

Review

"The Bignetti Model": A Review

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ABSTRACT

Most people believe in the freedom of their will, so they are convinced to decide their own voluntary actions, without being controlled by God, fate, or circumstances. Though, the cognitive success of a learning curve depends on a statistical correlation between the prior experience and the posterior effect. Since long ago, several scientific pieces of evidence denied the existence of free-will (FW). Our scientific work contributed to corroborating the idea that FW might be an illusion of the mind; then, the belief that our conscious mind might exhibit decisional ability without any form of external control, is nonsense. Since that, we may exclude that our conscious mind could host a "soul-inhabited self" or a "ghost of the machine"; if anything, it could host a sort of witness with a specific critical sense towards incoming experiences. Then, the intriguing question was how the mind could anyway exhibit cognition and behavior. Our answer was that our mind emerges from the brain as a probabilistic-deterministic computational machine with a self-oriented, cognitive, autopoietic purpose; to this aim, a virtual Ego-FW binomial is genetically installed in the mind in place of a real, concrete, independent Ego-FW binomial. According to psychophysical "push-no-push" experiments, we observed that learning curves show classic Bayesian behavior, i.e. the positive experience of a trial will ameliorate the further one. Then, we concluded that the action decision mechanism is elaborated by a computational mechanism genetically installed in the brain of all people, while the experience gained in everyday life is the epigenetic force that modifies the memory archive, thus contributing to shaping personal identity (PI). The 1st-person perspective (1PP) and the 3rd-person perspective (3PP) play a crucial role in these processes. 1PP is the emotive, subjective side of the conscious mind; it deludes to decide and control the actions according to the freedom of its will but it may move around only as an avatar in a virtual game. On the contrary, 3PP is the objective and rational perspective of the conscious mind; it works as an external witness of the constrained activity of 1PP. Obviously, while reacting in response to a stimulus, the subject is on the 1PP side of the conscious mind; thus, she/he cannot accept the idea that FW might be an illusion; paradoxically, the false belief in FW is the necessary condition of the mind to get the best cognition and behavior. In conclusion, we have investigated these mechanisms of human cognition and behaviour in over 20-years of work; in the meanwhile, we have elaborated "The Bignetti Model", a human cognitive model compatible with these results.

Keywords

The Bignetti Model; Free-will illusion; Consciousness; Personal identity (PI); Action-decision mechanism; Voluntary action; Probabilistic-deterministic brain; Trials-and-errors strategy; Cause-and-effect law.

INTRODUCTION

The mind earns great efficiency in cognitive processes and behavior due to the extensive lateralization of brain functions and synaptic plasticity. These mechanisms are maximized in the brain of higher animals in which the stable long-term memory (LTM) archive is upgraded with newer and newer knowledge and skills utilizing experience-based associative learning. However, the mechanism of making experience in the mind was elusive for a long time. This review will report the noteworthy neuroscientific

issues that, in over twenty years of work, have led to the definition of a human cognitive model, namely "The Bignetti Model" (Appendix).¹⁻¹⁷

About 20-years-ago, the existence of a domain where the cognitive faculties could operate (called "consciousness" or "global workspace")¹⁸ was a controversial theoretical issue.¹⁹ During that historical context, the analysis of learning curves obtained in different experimental setups (e.g. classic or operant conditioning), demonstrated that any action decision always depended on prior

experience. These results draw a veil over the conviction that an individual may “choose” a reaction in response to a perturbing stimulus, according to his free-will (FW).^{2,4,20} Moreover, every single step of motoric or psychic action is caused by a self-oriented gradient of attraction or repulsion towards a target; the nature of this psychological energy remains unknown.

Then, we posed crucial questions: “*May we scientifically describe the meaning of a perception (“Qualia”) in the mind? Secondly, who is the “driver” of our reaction in response to the perceptions; thirdly, who is in charge either of motivating the reaction with a reward or a punishment and of moving, accordingly with their influence?*” These questions had to do with the famous Chalmers’ statement on consciousness, i.e.: “*The Hard Problem of Consciousness*”.^{21,22} In other words, these questions were suggested by the evidence that mechanisms leading to the “so-called voluntary” actions against a perturbing stimulus are still obscure to neuroscience. Many religions, philosophers, etc., tried to define the psychic domain responsible for the action-decision mechanism with different epithets (e.g. the central processing unit (CPU), personal identity (PI), self-consciousness, the driver of the car, the soul-inhabited self, etc.). These epithets were all names tentatively evoked to give a scientific, objective definition of a conscious mind exhibiting voluntary actions. Dennett introduced the concept of “The driver of the car” and discussed the emptiness of these epithets.²³⁻²⁷ In this regard, one should note that all these definitions of the conscious mind are self-posed by the consciousness itself. So, that’s why “*The Problem of Consciousness Is Hard*”! The attempt to give a scientific, objective (conceptual) definition of consciousness is impeded by an unsurmountable conflict of interest.^{13,16}

Somebody hoped to find a way to overcome this obstacle, by investigating the “*neural correlates to consciousness*” (NCCs); but, NCCs investigation unveils only physiological, operational (functional) properties of the mind. In this regard, the hypothesis that FW might be only a mind’s illusion was growing²; so, a concrete, independent binomial ego-FW (or soul-inhabited self possessing FW) did not exist.⁵⁻⁷ Then, the following question was whether there is a replacement function that might control cognition and behavior. In response to it, we finally proposed that a false (virtual) ego-FW binomial in place of the real one, may be installed in the toddler’s mind, for the rest of his life. We were convinced that this virtual ego-FW might emerge by chance as a genetic character in the mind.¹⁷ Since this character activates a self-oriented autopoietic computational mechanism that may guarantee survival and resilience to humans, it has been indefinitely determined by natural selection, in analogy with the evolutionary theories of Darwin and Wallace. In conclusion, we elaborated a cognitive model: “The Bignetti Model” (Appendix), based on the idea that our mind might be functionally considered as a dual-state of the mind: Unconscious mind (UM) and conscious mind (CM), both cooperating in cognitive processes. On the one hand, the UM computational mechanism should elaborate the reactions against the stimuli by imitating the paradigms of past experiences or by adopting a trial-and-error strategy. On the other hand, the CM computational activity of CM can observe only a-posteriori the effects of the action; then, deluding to having freely decided that action, it rewards or blames itself depending on the action outcome. The success

of this experience is uploaded on the LTM archive. The upgraded knowledge in the memory archive will favour the UM computational mechanism in the future.

In this regard, two general comments can be made:

1. The arousal of a virtual ego-FW cannot be a conscious trick of the mind; conversely, it is our conscious mind that is entrapped in its physiological limits. Due to these limits, we have the suspicion we cannot escape from them.¹⁵⁻¹⁷ When moving within the borders of this game, we do not even realize we are constrained by them, so we delude to control our actions according to the freedom of the will.¹³⁻¹⁶ Conversely, by observing ourselves moving like in an animal laboratory, we may realize that we are the prey of our illusions and destined to move in a virtual game. The objective perspective of us in the game is intriguing; it is like an external witness observing our actions from outside; so, we (as witnesses of the action) cannot free ourselves (as subjects of it) from the game constraints.² PI develops with experience, time after time; so, new information uploading into LTM memory archive might function as a stable epigenetic modification of the individual PI. In this respect, one should note that, according to the Bignetti Model (TBM), an individual is only indirectly responsible for his so-called “voluntary” actions; UM decisions are taken on the basis of the information memorized in LTM; so, we might say that the responsibility of an individual action depends on the experiences accumulated up to that precise moment. In other words, the epigenetic modification of PI may play a crucial role in moral behavior.

In summary, this introduction has highlighted the main issues that lead us to propose TBM (Appendix). Below, these issues are singly and more deeply argued.

THE DUAL STATE OF THE MIND

In TBM we evaluated the possibility that different perspectives of the real could coexist in the same mind. As a matter of fact, we found in the literature that the mind may resonate between two functional states: UM and CM.²⁸ So, we analyzed their different functions: UM’s language is based on biophysical-biochemical signals, while CM’s language is a mother’s tongue-based inner speech by which one could formulate thoughts, comment on images, understand music, or imagine dreams. Moreover, it was interesting to note that UM and CM are two functional states of the same mind, i.e.: 1) they are not two anatomically, separated minds; 2) they cooperate for cognition; 3) They have nothing to share with psychoanalysis.^{2,13-15} The most intriguing aspect of this story is that CM may activate two different perspectives: 3rd-person- and a 1st-person-perspective (3PP and 1PP, respectively). 3PP can objectively witness the situation of 1PP and realizes that the subject is a prisoner of a virtual game; while, the necessary FW to break the chains is an illusion of 1PP.^{7,16,17}

The striking evidence was that a subject (1PP) of a “so-called voluntary” action in response to a perturbing stimulus, thinks to choose the correct paradigm at will. However, this is an illusion since the action is decided and performed only by a virtual ego-FW; so, the success of the action effect seems to occur by chance.

This paradox opened the door to an enormous work on the role of FW illusion in the action-decision mechanism.^{2,7,16,17} Then, our work in cognitive sciences started from this consideration: “At the beginning of our life, the LTM archive is void, like a Tabula-Rasa. So, initially, the reaction in response to an unknown stimulus is truly aleatory; then, the decisions stand on a trial-and-error strategy, somehow in analogy with the act of throwing the dice or trying to determine the sex of an unborn baby. However, as soon as the mind is growing and the LTM archive is upgraded with newer and newer pieces of information, the action paradigm will be tuned up, thus giving better and better results. This action amelioration will be statistically favored by a sort of copy-and-paste mechanism in which all the pieces of information of the past experiences will become useful for the present action. Now, assume that, after many repetitions, one has finally understood the nature of a stimulus and the correct paradigm to react against it; then, his next reaction to the same stimulus will become “automatic”, i.e. the result of a “conditional will”. In this case, the entire action will be performed bypassing the time-consuming intellectualization.¹⁵ In this regard, many examples can be taken from sports; in tennis, for instance, the goal of all the exhausting exercises a player must undergo is to self-habituate to fast and instinctive drives.⁸

The question now is: “Does FW exist? If not, we should justify how FW illusion and not FW may play a crucial role in cognitive processes”. The paradox is that people are convinced to freely decide and totally control their own actions, even though they believe in a virtual ego-FW binomial; these conditions recall a virtual game; though, the interesting evidence is that cognitive processes are successful. To give persuasive answers to all these questions and to come out of such a paradox, we travelled along with the theoretical and the experimental pathways, until we fine-tuned a fully compatible cognitive model: “The Bignetti Model” (Appendix). In synthesis, an individual will carry out a “so-called voluntary” reaction in response to an unknown perturbing stimulus, according to a trial-and-error strategy; then, using repetitive experiences, he will learn and memorize the correct reaction paradigm better and bett-

er, thus ameliorating the reaction efficacy. After tuning at best the learning mechanism the reactions will become automatic (Figure 1).^{9,10,12}

FREE-WILL

Free-Will Definition

Free-will is a lemma analyzed from many aspects by Oxford’s dictionary; however, the more comprehensive and folk definition that common people might share, recites: “*the power to make your own decisions about what to do, without being controlled by God, fate or circumstances*”.²⁹

To investigate what people think about the nature of consciousness and the existence of FW, we have carried out a specific survey. The data (not shown) on consciousness nature were highly scattered among many possibilities, e.g. soul, self, brain, etc.); instead, the data on FW were more clear: about 70% strongly believe in FW existence, of whom only x% might change their mind if they are convinced by science. Moreover, as to the question on FW definition, almost all will adhere to the folk definition reported to Stanford dictionary.

Free-Will and Libet’s Experiments

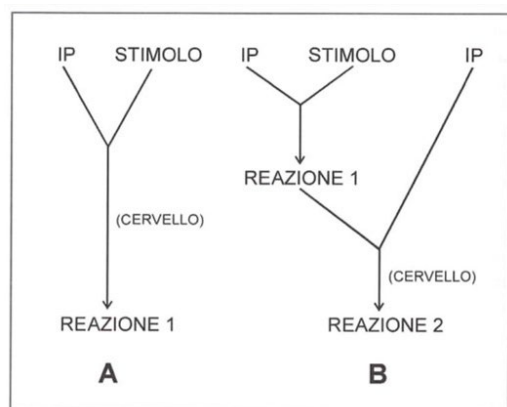
Libet’s^{30,31} studies on the timing of action decision-making and performance, showed the onset of early electrical activity in the brain, known as the “readiness potential” (RP), prior to the onset of conscious will. More recently, it has been shown that the outcome of a decision can be encoded in the brain activity of the prefrontal and parietal cortex up to 10 s before it enters our awareness. This delay presumably reflects the operation of a network of higher-level control areas that begin to prepare an upcoming decision long before it enters our awareness.³² This data is even more striking in the light of others’ research suggesting that the decision to move, and possibly the ability to halt that movement at the last second, maybe the result of unconscious processing.³³

Libet claims that since the subject’s decision is taken too early to be a conscious thought, there is still the opportunity to put a conscious veto thus stopping the action. We disagree with him first, because the probabilistic mind promoting the action is unconscious and cannot disagree with itself unless we consider the disagreement still part of the same “decisional” process. Second, the veto (actually, disapproval) could be conceived as a secondary action only after the subject has observed and evaluated the first action’s outcome.

Free-Will and the Individual Perspective

Searle is astonished that the problem of duality has not yet been resolved, and thus asks himself why we find the conviction of our own FW so difficult to abandon. He writes: “*the persistence of the traditional free-will problem in philosophy seems to be something of a scandal*”. Nevertheless, many thinkers have studied this issue and many papers have been written, but it appears that little progress has been made. Since FW illusion is a sort of unconscious error, a scientist

Figure 1. The Early Proposal of “The Bignetti Model”, Published in: “La Dissacrazione della Coscienza”. 2 IP Stands for PI, i.e. “Personal Identity”



A) Reazione-1 is based on the hypothesis that the brain may decide the voluntary action according to the freedom of the will; B) TBM: the unconscious brain elaborates Reazione-1, while, in Reazione-2, the conscious brain is the ex-post witness of Reazione-1.

is unable to enter into a 'scientific' discussion about it with most people. This belief in FW in people's mind exists prior to another cognitive process that attempts to disprove it. So, any discussion on FW illusion even if carried out on a scientific ground, will be unable to change the prejudice against FW of most people. In this regard, it is interesting to note that people believe in FW when discussing about their own actions; conversely, they consider others' actions the result of deterministic forces, as if the actions were conditioned by a strict interdependence between stimuli (causes) and reactions (effects).^{34,35}

Free-Will and Quantum Physics

Quantum physics claims that a subject that pretends to measure an object is altering it so that reality is the subject's object. Moreover, according to the indeterminacy law, one cannot predict an object's location in a Newtonian space by measuring the speed and vice-versa. On this basis, some authors have inferred that FW is intrinsically real since a deterministic correlation between a voluntary intention and the action outcome is nullified by intrinsic indeterminism.³⁶ Sometimes quantum scientists claimed that sub-microscopic world-scale natural processes are not determined due to the indeterminacy law; for extension, it was inferred that FW might exist so that we cannot predict the future.

Our rebuttal stands on several issues. At first, a very prosaic rebuttal is that the definition of FW on the basis of the indeterminacy law cannot be immediately understood by people; it is too sophisticated and has nothing to share with the folk FW definition given above. Second, even though sub-microscopic events do occur in the biophysical world that underlies mental processes, the mental processes (thoughts) concern macroscopic events governed by logic, so people are totally unaware of the indeterminacy effect on the sub-microscopic world and don't care about it; they are rather motivated by a cause-effect relationship. Third, the mechanism that manages biophysical signals and moves them in electrochemical fields, e.g. the phase mainly corresponding to ACTION, obeys rules imposed by classic physics; while those functions that explicitly manage ideas and judge situations on the base of a critical sense, e.g. mainly COGNITION phase, emerge from the collapse of a Quantum-Self with the incoming biophysical information of the ACTION phase. The target of a cognitive process is to obtain an expected outcome from the voluntary action; this expectation is built up on the base of a cause-effect relationship, a linear way of thinking typical of classic physics; without believing in this relationship, a learning-through experience could never occur. Many hypotheses based on Quantum mechanics have been proposed to explain consciousness. These efforts have risen strong criticism since, in many cases, they use the term Quantum somehow far from the "classic" Quantum mechanics; moreover, most of these theories shouldn't be taken as scientifically proven. Quantum mechanical phenomena such as entanglement, decoherence, or wave function collapse are proposed to occur during the interaction and measurements of a conscious mind with the environment.³⁷ The information circulating in the brain is based on a biophysical-biochemical language whose rate is in the range typical of biological events, i.e. much slower than light speed. With regard to the entanglement effect, it is intuitive that

both external stimuli and psychic reactions to them belong to the same macroscopic world, i.e. to biological events whose sub-microscopic quantum events have to be integrated within a larger scale to become macroscopically measurable. In other terms, since outer stimuli cause inner intentions which, in turn, cause reliable individual actions, the sub-microscopic indeterminacy law does not impair the macroscopic information processing. Concluding the cause-effect relationship on which our thinking process stands, is safe.

Free-Will and Action Decision Mechanism

The action decision-making is conditioned by the prior stimulus and the best expectation of action-outcome depends only on a cause-effect relationship. The coherent and rational finality of a reaction of the individual against a stimulus is to remove it or self-adaptate to its presence. This situation recalls the chemical equilibria and the way they respond to external perturbations according to Lechatellier's principle. In analogy with the reactions of chemical systems against a stimulus perturbing their thermodynamic equilibrium, our action decision-making is always "conditioned"; so, we must logically conclude we are never free: reactions move back and forth along pre-established kinetic and thermodynamic coordinates.

At the beginning of our life, our brain is a "tabula rasa"; we have no past experience in our memory, no action paradigm to imitate. So, at the very beginning of our life, we must decide our reactions against unknown stimuli on the basis of the trial-and-error mechanism. Experience after experience, a huge amount of information will stratify in memory, thus, ameliorating the action decision mechanism. Evidently, the process is a statistically-based, post-adapting mechanism in which only conditional-FW and not FW can take part. (Alternatively, in order to feel really free, we might decide our actions at random, by throwing dice which will be obvious nonsense).

Yet, the paradox is that we believe in our FW ("free from causes") although conditioned by the stimulus, by the situation, etc... Now the crucial question is: *"How may we decide and control a so-called 'voluntary' action in the absence of FW? Perhaps by rigid determinism, by true indeterminism, or by a sort of compromise, namely a probabilistic-deterministic mechanism?"* The question reminds us of the paradox of Buridan's ass placed in between two sacks of hay. We have discussed several times the issue on many occasions (e.g.: the 4th Intl. Conf. of "non-linear Science", March 15th-17th, 2010, Palermo, Italy⁵; the International Conference on: "Integrated Psychiatry and Clinical Psychology" December 3rd and 4th, 2012, Sarojini Naidu Medical College, Agra, Uttar Pradesh, India³⁸; International Conference on "Neuroscience and Psychiatry", November 8th and 9th, 2021, Vienna, Austria³⁹). The ass is motivated to eat the hay but neither of the two sacks is more attractive than the other; so, there is not an external stimulus indicating which sacks to start with. Then, this decision must arise within its mind. However, an ass with either a hard deterministic or true Indeterministic brain will never elaborate a choice. Conversely, a probabilistic-deterministic mind might elaborate the necessary choice thus eating the two sacks one after the other. The degree of attraction towards either sack fluctuates.

tuates, until the probability to move toward one of the two sacks is so high that is transduced into a deterministic, coherent choice. Then, a probabilistic-deterministic brain^{3-5,40} will guarantee survival.^{3,14}

Adaptation and resilience behavior seems to depend on “metastability” in the brain, i.e. a phenomenon studied in computational neuroscience to elucidate how the brain recognizes patterns. From a thermodynamic point of view, the energy state of the Buridan’s ass before the two sacks, is at first raised to an intermediate energy state (i.e. it is ready to eat); at second, when by chance the brain is only slightly pushed towards either one of the two sack, then, thermodynamic will deterministically push it to eat the most probable sack. So, the brain will settle back into its energetic hollow (satiety) (something similar has been described in metastable electronic devices).

Free-Will, Cause-Effect Law, and Reincarnation

This proposal cannot be accepted by religious people, especially by those who consider FW as a gift given to challenge man’s faith in God. Recently, Subhendu⁴¹ proposed the bizarre thesis that the human belief in FW can be conciliated with the deterministic cause-effect law by framing cognitive processes within the soul theory. According to the author, human behavior is under the control of two forces (action and reaction) as explained by Newton’s third law; however, even if meaningful, this contribution is not enough; the model should further intervene by introducing the “Reincarnation” which according to the soul theory is a global source of memory that anyone can see at any time. In conclusion, there are always two root causes for everything, and an ever-existent, amazing result effect. Simply speaking, this is a consequence of reincarnation. We may criticize many aspects of this theory: 1) According to Subhendu,⁴¹ action and reaction in Newton’s 3rd-law

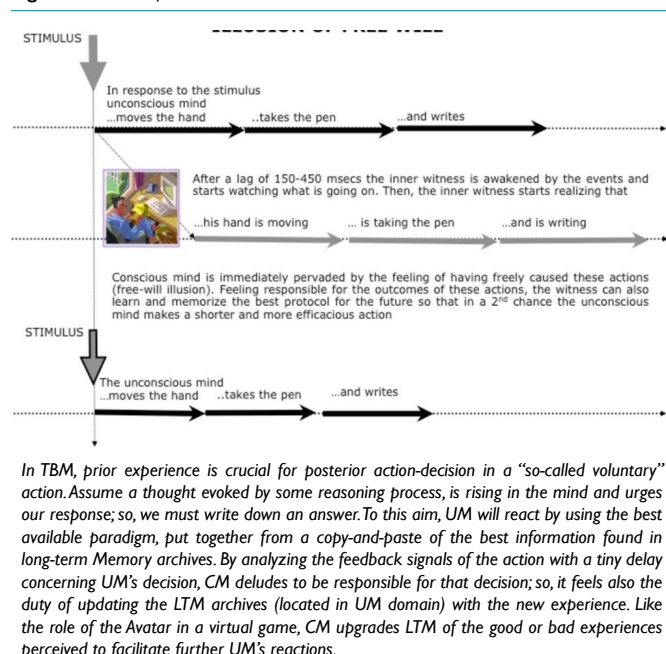
counter balance each other; however, this hypothesis will immobilize the system. The mind is a probabilistic-deterministic (statistical) system and from the initial stimulation to the final reaction, many different energy forms are engaged; the transduction from one energy form to the other will cause a thermodynamic energy dissipation; 2) Moreover, the mind will always move towards a specific aim or effect, along a field of attracting forces. The gradient of attraction “motivates” the so-called reaction of the mind towards a reduction of Gibbs free energy; 3) Soul theory and reincarnation is acceptable only for people believing in a Soul-inhabited Self. But how can those people demonstrate it? Actually, we have estimated the existence of about 7000 different sacred books; as a matter of fact, each one of these books pretends to report directly the God’s voice; but which one is saying the truth? That’s why each religion is discriminating against the others (Figure 2).¹⁵

THE LEARNING CURVE AND THE ACTION-DECISION MAKING IN THE PRESENCE OF A VIRTUAL EGO-FREE WILL

Some authors demonstrated that subjects, who are allowed to simulate a decision task, learn from their experience, so that decision making improves with repetition. When people do not have any summary description of the possible action outcomes or their likelihood, people can call only on their own encounters with such prospects, making decisions from experience.⁴² We, too, have carried out “press-no-press” psychophysical experiments with volunteers (no money but sincere gratitude was the reward for their openness to help scientific research), whose results showed a shortening of RTs with trials’ repetition; the output of the experiment is indicative of a progressive subjects’ learning of the task paradigm with the experience. Let us note that this kind of function has been firstly described by Ebbinghaus⁴³ and, then, officially termed the “learning curve” by others.⁴⁴⁻⁴⁶

In other words, the higher the probability of encountering the same stimulus, the higher is the probability that the agent may upgrade his baggage of knowledge towards a deterministically efficient answer.^{47,48} Note that a similar Bayesian learning model can be found in Jovanovic et al⁴⁹ with success; the authors said that “As experience accumulates, one makes better decisions” and “With each repetition of the activity, one grows more informed and the decision gets better and better; hence the model generates a learning curve”. The Bayesian learning model seems to fit well a variety of learning curves; the proof that a learning process is progressively increased up to a maximal level comes from the evidence that the ratio between prior and posterior probabilities tends to 1. We have carried out a series of “press-no-press” psychophysical experiments on mental information processing. The data were successfully interpolated either by using the formalism of enzyme kinetics, carried out in steady-state conditions (“Michaelis and Menten” kinetic conditions) and by applying Bayes’ theoretical equations; in both cases, the analysis confirmed that mental information processing is based on a statistical mechanism.^{9,11} This evidence was not such a surprise for us since the mind must retrace, at a macroscopic level the probabilistic-deterministic behavior shown by the microscopic-submicroscopic constituents of the brain.^{2,3,7,8,50}

Figure 2. Illusion of Free Will



In conclusion, likewise, the macroscopic pressure of an ideal gas in Newtonian conditions, must correspond to the mean energy distribution of all its molecules, so, the learning curve can be macroscopically predicted by a mathematical function that should contemplate the mean energy distribution of that information processing at a microscopic level of the brain; many are the examples of physical-chemical systems whose behavior can be interpreted in the same statistical way (e.g.: enzymes kinetics measured at Michaelis-and-Menten steady-state conditions; the final distribution of balls obtained in Dalton's machine; molecular osmotic pressure on biological membranes; etc.).^{2,3,13,14,16} Then, the specific laws that regulate the dynamics in these physical-chemical systems are only macroscopic descriptions that do not explain per se the mechanism at the molecular level. The causal nexus between the macroscopic description of system dynamics and its intrinsic mechanism can be revealed only by taking into account all the molecular motions and collisions at the microscopic level. So, the mathematical prediction of the behavior of a physical-chemical system, deterministically depends on the mean statistical distribution of energy of all the random processes at the microscopic-submicroscopic level. The feasibility of this statement is valid also within the biological systems; the mind-brain relationship is an example. Several experiments⁵⁰ demonstrated that the biophysical activity of neuronal circuits, as predicted by Hodgkin and Huxley, is the mean activity of many subcellular elements, each one working at random; among all the examples shown, single neurons in the visual cortex use Fourier transformation of many random responses to the same external object in order to integrate a correct image. Another striking experiment regards the generation and propagation of action potentials (AP) trains whose length and frequency both carry on specific information. The characteristics of AP trains depend on the mean open/close state of a huge amount of voltage-gated Na⁺-protein channels on the membrane that the AP wave is crossing. In other words, these channels randomly fluctuate between an open or a closed state but each one with its own kinetic; so, to find a channel in its open state is a random event but if we integrate the states of all the channels at a specific moment and in a specific position of the membrane, we get a deterministic result that will permit or not the propagation of AP. By modulating the number of channels involved (for instance by means of excitatory or inhibitory synaptic activity) we can modulate the result of the integral, i.e. we modulate the probabilistic-deterministic propagation of AP trains, changing as well the information carried out.

So that, all mind's abilities that underlie human behavior, e.g. the thinking activity, are correlated with a random activity of a handful of subcellular elements in the brain. One of the thinking activities we can mention is the learning process whose hyperbolic trend can be correlated with stimulus repetition/experience; such a macroscopic correlation is an example of the thinking process determined ex-post by collective microscopic elements working at random in the brain and not by a pre-meditated will (i.e. not by FW).

We have concluded just now that a thinking process cannot be freely decided a-priori; so, the interesting question now is: "How may the trend of the learning curve tend necessarily to ameliorate more

and more the reaction against a stimulus, though the thinking process is always using the same chaotic family of subcellular elements?"

THE BIGNETTI MODEL

Two are the main aspects of the mind/brain relationship that should be mentioned to explain the dynamics of a so-called voluntary action in response to a stimulus:

1. The mind functionally exhibits a dual state of the mind, one unconscious and the other conscious (UM and CM). UM can elaborate information (sensory and motoric) from the periphery to the center, back and forth, by using a biophysical-biochemical language. Instead, by using inner speech, CM builds up thoughts and evaluates images, music, and dreams. Then, UM carries out a so-called "voluntary" action on a statistical basis; instead, CM exhibits a critical sense by which it can analyze the action outcome and discriminate the positive experiences from the negative ones (CM can evaluate facts by assuming two opposite perspectives: the 1st-person, subjective, emotional, and self-oriented perspective (1PP) and the 3rd-person, objective and rational perspective (3PP). That's why they are evoked in different contexts and never at the same time, but cooperating for cognition and behavior, i.e. pointing to the same purpose (the example of "the phone call" is elsewhere reported).^{16,17} The two states can understand each other by translating the information from one language to the other, back and forth. The way these translations may occur is a true mystery; up to us, that it might be considered "the hard problem of the mind".
2. The crucial role of both states of the mind is to store memories that can be acquired throughout a long-life span. In particular, short-term memory (STM) and LTM acquisitions seem to be typical abilities of UM and CM, respectively. CM cannot scientifically and objectively define "consciousness" for the evident conflict of interest; CM can only define the physiological operative aspects of "consciousness"; to this aim, we can report an excellent definition of CM given by Halligan and Oakley: "Consciousness, as used here, refers to the private, subjective experience of being aware of our perceptions, thoughts, feelings, actions, memories (psychological contents) including the intimate experience of a unified self with the capacity to generate and control actions and psychological contents. This compelling, intuitive consciousness-centric account has, and continues to shape folk and scientific accounts of psychology and human behavior".⁵¹

So that, pieces of information can be accumulated in our brain since intrauterine life; during the toddler's life, we build up a PI with a specific "Sense of Ego" which is necessary to contextualize any external situation/object concerning our intrinsic nature/need. By this mechanism, we learn to manage all the basic instruments necessary to survive (spoon, knife, etc.). Along with adult life, knowledge and skill will be furtherly implemented, always with a Self-oriented motivation; in a way, the overall process recalls the mechanism of "autopoiesis" described by Maturana and Varela^{52,53} and by Bignetti.¹⁵⁻¹⁷ Our brain possesses about 1 billion neurons each with about 10000 connections; thanks to its complex structure, both computational activity and memory accumulation seem to be easy jobs for the dual-state of the mind.

Now, assume that a new stimulus should be perceived as a perturbing one by UM sensory fibers; UM would like to be spoon-fed to react to it, but in the memory stores there isn't any past experience that might suggest the correct action-paradigm. So, being the different hypotheses equally probable (i.e. with low probability), UM reaction will be aleatory. However, trial after trial, the CM can elaborate a statistical correlation between the prior experience and the posterior effect to attribute a degree of success to the present action. If the present experience has been positive, CM will update the paradigm in LTM archive; so, in case of the repetition of the stimulus, UM will find a more correct protocol.

One ultimate question must be solved: *"On which basis can CM decide the degree of success is increasing or not, trial after trial, so that it is worth updating LTM?"*. In classical or operant conditioning, various rewards or blames are administered respectively to motivate or not further actions. As regards, the case we proposed above, CM will realize the degree of success based on the extinction of the perturbing stimulus. the paradigm which CM has memorized as the most efficient one. The fewer hypotheses remain, the faster and the more instinctive will be UM's decision (improperly called "choice") and the least will be the need for an intellectualized decision through CM intervention.

THE BIGNETTI MODEL AND ETHICS

Kohlberg's model foresees the development of the individual moral reasoning from childhood to adulthood in three main levels, each with further sublevels.⁵⁴⁻⁵⁸ The three levels are Pre-conventional, Conventional, and post-conventional. In synthesis: the first one is especially common in children who adapt their behaviors to their parents' expectations (sometimes willingly and sometimes not); the concept of justice applied to ethics reduces to a simple mechanism: bodily/psychological rewards or punishments. At the second level, the main justice guidelines are respected by almost all families, adolescents and parents included; so far moral behavior assumes a great emotional impact. At the third level, in adulthood, people may assimilate the universal concept that justice is entrusted with the care of ethical issues; thus, human society depends on contractual conditions written on the basis of universal ethical imperative so that an objective, orderly, and efficient management of the overall society can be earned through shared moral reasoning. An interesting test demonstrated that the Self is highly engaged in extraordinary moral commitment. The test was carried out with moral exemplars (people that exhibited high-levels of moral commitment in their everyday behavior). What truly sets the exemplars apart from the 'ordinary' people was that the unity between self and moral goals was highlighted as the most important theme. It was discovered that the moral exemplars see their morality as a part of their sense of identity and sense of self, not as a conscious choice or chore.⁵⁹

In our opinion, this model primarily stands for the pre-conventional phase of development; we make it coincide with the toddler's phase, i.e. that phase during which the child is characterized by a self-oriented and autopoietic PI. In each brain, a genetically installed computational mechanism statistically elaborates all the experiences and then memorized one after the other

to implement PI (like the onion layers with nothing at the center). Obeying and sometimes disobeying parents or tutors trace the way of PI to the knowledge of the ethical bases favoring the sane PI development, of his "desiderata", and of the responsibilities of moral or immoral behavior, contextualized in everyday life (Piaget would call these individual cognitive reactions to new experiences as "accommodations or assimilations", a mechanism by which the mind enhances the understanding, thus building and rebuilding itself⁶⁰). According to TBM, PI is a bundle of thoughts by which we virtually conceptualize ourselves and distinguish ourselves from others. This virtual PI self-attribute FW, so that the toddler's age lays the foundation for any further cognitive development; then, our so-called "voluntary" actions absolutely depend on our virtual PI.

On the basis of TBM we have analyzed the relationship between morality and justice.^{7,16} The question is if our actions are decided and executed by the UM who then is legally liable? Gazzaniga argues that "personal responsibility is real"⁶¹ because it is the product of social rules established by people and *"is not to be found in the brain, any more than traffic can be understood by knowing about everything inside a car."* The accountability of ethical behavior stands on binomials, such as cause and effect, action and consequence, etc., which belong to a universal architectural principle similar to other information-processing systems (for example, the Internet). Moral rules enable social relationships to be organized on the basis of stable, predictable behavior in any context and time. Accountability of moral rules in social life provides the automatic brain with a self-protecting servo-mechanism, which may put a veto on decisions that may otherwise conflict with social rules. Although FW is an illusion, we are still responsible for our actions, and brain determinism has no relevance to personal responsibility in real life. To add weight to his arguments, Gazzaniga claims (in a review) that scientific advances in the study of brain mechanisms do not undermine the foundations of the action decision mechanism underlying moral responsibility; so it is time to get over the idea of FW and move on.⁶² From a different perspective, Dennett claims that the conclusion that FW does not exist, might mean "bad news".²⁷ The public generally. According to TBM, the conscious agent thinks he possesses FW, and this belief, though illusory, is a real and unavoidable part of the individual, thus, the importance of TBM lies in the fact that the first- and third-person perspectives of the role of the conscious agent in intentional action have the same dignity; they serve as tools to understand the mechanism of human cognition. In this mechanism, we do not lose sight of the fundamental role of FW illusion. In this perspective, the fundamental question is: *"Is the CM a sheaf of experiences collected and organized by some type of automatism in the brain, or is it the manifestation of a spirit?"* if duality does exist it is easier to discuss moral responsibility; however, there is an inherent contradiction in the belief in the automaticity of the brain in intentional actions (FW illusion) and the self-attribution of free responsibility in ethical decisions. Alternatively, we wonder if we can trust the intentions that determine personal and social behavior if we believe in TBM (see point 3). Conscious FW is invoked to attribute to an individual the responsibility of intentional action. A man can be liable by law only if his actions have been performed with conscious intentions (mens rea).⁶³ According to TBM, FW is not real (at least from the third-person perspective)

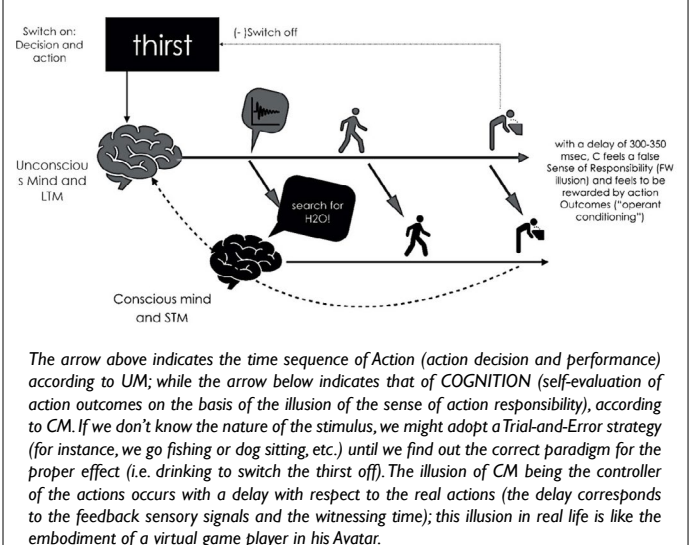
and thus, the obvious inference is that without FW, we would not have a sense of morality. However, as we perceive SoA and SoR as real, this feeling makes us responsible for determining our moral rules and our compliance with the law.⁶⁴ We know from psychology and cognitive neurosciences that moral judgment and intentional behaviour are the results of emotions, affects, and rational reasoning ability.⁶⁵ TBM suggests that decision-making and behavior are the predictable responses to a stimulus chosen from a collection of individual memories sorted by the unconscious mind. The model explains how people falsely believe that they grow up freely and autonomously albeit with cultural restrictions imposed by society and the affective and empathic relationships that develop between them and their environment. Since FW illusion is a sort of unconscious error, one is unable to enter into a 'scientific' discussion about it. This belief in FW exists prior to other cognitive processes that attempt to disprove it, and thus, TBM will be unable to change the opinion of any individual. However, because laws are acceptable only if their 'meaning' is understood, we can argue that 'education and scholarship' will remain the root of civilization.

Analyzing our theory, we can see that action outcomes and incentives, such as blame and reward, are essential for the conscious mind to learn correct actions. For actions with ethical implications, we may consider the motivational incentives of guilt. Feeling guilty may or may not determine an affective state by which one learns how an ethical action should be performed in the future. Moral rules, which are essential for our collective survival, are therefore the product of natural selection. Through socialization, children learn the rules and standards of behavior that are impressed on their memory. This collection of memories could function as a reference library to be utilized by the individual unconscious mind for future actions (point 1 in TBM). Obsessive-compulsive disorder, perpetuated by guilt symptoms that are not easily dispelled, was described by Freud⁶⁶ as the result of a complex struggle of "Ego" against threats from the external world (nature and society), the instinctive demands of "ID" and the critical and moralizing demands of "Super-ego". A malignant super-ego might also be the result of too lenient parenting. Thus, formal education together with familiar and social environments are essential for the imprinting of these moral values (see the issue of the epigenetic effects on PI development, as discussed in Introduction).^{7,14,16}

Even if FW illusion stands on scientific bases, it raises a crucial question in ethics, i.e. the one relative to the definition of "fault" and "guilt" and the moral implications in law. Actually, sane people are considered responsible for their voluntary actions and, for that, they are judged by the law. In case we reject this principle, and say that UM and not CM is responsible for any sort of "crime", we shouldn't anymore punish the criminals; obviously, this conclusion might appear unbelievable to the eyes of those people that are still fully conditioned by the idea that FW exists. In the past,^{7,13} we have discussed this problem, thus proposing that individuals dangerous both per-se and to the community, should be necessarily isolated but not in common jails like the ones our society is used to. In fact, criminals should be put in jails not to be punished, but rather to be psychologically and socially recovered. According to TBM, we should remember that the more the LTM

of a subject will be enriched with new valuable experiences and values, the higher the probability that his UM might "decide" correctly and adequate actions per-se and for the community, in the future. In conclusion, the solution is quite simple from the technical point of view but it is not simple at all if we consider that moral rules, which are essential for our collective survival, are the product of natural selection; so, not only moral rules should be involved in a worldwide change but also our everyday way of thinking should be turned inside-out like a glove. Until people understand the scientific reasons for eliminating jails as they are today, the pretentious ambition to make jails places of cultural, psychological, and social recovery will remain ignored (Figure 3).¹⁴⁻¹⁶

Figure 3. TBM: The Dynamics of a So-Called Voluntary Action in Response to a Perturbing Stimulus (for example thirst)



CONCLUSION

As we have seen, people approach the real from two opposite perspectives: a self-oriented, emotional 1PP and a self-detached, rational 3PP, respectively. 1PP is exclusively activated in action-decision making with egocentric motivation, i.e. when people delude themselves into controlling their actions by FW; conversely, 3PP is activated when people are observing and commenting on others' actions. In this case, 3PP may conclude that FW is an illusion of 1PP. So, the difference between what CM is subjectively thinking of the real world, during a so-called voluntary action, and what CM is objectively thinking of the same world when witnessing CM at work, is striking.

As a matter of fact, we have observed in various popular conferences that the non-scientific audience, will always remonstrate with the lecturer, as soon as he claims that FW is an illusion of the mind; people's reaction plausibly arises from a psychological fear of losing FW, since it is considered a sort of anti-panic handle in life, i.e. an irreplaceable tool for controlling life; that's why the idea of possessing it is deeply rooted in CM's 1PP. Then, we questioned when and how such a strong feeling might arise in the

mind; probably, during the toddler age, the virtual Ego-FW binomial with the innate propensity to cognitive mansions (i.e. with autopoietic motivations), self-installs in the mind, following genetic instructions. Paradoxically, this virtual binomial play a winning role in cognition. TBM is the only model that may justify cognition and behavior processes, under the “control” of a virtual Ego-FW.

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APPENDIX

“The Bignetti Model” is made of five compulsory steps:

ACTION

- 1) The so-called “voluntary” action is decided and performed by the agent’s unconscious mind (UM) in response to a stimulus. To this aim, the reaction paradigm that might have the best probability of success is retrieved by UM among those that are encoded in a long-term memory store.
- 2) After a slight delay, the agent becomes aware of the ongoing action through feedback sensory signals conveyed to the brain, as a consequence of action performance. Thus, CM (1PP) always lags behind UM activity.

COGNITION

- 3) Owing to this delay, CM (1PP) erroneously believes to have freely decided UM action. Though objectively false, this belief is perceived as true, due to FW illusion. It is so persistent and deep-rooted in the mind that CM (1PP) is unwilling to abandon it.
- 4) The FW illusion satisfies a psychological need to secure the arousal of the Senses of Agency (SoA) and Responsibility (SoR) of the action. Both senses inevitably lead CM (1PP) to act involuntarily as the Avatar of UM.
- 5) CM (1PP) self-attributes either reward or blame depending on the action outcome. Both reward and blame are motivational incentives that foster learning and memory processes; the updating of long-term memory (LTM) will be useful for further UM action (restart from 1).

As one can notice, only hundreds of milliseconds later than ACTION, i.e. after feedback sensory signals of UM action, the arousal of CM’s 1PP is triggered. This delay is necessary to resume complete information of the action, from the stimulus (that caused that reaction) to the response to it (that determined a consequent effect). Contrary to UM which is a mere executor, CM’s 1PP deludes to be the actor moving in the scene, like an Avatar in a virtual game.¹⁷ Believing to be responsible for action outcomes, it self-attributes reward or blame. This is the crucial step that triggers the learning process that leads to updating LTM. This final step is fundamental for UM which will adjust the paradigm of future actions.