying and selecting relevant aspects of a situation of the real world.

Also, when chemistry says: \(2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2\), it is modeling a chemical reaction where “2 molecules of potassium chlorate break down into 2 molecules of potassium chloride and 3 molecules of dioxygen”. We have here a modeling similar to that of physics: A chemical equation is a language allowing us to describe the reshuffling of atoms in a chemical reaction.

This short explanation of mathematical modeling was a way to show the means invented by man to represent and describe his surrounding environment, i.e., reality. But it took him a bit of time before he reaches this kind of modeling since the Hellenistic Era. Before this era, man uses a way of modeling which is characteristic of his nature and which distinguishes him from animal: language.

\(^9\) According to J. L. Krivine, mathematicians decipher the mechanisms of their own thought by using unconsciously the lambda-calculus which could be our “mentalese”, our brain’s machine language as defined by J. Fodor. By thinking, they just “reproduce calculations that have been brewing since millions of years”. In Science & Vie, No. 1013, février 2002.
When man lacks the tools allowing him to understand the world, he invents ways of explaining reality (see Figure 2). Even if he possesses the most powerful tool—the brain, which is the key of his development, evolution, and progress in many fields, man chooses a specific way of explaining reality that is particular to human kind: stories, such as tales or myths. He thus calls for this or that imaginary entity or force or power to explain phenomena whose meaning escapes him. In order to understand his environment—or rather to make others understand what he has understood—man began most probably to “tell stories” (and before or afterwards he probably engraved them on the walls of caves, which means in both cases that the story was already “carved” in his mind in some form). Man probably began to represent his surrounding environment—to model reality—with the help of fiction because it is a vehicle of knowledge. What does it mean “to know”—anything—other than having of that “anything” an iconic representation, i.e., a more or less precise and multisensory image, or, at higher levels of complexity, a more abstract model.

Why fiction? By borrowing this title from J. M. Schaeffer’s book *Pourquoi la Fiction* (Seuil, 1999), the author intends to say that man, in order to understand the world, imagined, invented, created fictions that later developed and evolved progressively into myths, legends, tales, Eddas, etc., until nowadays advertising without forgetting mathematics. This vision follows from Bernard Victorri’s *Narrative Function* (Victorri, 2006) concerning the origin—or rather the emergence—of human language. According to this hypothesis, the emergence of natural language resulted probably from and during crisis situations in the ancient Hominidae (archaic Homo Sapiens); and language could have been developed—by way of a progressive complexifying process—in order to avoid that the crisis be repeated within the society. This favored social cohesion and the group’s survival. From there to the birth of myths, there is a fine line. And the rest followed.

Protolanguage and language coexisted during a period of time until the extinction of the former. Protolanguage was probably some sort of a functional language with a rudimentary Tarzan-like syntax but with a rich lexis. Language, by borrowing lexis from protolanguage, developed specific features allowing it to become a full-fledged tongue by way of a complexifying process (and sometimes by a simplexifying process, as we will see it later with the modeling process): aspect in expressing temporality, modal verbs, demonstratives (which could be used as diacritics), syntax, polysemy, metaphor, metonymy, etc., many features that protolanguage lacked, which allowed language “to mention past or imaginary events that were not the immediate focus of the speakers”.

---

10 Please excuse this shortcut.
11 In fact, it concerns the passage from protolanguage to language, the protolanguage being a utilitarian system of communication much more rudimentary than language.
An answer to the question asked above could be the following extract from Victorri’s article:

Telling a story means most of the time to pull oneself out of the present situation in order to introduce another spatio-temporal frame, to conjure up real or imaginary characters, make them live, act, think, talk on some kind of a “verbal stage” set in front of an audience by unfolding, more or less quickly according to the needs, the course of a temporality that is fully mastered and that is used to serve the dynamic process of the events that succeed one another on this stage. This latter could in turn move to follow a character or a plot to the ends of the earth if need be. In short, the narrative function needs imperatively the use of all the complexity of languages which turn out to be astonishingly adapted to this exercise, …. But, beyond this fact, the narrative function has many other uses: from the first myths to children’s tales to dreams’ stories to science-fiction novels, it “informs” in a totally other way\(^\text{12}\); by shaping and educating the minds to exercise our imagination, … the narrative played and continue to play an essential role in setting up and permanently renewing the cultural world that characterizes all human societies. Storytelling, far from being an anecdotal activity restrained to leisure, lies at the very heart of these societies’ structuring as it lies on the sharing of common cultural values.

This narrative vision is corroborated by Jean-Guy Meunier in his article “Narration et Cognition” (Meunier, 1993) where he said: “Narration appears to be a representational way by which individuals, as society, organize and interpret their own stature in their environment”. According to Meunier (1993), we can find, on the level of the narrative act, identical features to the general cognitive functions: (1) perceptive functions; (2) praxiological functions; (3) control functions; (4) epitomical functions; (5) ipseical functions; and (6) didactical functions.

Concerning the perceptive functions, Meunier (1993) said,

Narration could be a way among others to set the individual or collective memory of the including and integrative representations of complex perceptions. The narrative could thus be, for the speaker, a way of representing his own perception of the world.

In view of the functions mentioned above—“cognitive models”\(^\text{13}\), according to Catherine Grall (2007), narration appears to Meunier (1993) as,

A process by which a cognitive agent sets her perceptions, develops them in action templates, marks/tags them with norms, weighs up their validity and sets herself as unity; it constitutes thus an original symbolic modality for the adaptation and insertion of a subject in the world vis-à-vis the others and the self.

Grall (2007) added that the cognitive agent whose various representational functions are all activated by his/her narrative performance, shapes simulation valued perceptions.

We could thus say that humans “fictionalize” not only for the sake of fun but above all to learn and know. The little girl who plays with dolls while pretending to be a mother, or the little boy playing cops and robbers, already possesses the faculty of creating a fictional world via her or his imagination, which remains linked to entities and objects of the real world. The child models in her mind—by simplifying unconsciously as she does for language—her future adult world, in order to learn to know and understand it better and hence to adapt to it.

In the same way, the author who invents a story creates a fictional world based on real entities. She is just modeling what the world could be (or could have been or has been) according to her own point of view.

“Fiction is an essential process for thought once it tends to free itself from raw perception”, said H. Wallon\(^\text{14}\).

---

\(^{12}\) Its first way of informing is factual, i.e., factual information, the ground zero of information.

\(^{13}\) The French word is “grille” (grid).

\(^{14}\) In *De l’acte à la pensée (From Deed to Thought)*, Flammarion, Champs, Paris, 1970, p. 142.
Modeling can hence take various forms by relying on a code as is summarized in Figure 3:

\[
\text{Modeling} \rightarrow \text{Code} \rightarrow \begin{cases} \text{symbolic} & \rightarrow \text{mathematical equations} \\ \text{language} & \rightarrow \text{narrative} \\ \text{graphical} & \rightarrow \text{drawings, pictures} \\ \text{acoustic} & \rightarrow \text{music (+ lyrics)} \end{cases}
\]

*Figure 3. Various forms of modeling.*

**Which Kind of Modeling?**

After having briefly stated two kinds of modeling, the mathematical and the narrative, the author will try to define the nature of the process of modeling in the case of artists and authors, and the cognitive process(es) that is/are at stake.

In systemic modeling, the observer (the modeler) is part of the system; her modeling is thus subjective as it is her point of view. Let us take as an example the numerous books on geopolitics on a given topic (say, oil): the points of view (the models) diverge or converge depending on the authors, but they all have a common basis, i.e., modeling. It is not quite the same in mathematics: The results (models) have to converge but the ways leading to the results (modeling) can be different.

Concerning modeling, Henri Planchon said the following\(^{15}\):

> Any perception, any idea creates a mental representation which, if it is thought and “made aware”, can be expressed, conveyed by a modeling. The very fact of wishing to have a written trace of this mental image is part of the process of modeling. Wanting to project our thoughts makes our mind organize itself and model. This progress from fuzziness, i.e., the “flared” shape of our mental modeling, towards clearer ideas through an image whose architecture appears more clearly, is facilitated and done by way of a written and/or an oral production. At this level, the elements are tested, corrected, adapted and above all linked to each other in a way that they form together a coherent whole that is perceptible and that can be grasped globally.

The author believes that the entire process revolves around this “flared shape”, as modeling presupposes that the cognitive agent/subject has already developed a mental representation during the stage of conceptualization. The author thinks that this stage consists of a complex process called “schematizing”, in which the cognitive subject develops quickly and subconsciously two kinds of schemas\(^{16}\). To reach this stage, it seems that the cognitive subject uses a natural cognitive process already “implemented” since her early childhood in order to learn her mother tongue: abduction.

It is the philosopher-logician C. S. Peirce who first discovered this type of reasoning, saying that it is a “weak” kind of reasoning as it lacks the rigor of the other two “strong” types of reasoning which are “deduction” and “induction”. However, Peirce recommended studying abduction as, according to him, it could well be the basis of human perception and because it could be the only type of reasoning allowing new ideas to crop up, thus allowing creation.

According to Peirce, abduction is a type of reasoning where a person, instead of following a logical method (as in deduction by “modus ponens”), infers a previous stage by means of a heuristical process from a


\(^{16}\) The author will explain this word further as it is used with various meanings; but it possesses a common sense from Kant to Piaget to Revault d’Allones and many others even if there are nuances.
Let us briefly present these three types of reason in17, beginning with deduction (or hypothetical-deductive reasoning) which is the most familiar one (Sherlock Holmes is its most perfect representative):

<table>
<thead>
<tr>
<th>Law</th>
<th>All humans are mortal;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case</td>
<td>Socrates is a human;</td>
</tr>
<tr>
<td>Result</td>
<td>Socrates is mortal;</td>
</tr>
</tbody>
</table>

In **induction**, we go on from a **case** and a **result** to infer a **law**:

<table>
<thead>
<tr>
<th>Case</th>
<th>Socrates is a human, as are B. Obama, the Dalaï Lama, you, me;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result</td>
<td>Socrates is mortal;</td>
</tr>
<tr>
<td>Law</td>
<td>All humans are mortal.</td>
</tr>
</tbody>
</table>

In **abduction**, we infer the **case** from the **law** and the **result**:

<table>
<thead>
<tr>
<th>Result</th>
<th>Socrates is dead;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Law</td>
<td>All humans are mortal.</td>
</tr>
<tr>
<td>Case</td>
<td>Socrates was probably a human.</td>
</tr>
</tbody>
</table>

Abductive reasoning is not as rigorous as the other two types of reasoning, as we can infer a wrong case: If Socrates is dead (**result**) and given that all cats are mortal (**law**), we can “abduct” the following **case**: “Socrates was probably a cat”. But, deductive reasoning, with all its rigor, can also lead to absurdities even more mindless than the probabilities resulting from abduction. For example:

<table>
<thead>
<tr>
<th>Law</th>
<th>A rare horse is expensive;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case</td>
<td>Yet, a horse of little value is rare;</td>
</tr>
<tr>
<td>Result</td>
<td>Thus, a horse of little value is expensive.</td>
</tr>
</tbody>
</table>

Abduction allows us to make a general prediction without guaranteeing a clear result. It starts from an observed result, invokes a law, and infers that something could have been the case. It is the kind of reasoning used by speakers of a tongue when they proceed by assumptions based on the data of other grammars and by inferring from these. This is why Henning Andersen says that the acquisition of a language by a child involves the three types of reasoning mentioned above, the most important of them being abduction as it is used the most on the subconscious level.

In the course of acquiring a language, the child builds the grammar of the language she hears around her. In so doing, she interprets it as a result and makes assumptions—by way of heuristics—concerning the structure of this grammar by relying on linguistic rules supposed to be innate; this is the abductive stage18.

The grammar that the child builds progressively is tested in two ways:

1. The child can hear new structures and check whether the grammar she has built so far can reproduce them; this is the **inductive stage**. If this fails, the child will proceed with other abductive innovations;

2. The child reproduces the structures heard, checking thus the grammar she has built with the other speakers; this is the **deductive stage**. If the speakers do not understand her or if they correct her, the child will rectify her grammar.

Abduction can thus be the basis, the grounding, and the **substructure** of human reasoning. Moreover, abduction possesses a specific feature, an asset that the other two types lack. Indeed, vis-à-vis the rigor—thus

---

17 According to some logicians, there exists a fourth type of reasoning, transduction, where we have the possibility to transfer a reasoning from one domain to another provided some degree of homomorphism.

18 It is well known that if a child does not hear a language spoken in her environment, her faculty of language is not activated and she will not acquire any language.
the rigidity\textsuperscript{19}—of deduction and induction, abduction refines with time and experience. Not only the heuristics implement themselves more easily, but they can be easily transferred to another domain. This is called “transduction” (more commonly known as “analog“\textsuperscript{20}). “What the scientist does as explicitly and as completely as possible by reasoning, the active thought does spontaneously, implicitly, and incompletely, yet with partial success” (Piaget visité par la didactique, Vergnaud, 2001/2002).

It thus seems that logical deduction is not the strong point of humans, as it is a method created, developed, and used on a large scale long ago, especially since the 19th century. What we humans are good at is jumping to conclusions after having gathered some bits of proof in order to pull out some fuzzy rule (a schema), which makes us feel that we are on the right track. The schema conveniently allows us to bypass our way of dealing with the details of our surrounding reality, and this saves our energy for other matters. It seems that Zipf’s law works everywhere.

This fuzzy rule—according to the author—seems to be a cognitive process somehow similar to “Ockham’s razor”: simplicity. It is a way of simplifying complexity while retaining its essence but without losing complexity. An approximate analogy to figure out this process would be data compression software: A huge volume of data is “reduced” (compressed, zipped) to save space, but the data is safe. In the simplicity process, volume is replaced with complexity.

Simplicity is not simplicity; it is deeply linked to complexity. To begin with, both words share the same Latin root “plex-”: simplex (lat. “simplexus”) means “with one fold”; complex (lat. “cumplexus”) means “intertwined”. According to A. Berthoz (2009), simplicity is those solutions or mechanisms that Life developed to make its life easier:

… Simplifying rules that reduce complexity and allow us to deal quickly with information or situations by taking into account past experiences and by anticipating the future; those rules make it easier to understand intentions without altering the complexity of reality.

This means that simplicity is in itself a complex process, since in order to deal with complexity, the means used—It is a principle in complexity science—must at least be as complex as the system under study\textsuperscript{21}. The means, however, will have “compressed” the complexity.

Here are some examples to better grasp this process:

Some languages use affixes that express a lot at a time, e.g., the Turkish suffix “mIş” which expresses at the same time the past and some distance of the speaker towards an event (“It probably happened but I am not sure of it”). Some Amerindian languages, lacking verbal forms, possess nominal suffixes expressing at the same time the aspect, the place, and the time. While still on the topic of language, metaphor (not only the figure of speech but G. Lakoff’s conceptual metaphor) allows us to summarize in one sentence a complex situation that would otherwise need a longer explanation. Once again, in language, at the level of tropes, irony allows us to give our opinion in a quick way without expanding into diatribe. Finally, we return to the narrative function with the myth, which as a “detour through imagination, contains realities, synthesized complex relations despite their apparent complexity” (Berthoz, 2009, p. 223). We could say the same for the tale, the fable, the parable, advertising, propaganda, symbols, etc.. Human language seems to contain various

\textsuperscript{19} Usually those two go hand in hand.
\textsuperscript{20} The author personally prefers the term “analogical metaphor”, but the author will not develop this concept further here.
\textsuperscript{21} This concurs with Ashby’s law of requisite variety.
mechanisms using simplexity to convey a message.

Simplexity is thus the means used by the human mind to hold complex information concerning the surrounding world but also to express and convey this information. It is a cognitive process that compresses information and synthesizes it without losing its complexity. What mechanism implements this cognitive process?

The author mentioned earlier Ockham’s razor. Taken from Aristotle (who himself cited Empedocles), Ockham’s razor is in fact a process involving simplexity. As Berthoz said:

… Ockham’s idea is subtle: The abstract shapes of thought—concepts, intentions, similarities with the outside world, the “intellections”—are all mental signs that we have no reason to differentiate from the very act of intellecting. (Berthoz, 2009, p. 211)

The terms “abstract shapes”, “mental signs”, are, within the framework of this article, what Kant and many others name mental schemas, and what Johnson-Laird calls “mental models”. What Berthoz explains in the above-quoted sentence is the mental process called schematizing by R. Estivals (Fr. “schématisation”). It is a subconscious process used by the human mind to simplexify one’s perceptions of the surrounding world. We find, at the basis of this process, the schema (Gr. skéma).

The author will proceed to a “simplexified” explanation of the word schema without developing the concept further, as there are various meanings depending on the philosopher, the logician, or the scientist using it. However, the main structure of all these various schemas is similar.

The schema is a mental framework that can lead to other forms of expression. “The schema is a psychological representation intermediate between the concrete image and the abstract concept”, said M. Piéron.

E. Kant defined the schema as “a general process of the imagination to give an image to a concept” (Emmanuel Kant, Critique of pure reason, AK., A140).

In his article, G. Vergnaud (2001/2002) said:

Revault d’Allones developed the concept of schema many years before Piaget did, by introducing it mainly in a theory of perception and recognition; he even talks about glimpse23, i.e., a process of a quick information grasping, which is inevitably reducing. His idea, already very interesting, is that we organize perceived information in schematic scenes, in silhouettes; psychological phenomena and many other cultural products like proverbs, trade names/signs, logos, prove it.

R. Estivals (2003) believed that the schema is a structured intuition, a pre-conceptual object/phenomenon “which can appear in the consciousness without triggering a verbal expression”. This “pre-symbolic cognitive structure” of the connexionists could be part of our mental language, the mentalese of J. Fodor.

According to J. J. Wunenburger (2005),

… the schema appears…as a sort of sensitive representation, which can be visualized, but which is reduced to an uncertain sketch, whose recourse allows us precisely to lead a concept towards perceptive exemplifications and, inversely, allows us to lead specific perceptions towards a unique categorical referent… The notion of schema thus selects and promotes a special type of representation that is not reduced to the reproduction of a referent, but conveys from it refined, simplified, generic and genetic information.

E. Manguelin (2005) claimed that, “The schema is a power of figuring, a figural matrix, which lies beyond

---

22 In Vocabulaire de la Psychologie, PUF (Presses Universitaires de France), 1963.
23 The French text says “apperception”.

the represented objects. It is creative because, contrary to the image, it exists at the state of pure tendency and
can be constantly reactualized\textsuperscript{24}.

B. Duborgel (2005) based his definition of the schema on Kant’s definition:

This peculiar representation is neither the concept nor the image; the schema is not the specific detailed image, it is its
status of possibility; it lies near the image but beyond it and it lies near the generality of the concept but already beyond it.

Commenting on Kant who said about the schema that it is “an art hidden deep in the human psyche and it
will be very difficult to dig out its mechanism…”, Duborgel clarified that Kant’s metaphor of the monogram
aiming at grasping the schema is important as “The monogram is indeed the condensed and abbreviated
expression of a name, this latter being reduced to some main letters or to a non-scriptural graphical sign that
can serve as a signature”.

In view of the preceding, it can be said that the schema is a \textit{minimal mental mold} implementing a quick
simultaneous process of reduction-organization of information. It is creative, generative, and shaping, i.e., it
gives shape to perceived information. It is probably the crucible, the generating matrix in which and by which
the mixed abduction-simplexity process occurs. It is after this process that thinking (analysis, modeling\textsuperscript{25}, etc.)
takes place.

In order to clarify the concept of schema, the author will give some examples from various fields:

(1) To begin with, Chomsky’s universal grammar can be considered as a schema (even a megaschema) as
it is supposed to be the matrix generating all the grammars of all natural languages. As a proof, we can consider
Creole languages (born from pidgins) and sign languages as that of the deaf children of Nicaragua or that of
Al-Sayyed Palestinian village in the Negev (Israël). In those two last cases, the generation that followed the one
that created the pidgin or the sign language, developed this pidgin or the sign language into a fully-fledged
language, i.e., a language possessing a syntax; the pidgin usually possesses a Tarzan-like arrangement of words.
Also in linguistics, we have in Semitic languages the schema which is a pre-established mold giving birth to
verbal and nominal forms;

(2) In the computer field, the XML (eXtensible Markup Language), a kind of mold-format, can be
translated into another format (doc, pdf, ect.) without losing its pre-established characteristics;

(3) In the Hindu religious field, the mantra can be considered as a phonic schema (vibratory if it is only
“thought” but not pronounced) and the mandala can be considered as a graphic-symbolic schema.

Now, if the schema is the basis of human thought (“To think is to schematize”, said Goblot), this means
that it is a cognitive invariant, some sort of a cognitive substructural framework. In fact, if we consider human
thought, we notice the following:

(1) Human beings have the power of abstraction, the most compelling proof being mathematics: One can
think in the abstract, about the abstract, towards the abstract;

(2) Human beings have the power of imagination, the most compelling proof being fiction created by man
long ago, which gave birth to myths, legends, novels, etc.;

(3) Human beings have the power of analysis, the most compelling proof being the huge progress in all
fields of science.

It goes without saying that these three powers can combine together to form a complex system that allows

\textsuperscript{24} Nowadays we would say “updated” but it is not the adequate word here.

\textsuperscript{25} The author likes the porte-manteau word “modelyze” as he believes that analysis is part of the modeling process.
modeling.

Now, after looking more deeply into the schema, this is what the author deduces:

If (1) it is pre-conceptual (or pre-symbolic); and (2) it is “a general process of the imagination to give an image to a concept”, this means that there are two kinds of schemas:

(1) A first one, “schema i”, intuitive, pre-conceptual, and barely sketched, that leads to conceptualization;
(2) A second one, “schema d”, post-conceptual, definite, and definitive, that sets itself into a shape, an image, a model, and that leads to categorization.

In order to clarify all the above-mentioned ideas, the author suggests Figure 4, which translates what could be—in the author’s view—the representational system of the human being:

![Diagram of representation process]

**Conclusion**

The author has tried in this article to show that the modeling process, as defined at the beginning, is the main cognitive activity of human beings used in the process of mental representation. The author’s starting point was: What is going on in the minds of artists, authors, and other creators? How do they represent to themselves their surrounding world? How do they imagine, invent, and create?

Next, the author divided the modeling process into four kinds and the author looked briefly into two of them: the mathematical kind and the narrative kind. By developing this latter, the author showed that the narrative function was essential for human beings as it stands at the core of their understanding of the world: The human being “fictionalizes” in order to better understand her environment. Fiction is a vehicle for
knowledge and it involves modeling. But there is at first another process that leads to this modeling process: The schematizing process, in which abduction and simplicity mix together and lead to the conceptualizing process.

Scientific modeling is claimed to be objective, and systemic modeling is claimed to be subjective. What about “artistic” modeling, i.e., that of artists, writers, and designers? In view of the preceding, the author would say it is a mix of the first two modeling processes with the personal touch of the artist, and it results in a “modal” modeling process. Thus, the modeling process can take various aspects:

Modeling could be envisaged under other aspects than that of the slaving mathematical models. Trying to model what is… specific to human situations… requires also building… another view to the model than that proposed by mathematics…. The transdisciplinarity invites us to experiment with various modelings producing meaning, being interpretative rather than explanatory, which tries hard to show the various plausibilities that these modelings contain. Henceforth, the power of a model can be revealed just as much by a parable, a story, a poem as by a diagram, a drawing, or equations. (L’Harmattan, 2004)

It goes without saying that this article only skimmed over the concerned topic at hand. But the author believes that this topic could be part of a new theory—or model—of information, containing itself a theory of knowledge that contains a theory of cognition which in turn includes a theory of representation.

References


Meunier, J. G. (1993). *Narration et cognition (Narrative and cognition).* In Duchet & S. Vachon (Eds.), *La recherche littéraire, objets et méthodes (The literary research, objects and methods).* Montréal: XYZ Publisher.


Victorri, B. (n. d.). *Homo narrans: Le rôle de la narration dans l’émergence du langage (Homo narrans: The role of narrative in the emergence of languages).*


Werner, W. (2010). *Les mathématiciens sont des rêveurs (Mathematicians are dreamers).* Sciences Humaines, 221 (dossier: Imaginer, créer, innover (special report: Imagining, creating, innovating)).